No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR RAMA IV MARKET CONSTRUCTION
IN
BANGKOK
THE KINGDOM OF THAILAND

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BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR RAMA IV VIADUCT CONSTRUCTION
IN
BANGKOK

THE KINGDOM OF THAILAND

DECEMBER 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

国際協力事業団
20303

P R E F A C E

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

The team exchanged views with the officials concerned of the Government of Thailand and conducted a field survey in Bangkok. After the team returned to Japan, further studies were made. Then a mission was sent to Bangkok in order to discuss the draft report and the present report has been prepared.

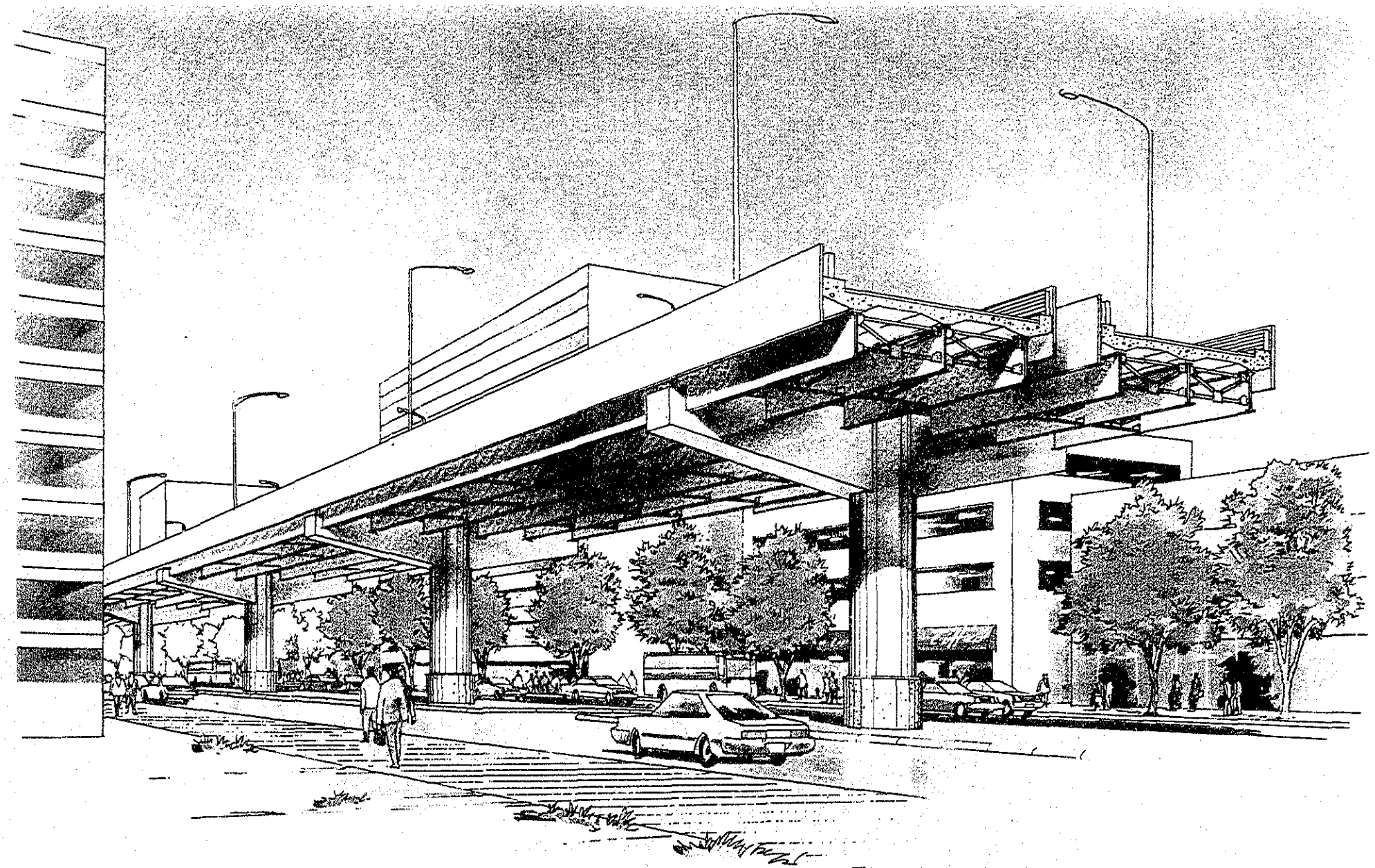
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

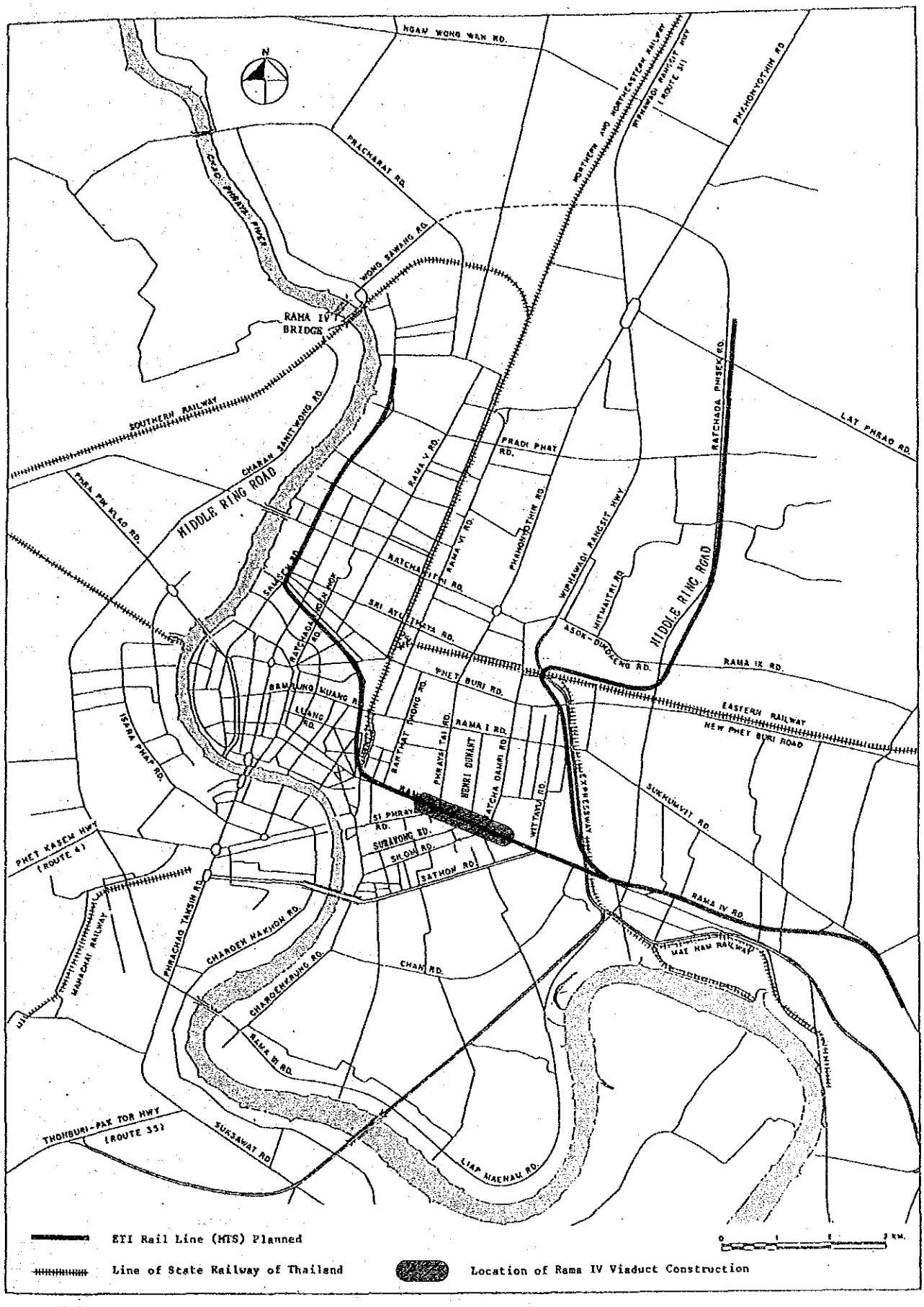
December, 1989

Kensuke Yanagiya

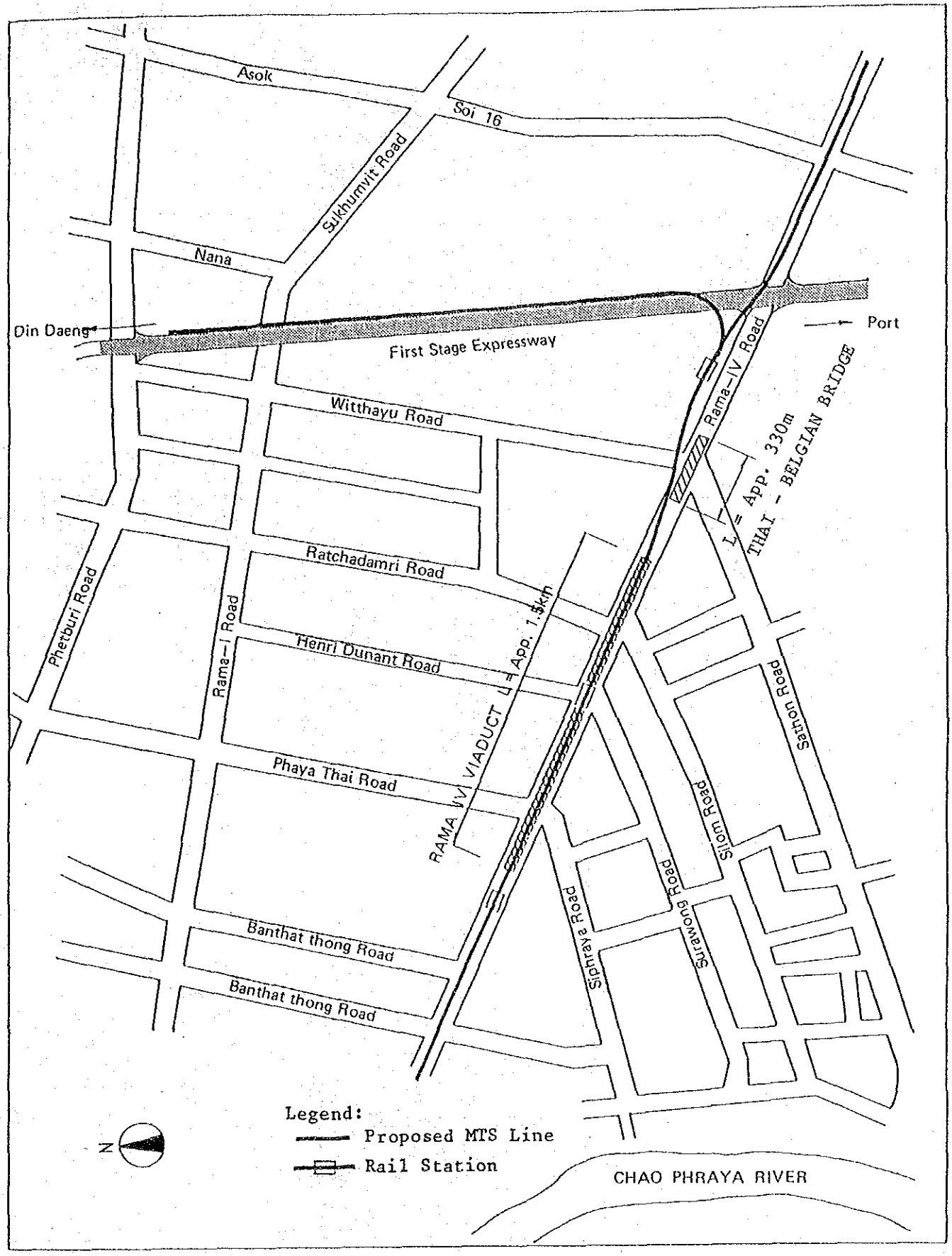
Kensuke Yanagiya
President
Japan International Cooperation Agency



PERSPECTIVE SKETCH OF RAMA IV VIADUCT COMPONENT

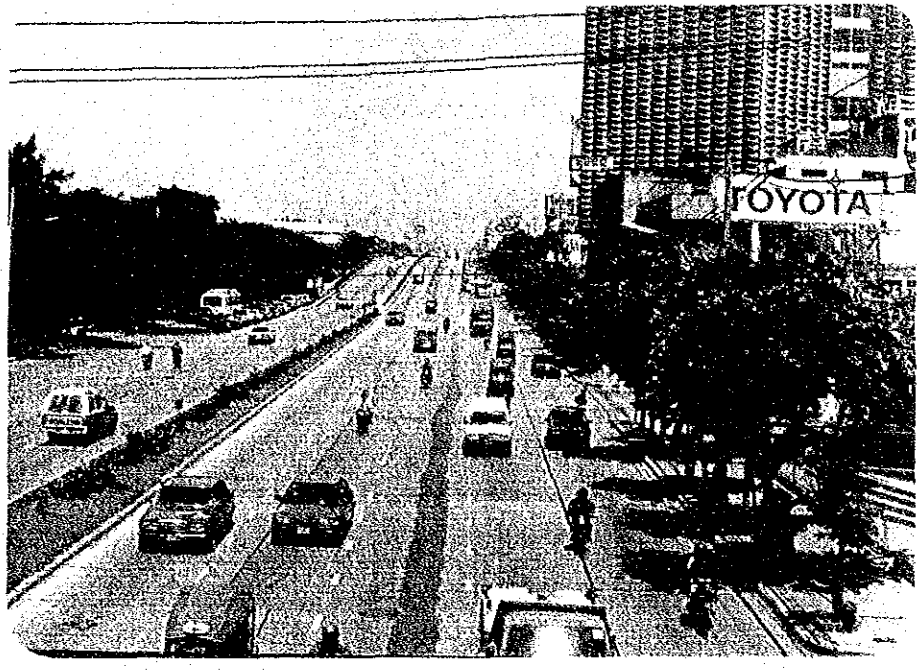


Map of Project Area

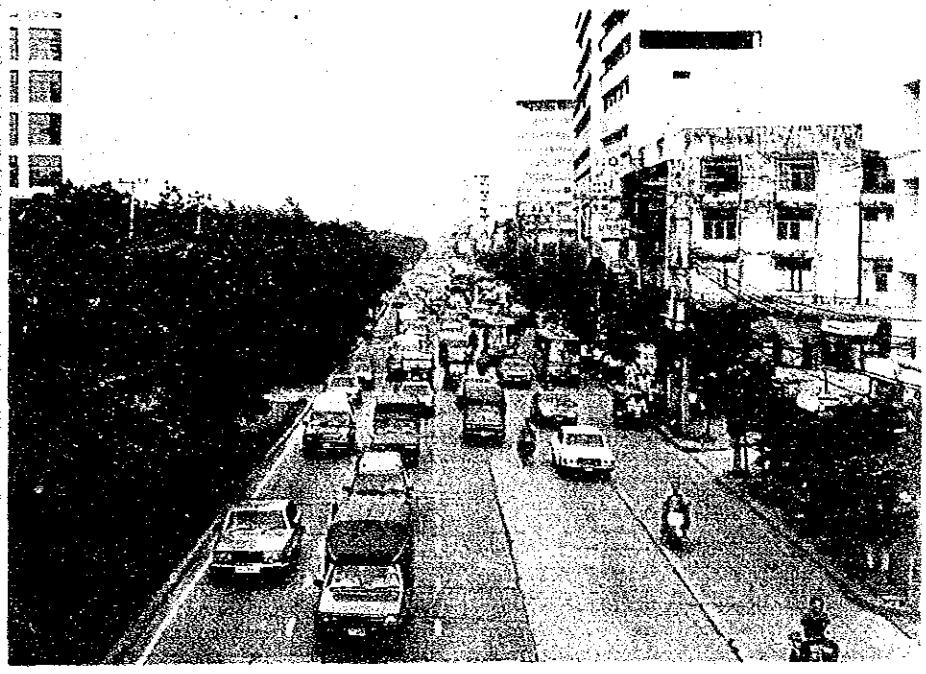


Map of Project Site

View of Thai-Belgian Bridge and Rama IV Road



Traffic on Rama IV Road (west-bound) and Roadside Development near Intersection with Surawong Road

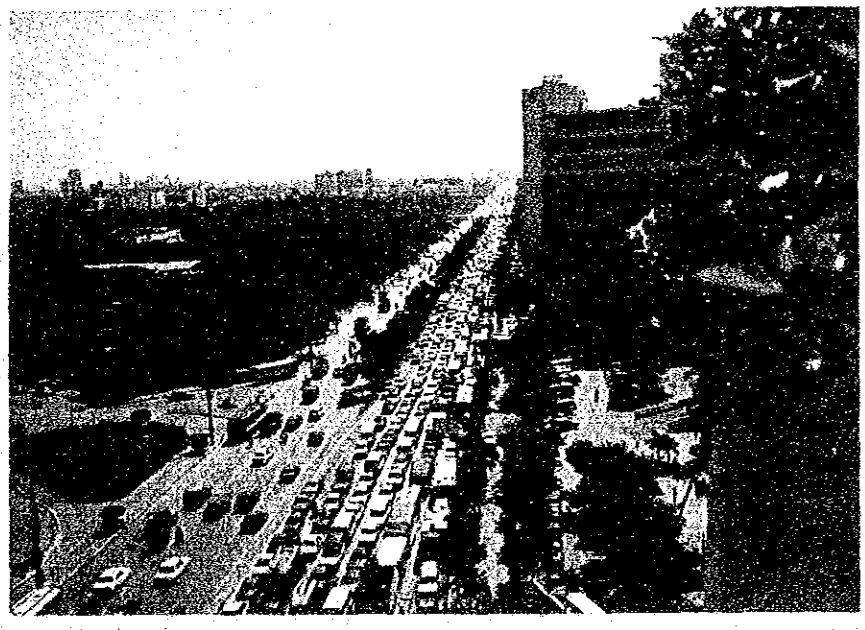


Traffic on Rama IV Road (east-bound) and Roadside Development near Intersection with Siphraya Road

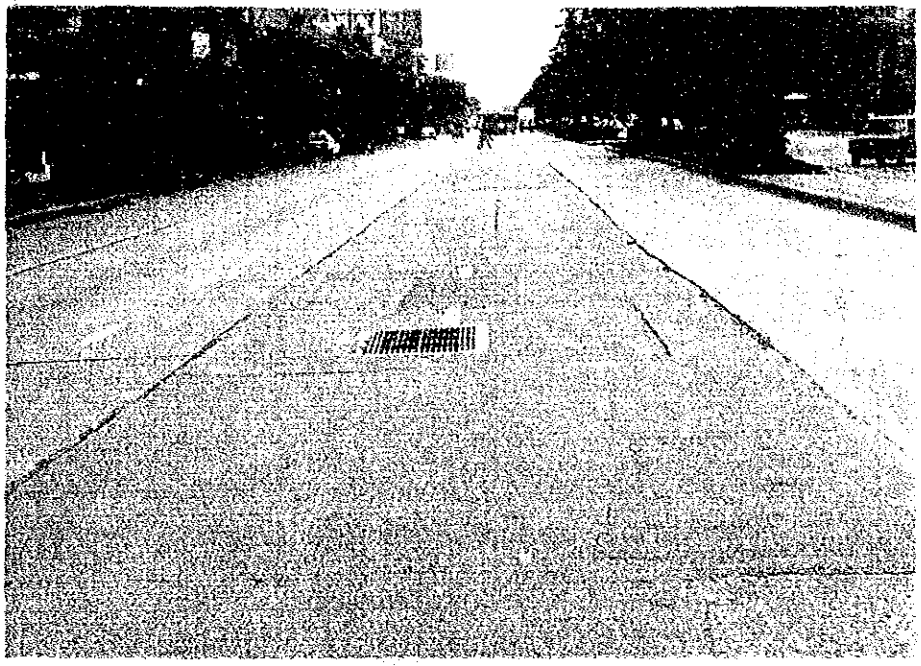
Rama IV Road (east-bound) in front of Chulalonkorn University

Rama IV Road (east-bound) in front of Hospital

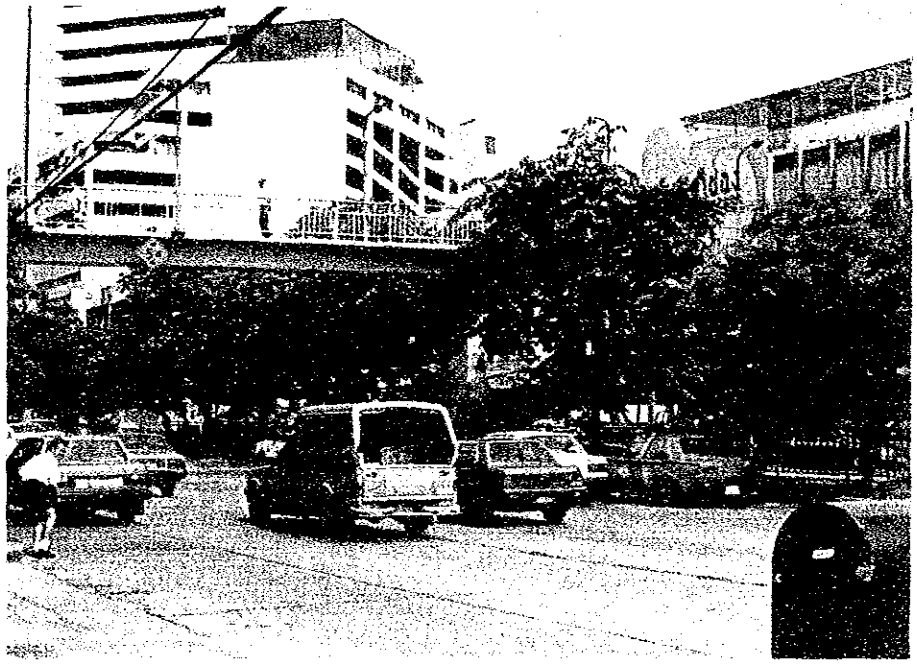
Silom Road Viewed from Rama IV Road



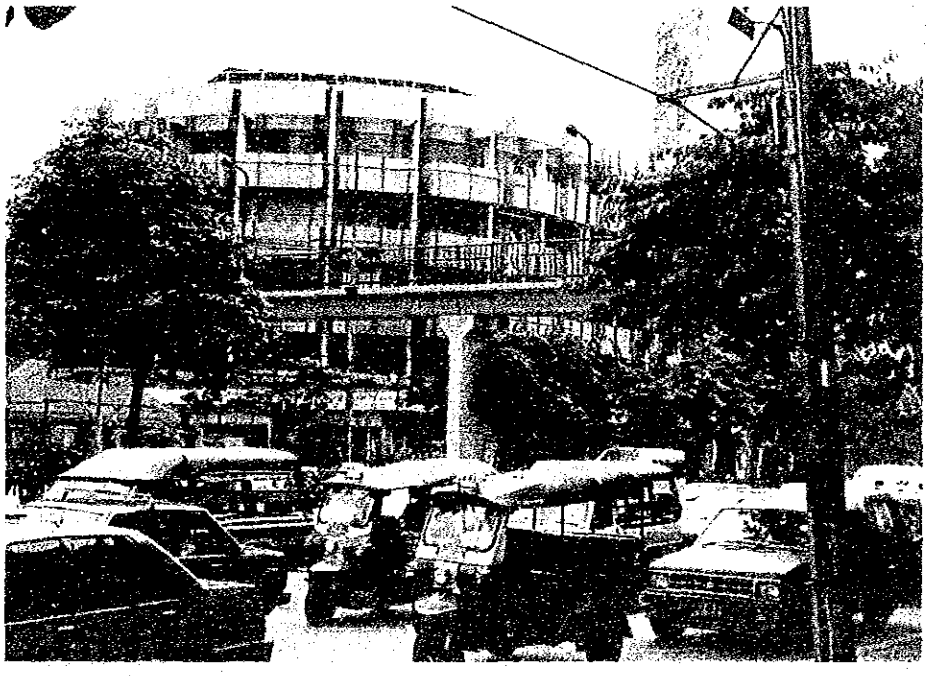
Inlet and Grating Cover of Box Culvert Drainage under Rama IV Road



Pedestrian Crossing Bridge (to be removed) between Silom Road and Surawong Road



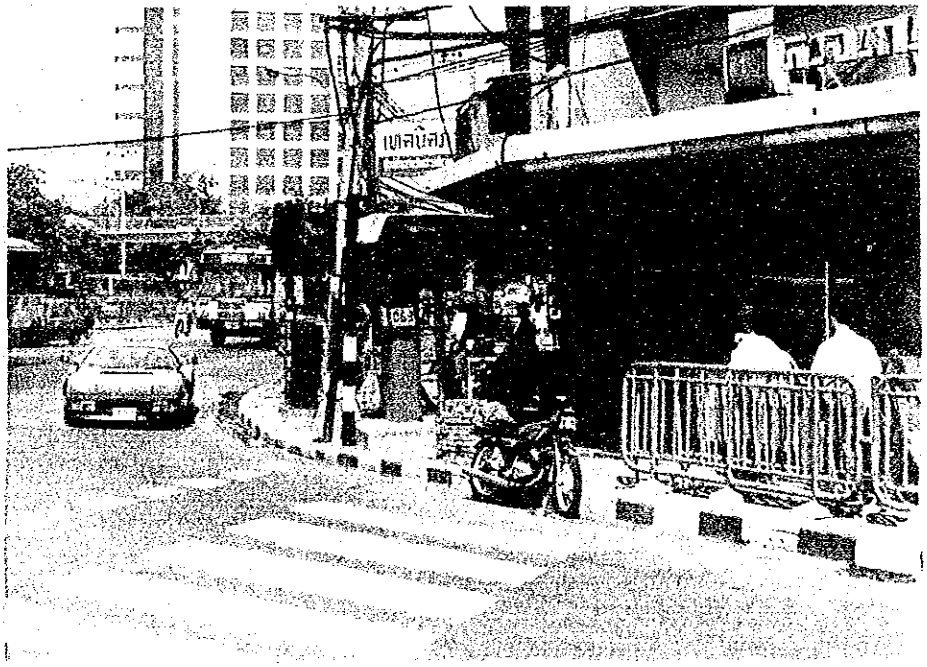
Pedestrian Crossing Bridge (to be removed) West of Siphraya Road



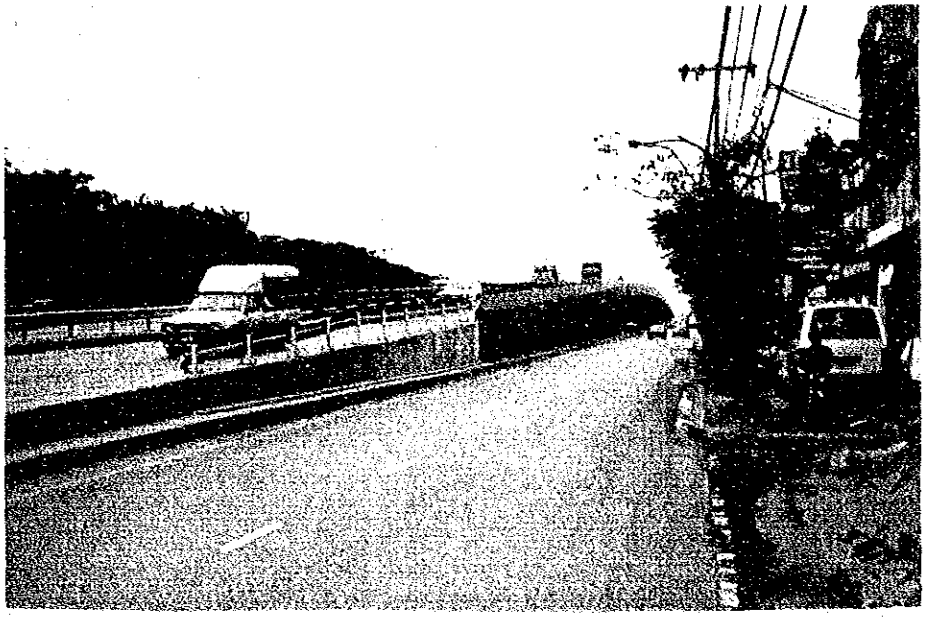
Rama IV Road (west-bound) by Lumpini Park Carriageway and Roadside

Rama IV Road (west-bound) Carriageway and Roadside

Traffic Signal Controlling Device at Intersection with Surawong Road

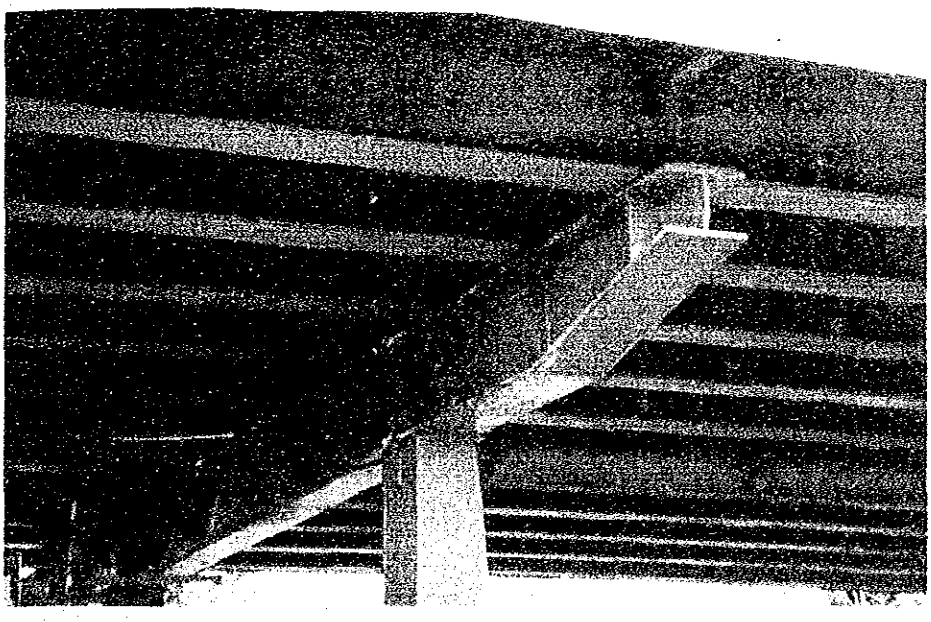


Thai-Belgian Bridge over Intersection of Rama IV Road and Sathon Road

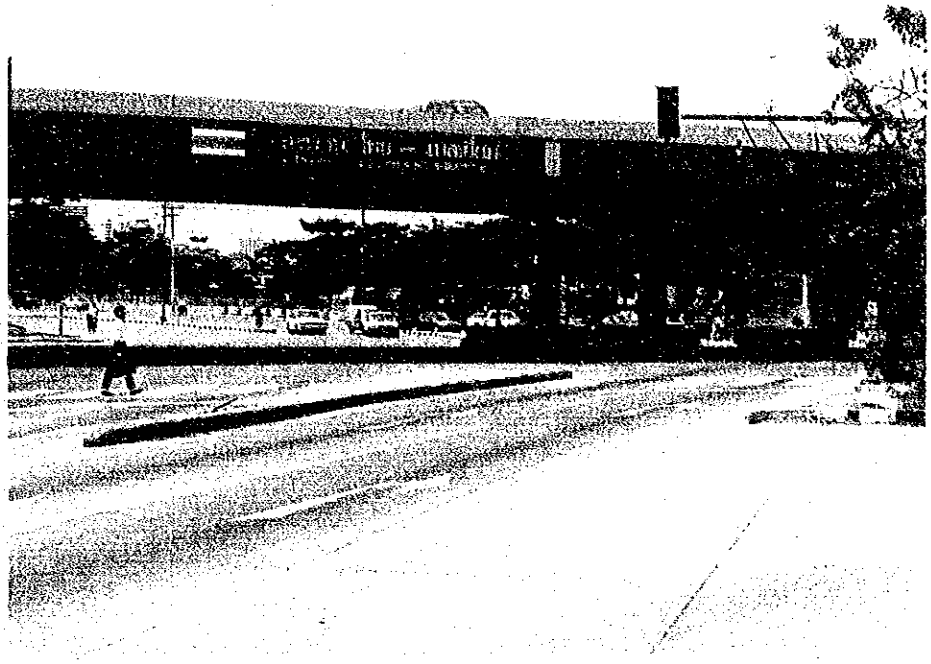


Surface of Thai-Belgian Bridge near Abutment

Thai-Belgian Bridge: Steel Girders and Steel Pier Column



Thai-Belgian Bridge:
Pier Column within
Intersection



Thai-Belgian Bridge:
Centre Pier Column
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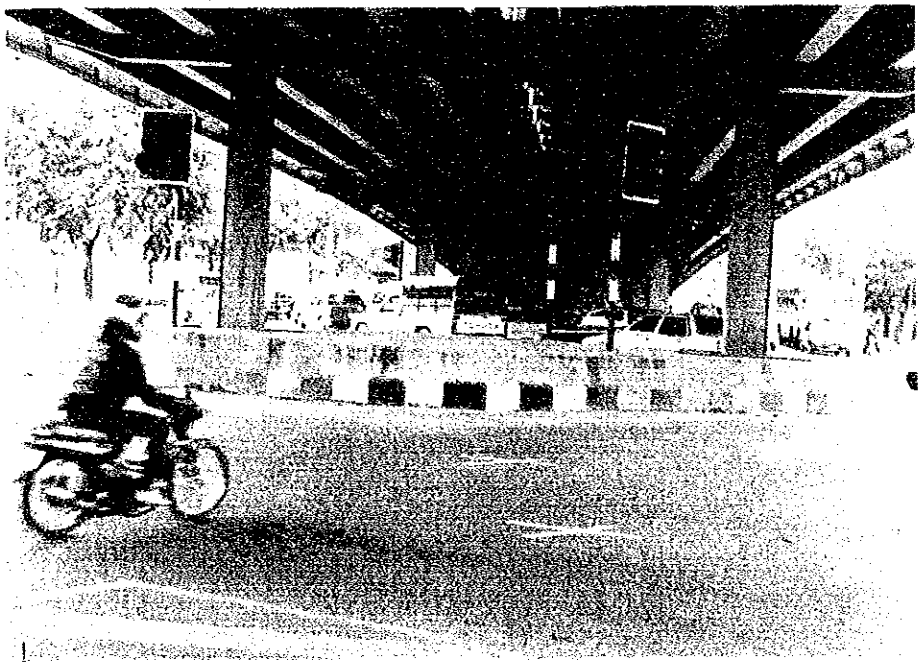
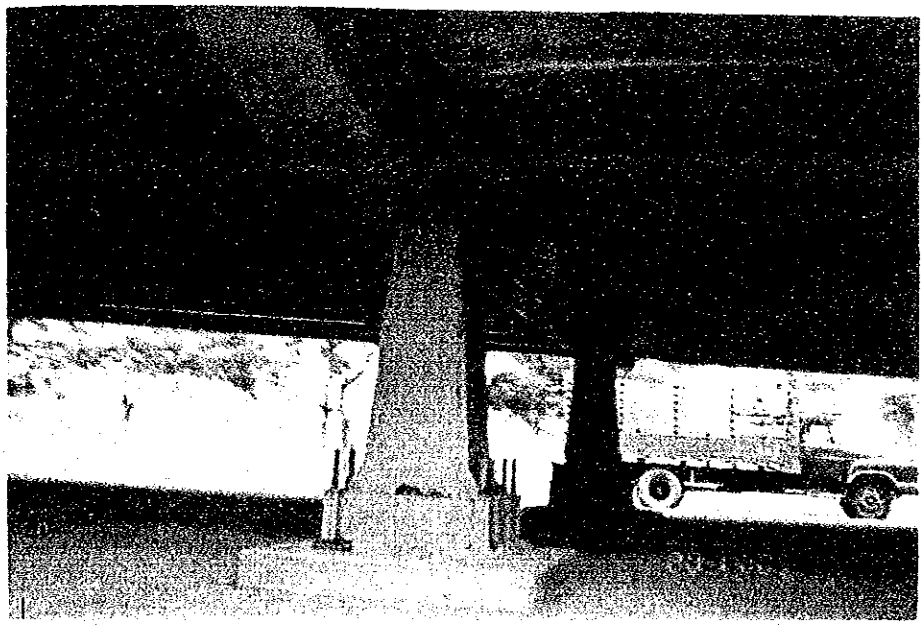


Thai-Belgian Bridge:
Anchor Bolts of
Pier Column



Asok Flyover:
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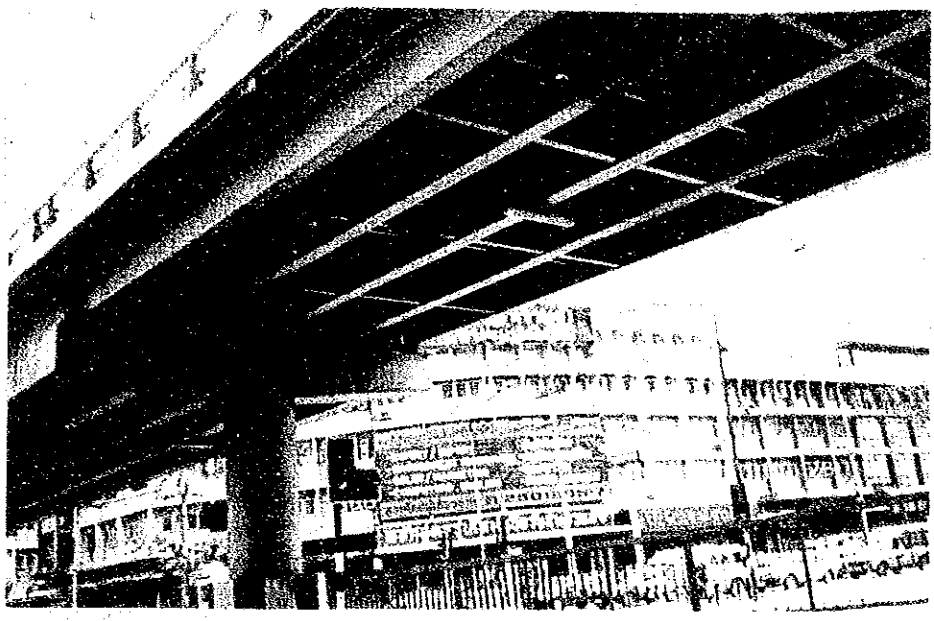

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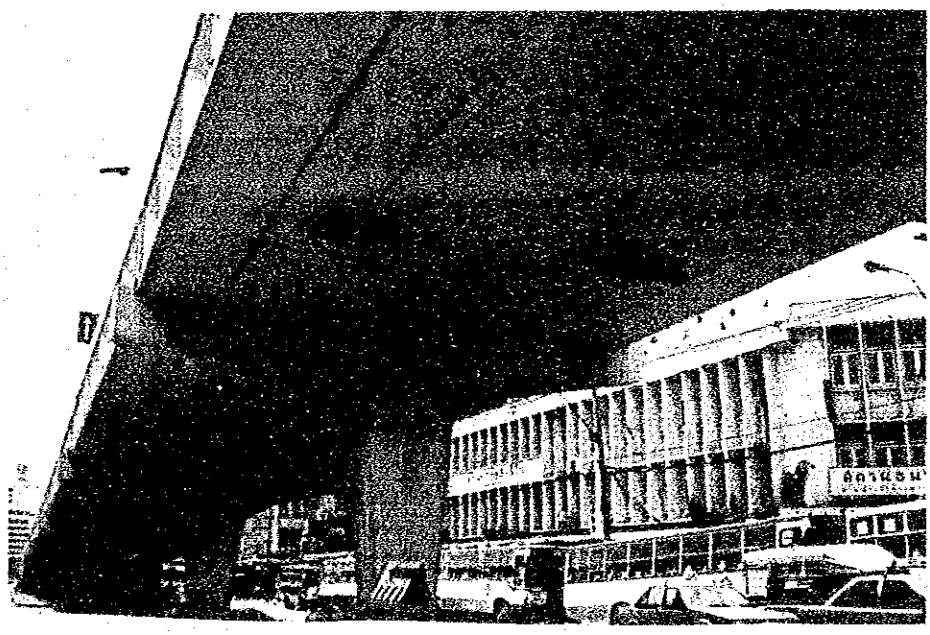

Rama IX Bridge:
Pavement Repair on
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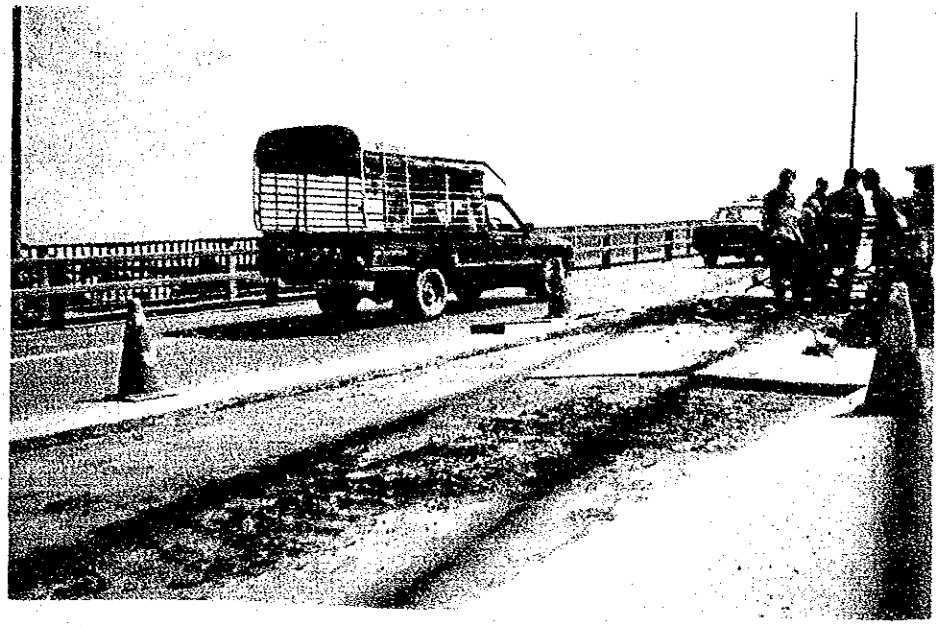
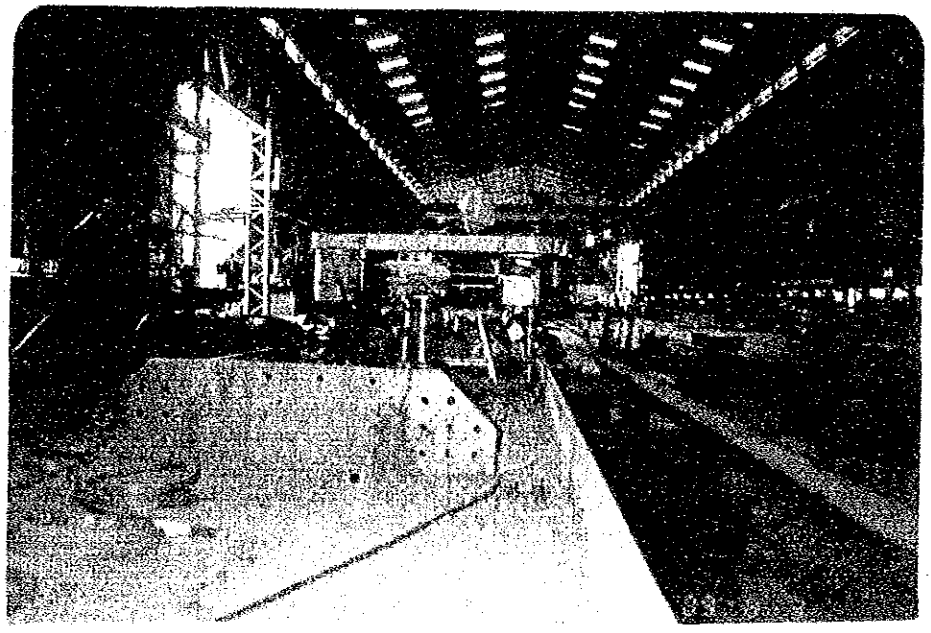


Inside Factory of
Local Fabricator



Inside Factory of
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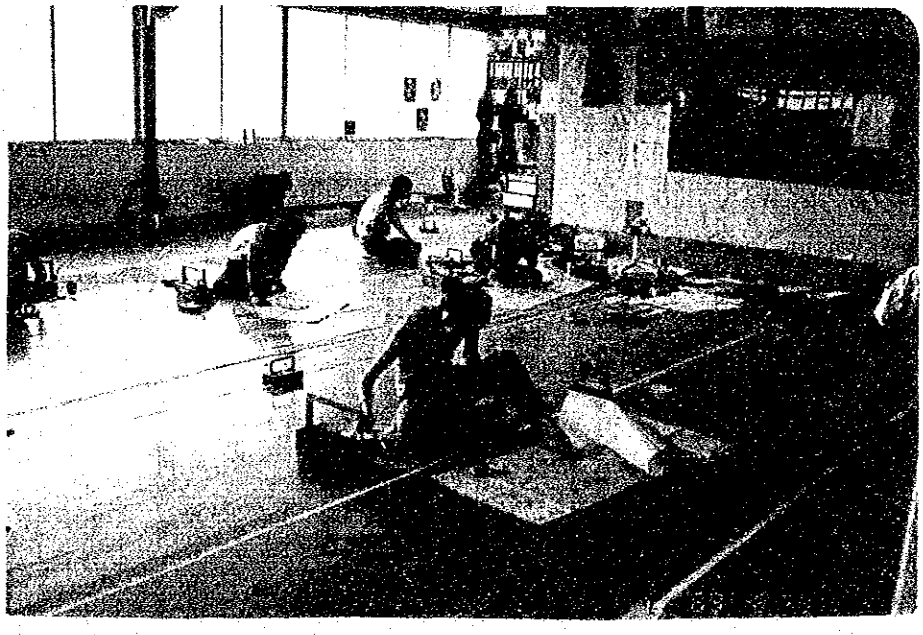


SUMMARY

S U M M A R Y

The recent intensive economic development in Thailand has concentrated on the Bangkok region, and the population of Thailand has increased at an annual rate of 2.44% between 1970 and 1988, whilst that of the Bangkok has a growth rate of 3.31% in the same period. As Thailand witnessed an economic upturn due to the influx of investments and good export performance, the rate of GDP of the Bangkok area to that of the whole country is steadily increasing, and its annual growth rate is nearly double that of the Kingdom. The main transportation means in the Bangkok metropolitan area are roads, and with the recent social economic development the traffic demand in the city has greatly increased.

Rama IV Road on which the project site lies is a 10-lane dual carriageway arterial road. It has an approximate 5.5km length and directly links the Bangkok Port to the core-centre of Bangkok City having intersections with major roads which run in a north-south direction. On its northern side lie Chulalongkorn University and its hospital, Lumpini Park, etc. and the southern side constitutes the most important commercial area including prominent business, hotel, shopping and restaurant quarters of Bangkok.

Rama IV Road, which is a wide road of 10 lanes, is always congested with traffic because of the short distances between intersections. A record shows that the present traffic volume of Rama IV Road amounts to 100,000 - 140,000 vehicles (including motor cycles) per day and 6,300 - 8,400 vehicles per peak hour. The traffic on the intersecting roads, Sathon, Wittayu, Henri Dunant and Phaya Thai is also heavy with a volume of 40,000 - 90,000 vehicles per day, and the traffic congestion is very serious; the average traveling time at peak hours is 12 km/hour; the length of queuing vehicles is 500 - 600m; and the waiting time for signals at each intersection ranges from 3 to 12 minutes.

In response to a request from the Government of Thailand, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of economic and technical cooperation program of the Government of Japan conducted the "Study on Road Improvement,

Rehabilitation and Traffic Safety in Bangkok" in the period June 1985 to March 1987. The main objectives of the study were to provide the Thai Government with engineering expertise and information necessary to the planning of road and pavement improvement and traffic safety measure, based on the findings and studies for the network of a total length of 350km within the area encircled by the Middle Ring Road. The study revealed that a major part of bottlenecks of traffic in road system of Bangkok occurs at intersections, and that improvement of intersections would be an effective alternative to maximize the use of existing road systems, and proposed for improvement of eleven (11) intersections. Among the above-mentioned intersection improvements, grade separation of four intersections: Sathon, Silom, Surawong and Siphraya is included. Especially the last three should be crossed by a continuous flyover (viaduct) to suit the configuration of closely-spaced intersections. The report of the above-mentioned JICA Study presented such high returns as with cost-benefit ratio: 2.64 and internal rate of return: 23.3% in its economic analysis (in a 10 year period) of the Project including the construction of the flyover across Sathon Intersection, and it concluded that among the 11 intersection improvements mentioned above the grade separation of Rama IV Road gives the largest effects of all in terms of both engineering and economic aspects.

In April 1988, the Sathon intersection was grade-separated by the provision of a flyover (Thai - Belgian Bridge) donated by the Belgian Government. Although the traffic condition around the Sathon intersection has been improved, the traffic on the portion of Rama IV Road intersected with the remaining three major intersections has not been benefited by the flyover. Considering the importance of Rama IV Road, the Government of Thailand has requested the Government of Japan for the construction of a continuous flyover over the three intersections on a Grant Aid Assistance. In response to the request of the Government of Thailand, the Government of Japan sent, through the Japan International Cooperation Agency, a Project Formulation Survey Team to Bangkok from March 26 to April 4, 1989 to confirm and examine the request of the Thai Government as appropriate and valid for the Grant Aid Programme of the Japanese Government. The contents of the request of the Thai Government are as follows:

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

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

(3) The location of the Project is from the intersection of Siphraya Road to that of Silom Road along Rama IV Road.

(4) Outline of Project:

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

(5) The Thai Side has understood Japan's grand aid system.

(6) The Government of Thailand will take necessary measures on condition that the grant aid by the Government of Japan is extended to the Project.

Based upon the request of the Government of Thailand, the Government of Japan decided to conduct a basic design study on the "Project for Rama IV Viaduct Construction", and JICA sent to Thailand a study team from July 19 to August 17, 1989. The study team had discussions on the Project with the officials concerned of the Government of Thailand and carried out the following field surveys with cooperation of officers from the Thai Government:

(1) Study of the project site and conduct of topographic survey and traffic survey;

(2) Study of the traffic management and control in the project site during construction;

(3) Study of cost estimation and local constructional conditions necessary for the preparation of construction schedule and related regulations and laws with local construction practices, etc.;

(4) Study of the construction plan and execution system for this Project;

(5) Study of undertakings by the Thai Government and his implementation system;

(6) Study of the bridge maintenance system and capability of the Thai Government;

(7) Study of the validity of the Project and the effects arising from the implementation of the Project; etc.

The result of the field survey by the study team is briefed as follows:

The traffic along the Project is predominantly great on Rama IV Road which serves one of the greatest traffic flows in Bangkok. Accordingly careful precautions will be required for the construction. 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, and between consultants and contractor. Full support and close cooperation must be extended between the four organizations.

Under the existing median of Rama IV Road three main water pipes are installed and in the south in parallel with it a box culvert drain (2.7 x 2.75m) is provided under the pavement. The Expressway and Rapid Transit Authority of Thailand (ETA) has planned a large scale skytrain system for eight years and one rail line is to be provided along the centre of Rama IV Road in the same way as this Project. ETA has requested for a 2.8m gap between the two viaduct structures, east-bound and west-bound to provide the pier columns of the skytrain structure.

Check of the soils data obtained has revealed that the subsoil condition at the project site conforms to the general description of Bangkok subsoils and it is estimated that the depth of sand layer which is considered as the bearing stratum for the foundation is about 30 metres below the existing ground surface.

Several Thai contractors are found excellent in construction capabilities and there are some who have entered into joint-ventures with Japanese

construction companies. The field survey of the study team has revealed that among the construction materials cement, aggregates, reinforcing bar, ready-mixed concrete, concrete products, asphaltic material, rubber bearings, traffic signals and signs are all available in Thailand. However, the steel material for steel bridge must be brought from Japan because no such steel material is produced in Thailand and because the Project requires schedule procurement of steel in the same quality in large quantities. As for the processing of steel material, the steel in general use such as SS41 can be processed in Bangkok. However, in Thailand there have been no experiences in bending to a large diameter steel member and welding of high-strength steel material nor equipment therefor. Almost all construction machineries could be procured in Bangkok. For the transportation of construction materials and equipment from the Bangkok Port to the project site, goods having length: 20m, height: 3.5m, width: 4.0m and weight: 30 - 50 tons can be hauled if approval is obtained from the police.

The Government of Thailand has agreed to complete their undertakings, before the construction starts, such as displacement of existing public utilities installed underground, removal of existing road surface facilities (such as median, median strip fencing, channel islands, bus stops, traffic signs and signals, trees, etc.) all of which hinder the construction, provision of spaces for field fabrication site, office site and stockpile, and extension of water pipe, power cable and telephone cable to the boundary of the above-mentioned sites. The Metropolitan Waterworks Authority (MWA) has agreed to complete the displacement of the three main water pipes installed under the median of Rama IV Road before the construction starts. In addition to the above undertakings, the Government of Thailand will conduct road works such as collection of rainwater drainage, provision of panels for illumination of the viaduct, reinstatement of displaced road facilities mentioned above, pavement on intersections which are to be remodeled, and traffic control, etc. For the construction of the Rama IV viaduct BMA plans to organize the same or similar task force as for the construction of the Thai-Belgian Bridge which was completed in April 1988.

As mentioned, the executive agency of the Project is the Department of Public Works (DPW) under the Bangkok Metropolitan Administration (BMA), which is responsible for the construction and maintenance of the viaduct. The Bridge Maintenance Section under DPW has at present 3 engineers and 18 technicians for the maintenance of the existing concrete bridges in the Bangkok area, but none are familiar with the maintenance of steel bridges. Since DPW's budget for roads occupies more than 20% of the BMA total, it is considered that BMA can recruit some competent engineers for steel bridge maintenance.

Most of the span lengths of the Rama IV viaduct are 30m and the span over the intersections has a 50m length. The outline of the viaduct is as follows:

(1) Total length of viaduct structure: 1,487m

(2) Type

a. Superstructure : Steel orthotropic deck simple girder (span length: 50m): 8 spans in 2 ways

Precast concrete deck on simple steel girder (span length: 30m): 90 spans in 2 ways

b. Bridge pier : Single column T-shaped steel pier: 43 units

c. Foundation : Cast-in-place concrete pile, diameter 1,000mm, about 30m deep

(3) Standard effective width : 7.00m (2-lane carriageway) and 4.75m (one-lane carriageway)

(4) Load : 1.3 x AASHTO Load, Thai Truck Load

(5) Pavement : Asphalt pavement

(6) Design earthquake coefficient : Kh = 0.05

The viaduct consists of one lane in each direction for the section from the western end beyond the Siphraya intersection, two centre ramps having one lane in each direction come up between the two intersections, Siphraya and Surawong, joining the above-mentioned two lanes, giving four lanes in both directions. The four lanes of the viaduct overpass the intersections, Surawong and Silom and go down on Rama IV Road at the east end. In order to avoid the aggravation of traffic flow during the construction of the

viaduct, steel is suitable for both the superstructure and the pier of the viaduct, because steel is light in weight and adaptable for quick erection techniques, requiring a smaller work volume at the site. The steel for bridge pier columns and 50m-long orthotropic deck girders will be processed in Japan while that for anchor frames, pier brackets, 30m-long steel girders and other accessories processed in Thailand. For the foundation piles which support the structure, cast-in-place concrete piling will be used as construction noise and vibration are reduced which will reduce the impact on the adjacent environment.

It is estimated that seven months will pass after the Notes have been Exchanged for this Project between the Government of Thailand and the Government of Japan (E/N) until the commencement of the construction contract. This time is taken up by the conclusion of a contract for the Consultancy Services, the preparation of the detail design and tender documents, and the tendering and evaluation. After contractor's tender evaluation, the successful contractor will conclude his contract and start construction. The construction is estimated for completion in minimum of 18 months.

Estimated cost covered by the Government of Thailand is about ฿54.2 million for the above-mentioned undertakings and works.

By the implementation of the 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 peak 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 traffic accidents of these intersections with Rama IV Road will be reduced, with a proportional reduction in delays.

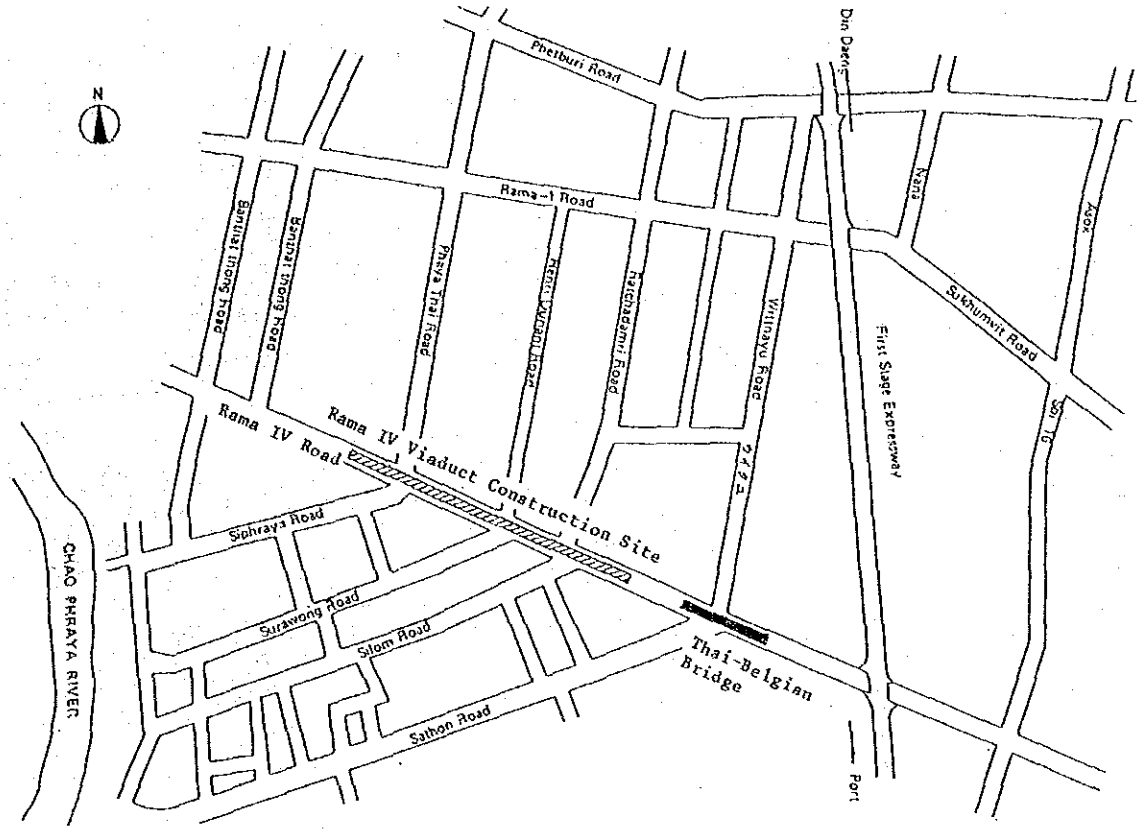
(4) From the matters mentioned in (1), (2) and (3) above, the national cost for vehicular transportation, fuel consumption and users' travelling time will be greatly reduced.

(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.

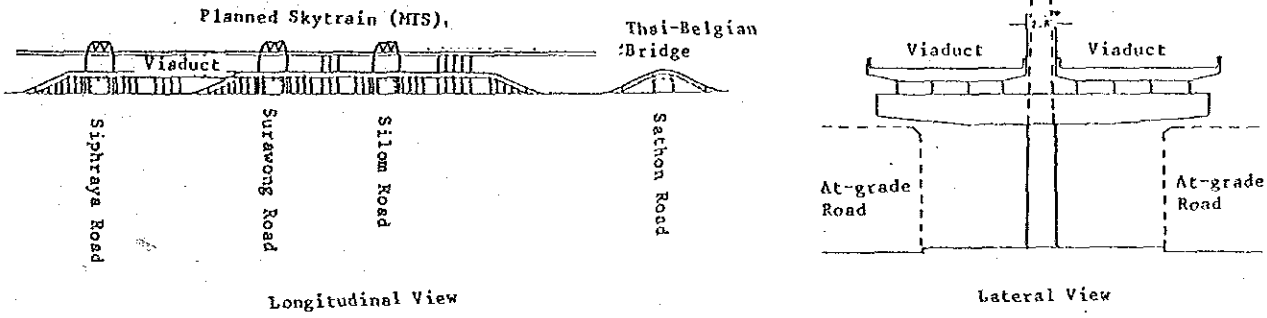
(6) Up to now it is dangerous for pedestrians to walk across Rama IV Road due to the heavy traffic. After the completion of the Project, however, the through traffic can run on the viaduct which will make crossing the road by pedestrians much easier.

(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.

In conclusion, the implementation of the Project under Japan's Grant Aid Programme is extremely meaningful and the early completion of the Project is highly recommended.



Roads Adjacent to Rama IV Viaduct Construction Site



Viaduct and Skytrain (MTS)

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ABBREVIATIONS

The following abbreviations have been generally used in the Report:-

AASHTO	:	American Association of State Highway and Transportation
BMA	:	Bangkok Metropolitan Administration
CAT	:	Communication Authority of Thailand
C&MD	:	Construction & Maintenance Division, DPW
DPW	:	Department of Public Works, BMA
DTEC	:	Department of Technical and Economic Cooperation
E/N	:	Exchange of Notes
ETA	:	Expressway and Rapid Transit Authority of Thailand
GDP	:	Gross Domestic Product
JICA	:	Japan International Cooperation Agency
JIS	:	Japan Industrial Standard
JSS	:	Japan Society of Steel Construction
MEA	:	Metropolitan Electricity Authority
MTS	:	Mass Transit System
MWA	:	Metropolitan Waterworks Authority
NESDB	:	National Economic and Social Development Board
ODA	:	Official Development Assistance
PC	:	Prestressed Concrete
PCU	:	Passenger Car Units
RC	:	Reinforced Concrete
RD.	:	Road
STA.	:	Station
TOT	:	Telephone Organization of Thailand

CHAPTER 1: INTRODUCTION

CHAPTER 1 INTRODUCTION

1-1 Objectives of the Study

The Bangkok Metropolitan area has been and will be the main focus of human activities in the Kingdom of Thailand, generating social and economic benefits that have important multiplier effects over the rest of the country. The greater opportunities for social and economic advancement has consequently led to rapid population increase and continuing expansion of the urban area of Bangkok.

In the Bangkok Metropolitan area the main transportation means both for passengers and goods are roads. In parallel with the rapid expansion of social and economic activities, the number of vehicles running on the major central business district and its fringe areas has increased, outpacing the development of road facilities. This has resulted in a serious road traffic problem in the form of traffic congestion and frequent occurrences of accidents.

To cope with this situation, the Government of the Kingdom of Thailand had requested the Government of Japan for technical assistance to conduct a study on road improvement, rehabilitation and traffic safety in Bangkok, and the Japan International Cooperation Agency (JICA) had conducted the said study for two years in 1985 and 1986. The study revealed that a major part of bottlenecks of traffic in road system of Bangkok occurs at intersections, and that improvement of intersections would be clearly an effective alternative to maximize the use of existing road systems. The study proposed for improvement of eleven (11) intersections. (See Fig. 2-1-5 and Table 2-1-2)

Rama IV Road is an important East-West corridor which links the Bangkok Port area and the inner-core of Bangkok for the approximate length of 5.5km. Four major intersections along this corridor, namely: Sathon, Silom, Surawong and Siphraya, are recommended to be grade-separated. Especially, the last three should be crossed by a continuous flyover (viaduct) to suit the configuration of closely-spaced intersections.

Considering the importance of Rama IV Road, the Government of Thailand has requested the Government of Japan for the construction of a continuous flyover over the three intersections on a Grant Aid Programme from Japan, to eliminate the main bottlenecks at the three intersections. JICA sent a Project Formulation Survey Team to Bangkok from March 26 to April 4, 1989 to confirm the request of the Thai Government and to examine the appropriateness and validity thereof as Japan's Grant Aid Programme. Based on the report of the Project Formulation Survey Team, the Government of Japan decided to conduct a basic design study on the "Project for Rama IV Viaduct Construction", and JICA sent to Bangkok the Basic Design Study Team from July 19 to August 17, 1989.

The objectives of this study are to confirm the contents of the Project requested by the Government of Thailand and assess the technical and economic viability of the Project under the Grant Aid Programme, and to make a basic design study for the Project.

1-2 Mission to Thailand

In response to the request of the Government of Thailand and based on the report of the Project Formulation Survey Team, the Government of Japan decided to conduct a basic design study on the Project as stated in Section 1-1. JICA sent to Thailand a study team headed by Mr. Kazuya Ohshima, Advisory Officer, Engineering Department, Hanshin Expressway Public Corporation from July 19 to August 17, 1989. Minutes of Discussions were agreed and signed.

After the team returned to Japan, assessment of the studies was made and a draft final report was prepared. A mission headed by Mr. Kazuya Ohshima was again sent to Bangkok for the explanation of this draft report from October 15 to October 22, 1989. The mission team exchanged Minutes of Discussions with Thai Government Officials.

1-3 Outline of the Study

The basic design study team had discussions on the Project with the officials concerned of the Government of Thailand and carried out the following field surveys with cooperation of officers from the Thai Government:

(1) Study of the project site and conduct of topographic survey and traffic survey;

(2) Study of the traffic management and control in the project site during construction;

(3) Study of cost estimation and local constructional conditions necessary for the preparation of construction schedule, and related regulations and laws with local construction practices, etc.;

(4) Study of the construction plan and execution system for this Project;

(5) Study of undertakings by the Thai Government and his implementation system;

(6) Study of the bridge maintenance system and capability of the Thai Government;

(7) Study of the validity of the Project, and the effect arising from the implementation of the Project; etc.

JICA reviewed the contents of the study carried out by the basic design study team, on the scale of the structure, construction period and cost, and then compiled the basic design study report (draft final report). The team submitted and explained the draft final report to the Government of the Kingdom of Thailand, and consequently the both representatives agreed basically on the contents of the study.

The present report has been prepared based on the above study results.