KINGDOM OF THAILAND

REPORT ON THE PRELIMINARY STUDY

OF

BANGKOK-THONBURI BRIDGE NO.2 PROJECT

OCT. 1968

OVERSEAS TECHNICAL COOPERATION AGENCY,

JAPAN

国際協力事業団
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Preface

Upon the request of the Government of Thailand, the Government of Japan agreed to send a survey mission to investigate the construction program of the Second Bangkok-Thonburi Bridge Project in view of the traffic congestion in Bangkok, Thailand, and entrusted the Overseas Technical Cooperation Agency with the task.

The Overseas Technical Cooperation Agency dispatched a team of four engineers from the end of March to beginning of May, 1968, to conduct investigations to estimate the future traffic in Thailand and to draft plans for the construction of the bridge from the economic and engineering point of view.

We wish to present a report on the results of the investigation and we hope that the report will contribute to solve the problem of traffic congestion in Thailand.

We wish to take this opportunity to express our gratitude for the cooperation of the authorities concerned in Thailand.

Overseas Technical Cooperation Agency

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October, 1968

Mr. Kanjana Hengsuvanich
Director General
Department of Public and Municipal Works,
Ministry of Interior, Thailand

Subject: Report on the preliminary study of the second Bangkok-Thonburi Bridge project.

Dear Sir:

We have the pleasure to submit you the report on our preliminary study summarizing the results of our study in Bangkok from March 30th to April 30th, 1968.

In this report we have recommended the bridge site and the structural type of the second Bangkok-Thonburi bridge and the related structure.

We hereby present our sincere appreciation for the great favor of the officials of your Department during our stay in Bangkok.

With our best regards to you,

Respectfully yours,

Mitsuo Nishino
Leader of Surveying Team

Hiroyuki Wada

Tohru Ida

Yutaka Yamaguchi
Japanese Experts Team of the
Second Bangkok-Thonburi Bridge

CONTENTS

Section 1. Selection of Site of the Second Bangkok-Thonburi Bridge, as Reviewed from the Standpoint of City Planning.

In Bangkok City, following two are the most serious problems to be solved immediately.

(a) Traffic congestion on the Memorial Bridge.

(b) Traffic congestion in the center of Bangkok, especially on the western sector of the Khlong Krung Kasem Road.

The possible direct solution to the problems above enumerated will be either widenning the Memorial Bridge, or constructing another new bridge alongside it. The congestion on the Memorial Bridge will be solved, but the problem (b) which is the traffic congestion in the center of Bangkok City, will remain unsolved.
Solving this, it will be necessary to reform the traffic treatment system, that means the reorganization of the road network and widenning them, all over the sector. Not only does it entail a huge sum of money, but also takes so many years till full effect can be expected.

The scheme of the Second Bangkok-Thonburi Bridge is aiming to form a circular highway around the southern part of Bangkok to disperse the traffic coming into the city center and to eliminate the traffic from city center which could bypass it. It will give an effective solution, though somehow indirect.

Now, there are two proposale for the location of the Second Bangkok-Thonburi Bridge on Bangkok side. Those are the Silom Road and the Sathon Road.

The Japanese Surveying Team would recommend the Sathon Road as the approach road and the site of the Second Bangkok-Thonburi Bridge from the standpoint of city planning, for the following reasons.

1 The Silom Road is nearer to the commercial area than the Sathon Road, and may constitute a circular highway connecting the Krung Thon Bridge, Rajauithi Road, Raja Drarop Road, Raja Dawri Road (see Fig 1-1). It is fascinating but on both sides of the Silom Road are almost already developed as a shopping street. Such utilization along the both sides of the road, reducing the running speed, consequently traffic volume, is not recommendable the Silom Road as the main circular highway.

The Silom Road is equipped with four lanes already and the congestion has reached its limit and cannot receive additional traffic through the Second Bangkok-Thonburi Bridge. The traffic volume through the Second Bangkok-Thonburi Bridge will be amounted to about 84,000 vehicle/day in 1975, and about 133,000 vehicle/day in 1990, as mentioned in Section 3. It means, the bridge carrying 6 carriage lanes will be needed even in 1975. If the Silom Road is used as approach, it will be necessary to be widenned to 6 lane road.

2. The Sathon Road is located farther away from the commercial center than the Silom Road and may not form an ideal loop way. However it is believed that this road may be able to provide an adequate benefit as a loop way (see Fig. 1-2). The utilization of the land along the road is not highly populated commercial center and no much change is expected in the future.

By reconstructing the Khlong Sathon as a culvert burried under the Sathon Road, it is possible to construct an eight-lane road easily with low cost. The Khlong Sathorn planted on both dikes with fine looking trees is city's scenic beauty and has a function of natural drainage. As suggested in Fig. 1-3, it is possible to leave the fine scenery and the function of drainage, as a culvert.

3. On the Bangkok side, the approach road to the bridge will be recommendable, as mentioned in section 2, to cross elevatedly the Charoen Krung Road. And it will result to add more lanes for the frontage roads or rampways. If the approach road has six main carriage lanes, the width of right of way would be 40 - 42 m in total for a about 200 m from the Charoen Krung Road. In case of the Silom Road which has been already developed as a shopping street, it will bring about enormous increase in the cost of the right of way and the compensation. But using the Sathon Road as the approach, the widenning would not be needed at all.

4. The benefit of the second Bangkok-Thonburi bridge construction, be it in the Sathon Road or Silon Road may, only be realized by extending the Rama VI Road to as far as the Sathon Road, or to as far as the Silom Road. (See Fig. 1-4)

5. Street network in Bangkok extending in the eastern direction beyond the Khlong Kasem has a relatively large width and forms a grid. On the other hand, street network extending in the western direction beyond the Khlong Krung Kasem has relatively small width, despite the fact that it is one of the most traffic congested areas in

Bangkok. What is more, this street network is considered highly complicated and imperfect. These facts make the congestion of traffic more fatal, coupled with the problem of extremely highly population density and the confusion of land use.

While we mentioned that the widening of the Memorial Bridge or the construction of a new bridge alongside it would be the most effective solution of traffic problem, for the above purpose and for the sake of the future Bangkok, it is essential for the Government of Thailand itself to formulate a full-scale city planning incorporating with the programs of city redevelopment and overall improvement of street networks.

Fig. 1-1

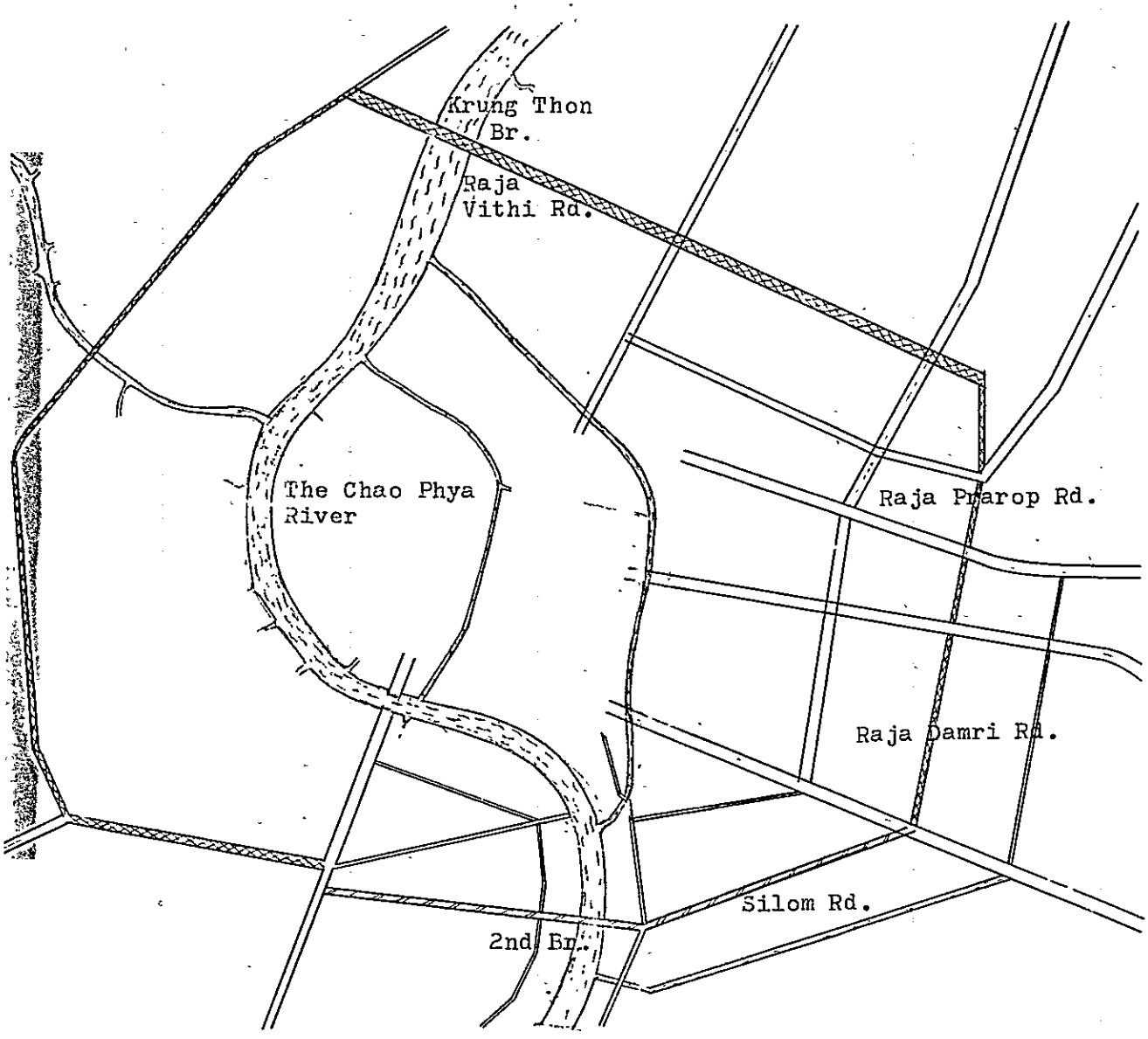

Krung Thon
Br.
Raja
Vithi Rd.
The Chao Phya
River
Raja Prarop Rd.
Raja Damri Rd.
Silom Rd.
2nd Br.

Fig. 1-2

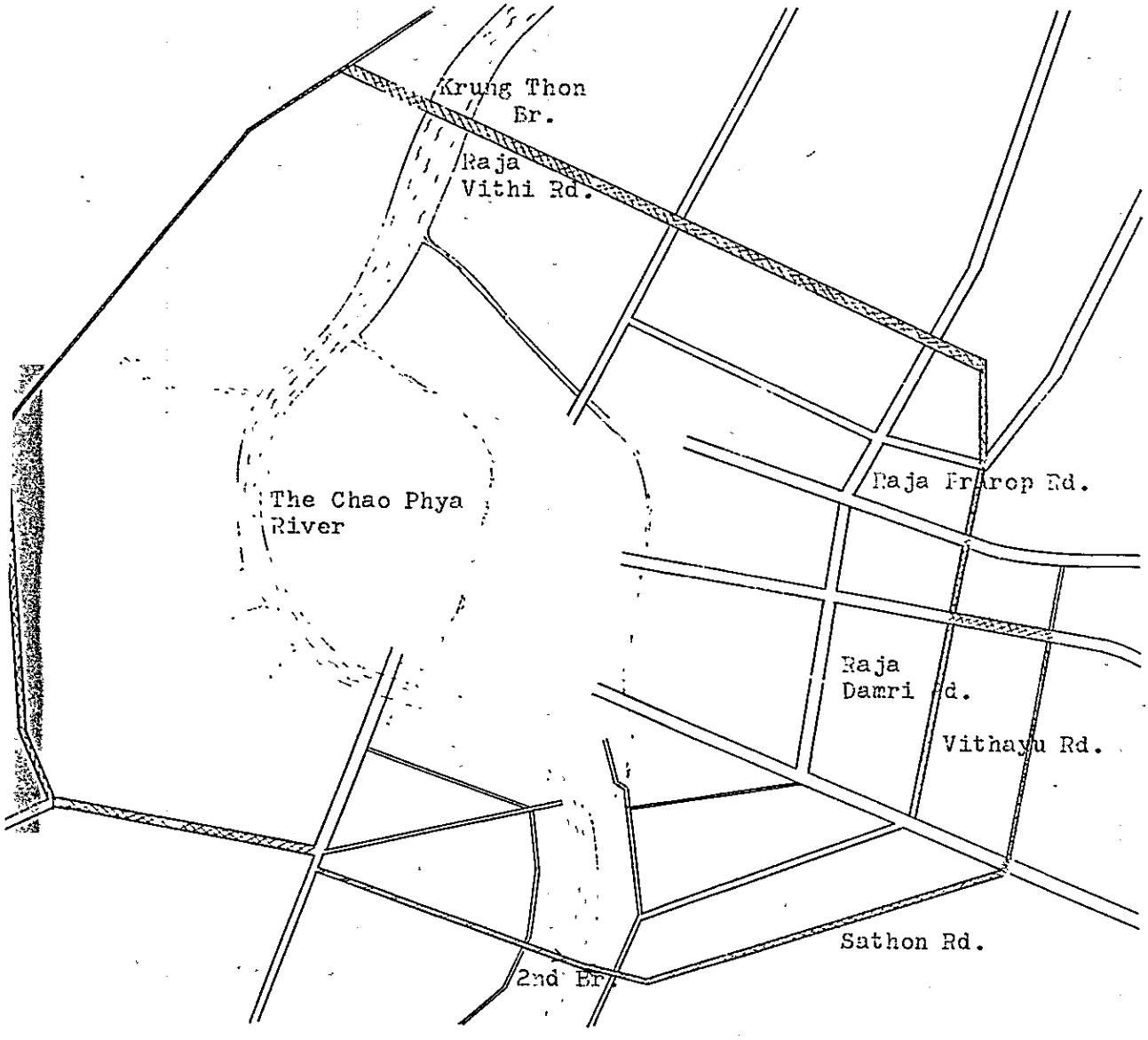

Krung Thon
Br.
Raja
Vithi Rd.
The Chao Phya
River
Raja Prarop Rd.
Raja
Damri Rd.
Vithayu Rd.
Sathon Rd.
2nd Br.

FIG. 1-3 SATHON ROAD

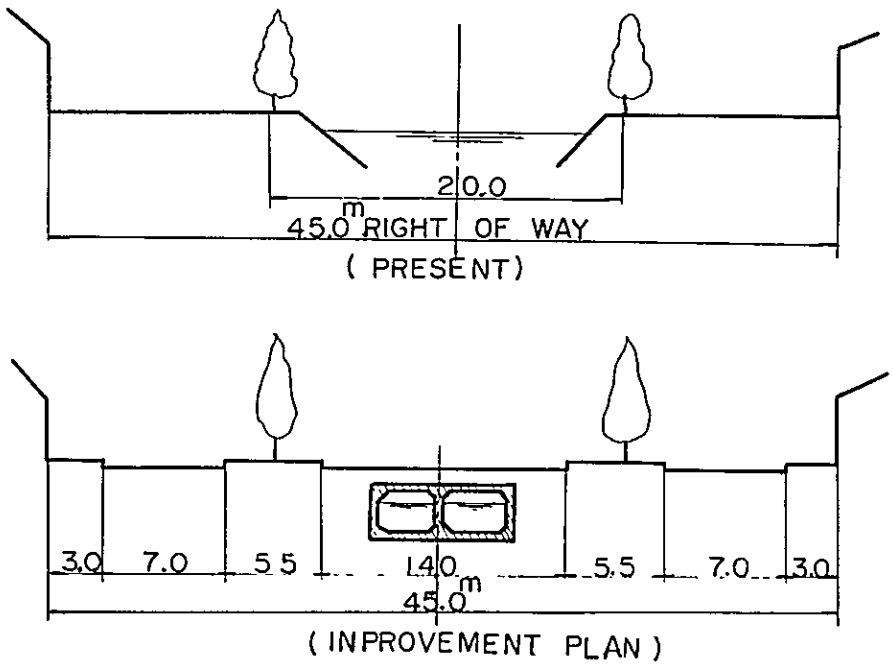
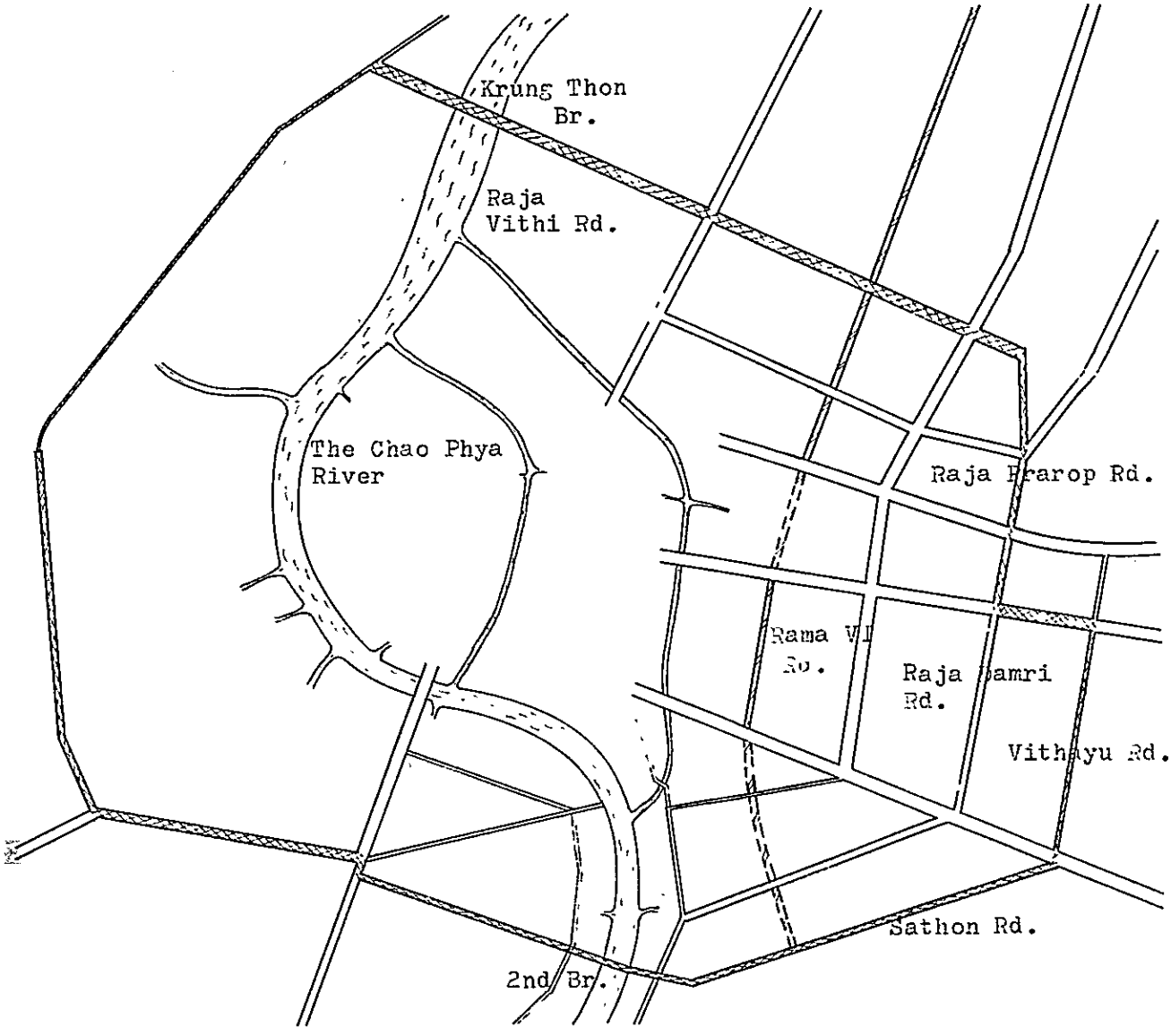


Fig. 1-4


Krung Thon
Br.
Raja
Vithi Rd.
The Chao Phya
River
Raja Prarop Rd.
Rama VI
Rd.
Raja Damri
Rd.
Vithayu Rd.
Sathon Rd.
2nd Br.

Section 2. Road Intersection Planning

1. Bangkok Side

On the Bangkok side, it is desirable to elevate the crossing of the Charoen Krung Road.

Traffic on the Charoen Krung Road is so heavily congested that the traffic control is almost difficult to enforce. If the bridge will be of the movable type, cars passing over the Chao Phya River have to wait during the navigation and have a very big influence against traffic on the Charoen Krung Road.

(a) In case of elevated crossing, the ramp from the Second Bangkok-Thonburi bridge to the Charoen Krung Road will be meaningless as the road is so congrested, unless its width is widened.

There is no room taking up the additional traffic quantity to and from the second Bangkok-Thonburi bridge.

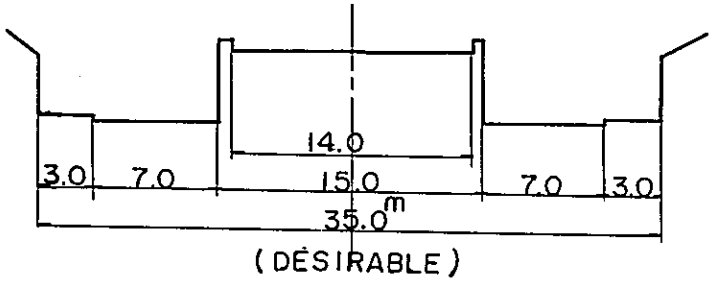
(b) At the elevated crossing over the Charoen Krung Road, the Silom Road shall be widened to a 32m. - 35m. wide road in case the approach of the proposed bridge is a 4 lane road, or to a 39m. - 42m wide road in case the approach is a 6 lane road. (see Fig. 2-1) In case of the former one, the above-mentioned width shall be secured for the length of about 200m. from the Charoen Krung Road. It is not required to widen the Sathon Road, even if the approach is a 6 lane road.

2. Thonbur Side

The Charoen Nakorn Road have the right-of-way of 30 m.wide and still the traffic is not so congested, and which tells us that there is some room to absorb additional traffic. The access road only to attach to the Charoen Nakorn Road or the surface intersection with the above will be sufficient for the time being.

The extension of the access road to the Phra Chao Tak-Sin Road will be necessary in the near future, and taking this into account, the planning of the elevated intersection at the point having ramp is desirable.

FIG. 2-1 SILOM ROAD



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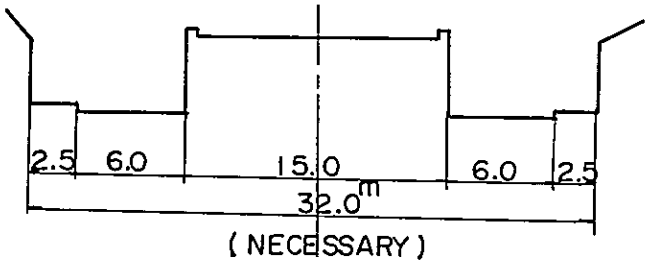
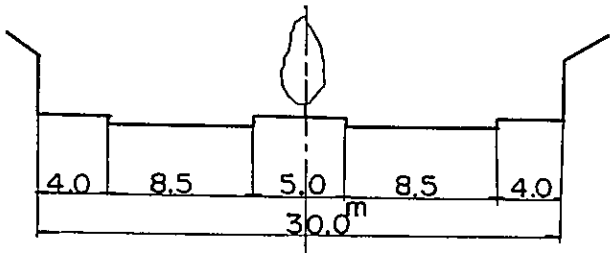


(NECESSARY)



(PRESENT)

Section 3. Traffic Forecast Between Bangkok and Thonburi

In formulating a proper traffic plan, it is first necessary to estimate the anticipated traffic volume in a proper manner. Basic data such as OD tables (origin and destination tables), economic statistics and a road improvement plan are necessary for estimating properly the amount of future traffic, but they are completely insufficient at present. For this reason, traffic forecasting in this report has relied largely on our assumption. It will be desirable to make an accurate forecast after conducting a series of a proper traffic survey and making a traffic plan at an early date. We are obliged to forecast traffic with rather insufficient data under the following procedure.

An OD survey, which is performed to determine the movement of vehicular traffic, serves as an important basis to forecast the anticipated volume of traffic. In this survey, all the movements of normal daily vehicular traffic have been checked taking into consideration the type of vehicles, origin, destination, travel time, purpose of travel, load, etc.

However, since no vehicle OD survey has ever been conducted in Bangkok, we had no choice but to rely on the person trip survey on bus passengers conducted in 1965 by the Ministry of Transportation, Thailand, which seems the only available survey. This survey is rather incomplete for person trip survey, because the purpose of trips was limited only to daily commutation and persons surveyed for the most part were government office people. The data, therfore, was considered not reliable, but we had to consider the OD table as a vehicle OD distribution.

In order to convert this bus passenger OD table to a vehicle OD table, we have multiplied the bus passenger OD table by the ratio of the number of vehicles crossing the Chao Phya River to the number of bus passengers crossing the Chao Phya River. In other words, a vehicle OD distribution is assumed to show substantially the same pattern as that in bus passenger OD table, and the volume of vehicular traffic crossing the Chao Phya River has been adjusted to correspond to actual traffic observations.

The future trips generated by each zone, which is necessary as part of the data to calculate the future vehicle OD table, has been estimated by multiplyed the present trips generated by each zone obtained from the OD table by the rate of population increase in each zone.

For an accurate and proper forecast of trips generated by each zone, it is essemtial that a regression formula is obtained by adjusting the present trips generated by each zone derived from the OD survey to economic factors of each zone, such as population, number of workers, products and sales. Applied to the future values of economic factors anticipated from the city planning to this formula, the future trips generated by each zone can be forecast.

While it is necessary to know economic statistics of each zone and city planning, we have relied upon population data only, the most fundamental of the economic statistics, because we were not able to obtain other useful informations. The anticipated volume of the population has not been found from the city planning but from a simple presumption.

On the other hand, we have figured out the total trips of anticipated vehicular traffic in Bangkok and Thonburi by the number of trips per vehicle and anticipated vehicle registrations reported by Dr. Gun Nagamati, Deputy Director General, Department of Road Transportation, Ministry of Communications, Thailand. From the present vehicle OD table and the present total vehicle registrations, we have now calculated the number of trips per vehicle.

In order to properly forecast the volume of future vehicle traffic, we must accurately estimate the anticipated vehicle registrations. In this case, it is desirable to predict the future vehicle registrations by each vehicle type for the reason that both vehicle registrations and the trips vary with the type of vehicle.

The future traffic distribution has been predicted from the above anticipated trips generated by each zone and the total trips using the Entropy method.

It will be necessary to estimate traffic assignment by assigning the anticipated traffic throughout the road network. The road network in which traffic is to be assigned has been considered herein to consist of the existing roadways, the proposed Bangkok-Thonburi bridges and their access roads, for we know little or nothing of future road plan. It should be noted, however, that we have taken into consideration a probable increase in street width.

It will be appreciated that future road traffic cannot be forecast without considering a certain road network. In order to determine whether such a road plan is quite proper or not, it would be an idea to assign OD traffic to some conceivable road network, so that a reliable and accurate selection of a proper road network can be made.

Years predicated are 1975, a few years after the proposed bridges are scheduled to be constructed, and 1990, when the current Bangkok city planning is expected to be completed.

Fig. 3-1 is the flow diagram showing the method of estimating the anticipated traffic between Bangkok and Thonburi.

Of the results of assignment computation, the traffic between Bangkok and Thonburi are indicated in Table 3-1 alongside the 1967 figure for the purpose of comparison. All results are also given in Fig. 3-2 through 3-3.

A traffic volume per lane of a road within a city is said to be planned nearly 20,000 vehicles per day. It will be concluded that the second Bangkok-Thonburi bridge and its related roads shall have six lanes, because the traffic volume will be about 130,000 vehicles per day.

Table 3-1. Traffic between Bangkok and Thonburi

Link No.	Bridge	1967	1975	1990
14	Rama VI	5,380	24,565	35,757
20	K.Thon	27,060	73,356	104,151
50	Memorial	105,400	112,455	114,527
63	K.Thep	22,200	61,538	79,855
94	First	-	91,384	134,854
96	Second	-	83,857	132,929
Total	-	160,040	447,155	602,073

Most of the data necessary to forecast the anticipated traffic in such a manner as above have been compiled from other data or our assumptions. In order to make results of forecast highly reliable and trustworthy,we feel it will be necessary to re-estimate anticipated traffic volume by performing a more extensive surveys described section 7, paragraph 5.

Another report "Traffic Forecast Between Bangkok and Thonburi in 1975 and 1990" complied as supplement to feasibility report on Bangkok-Thonburi bridge No. 1 project, deals with the details of the data and methods used.

Fig. 3-1 Flow Diagram for Traffic Forecast Between Bangkok and Thonburi

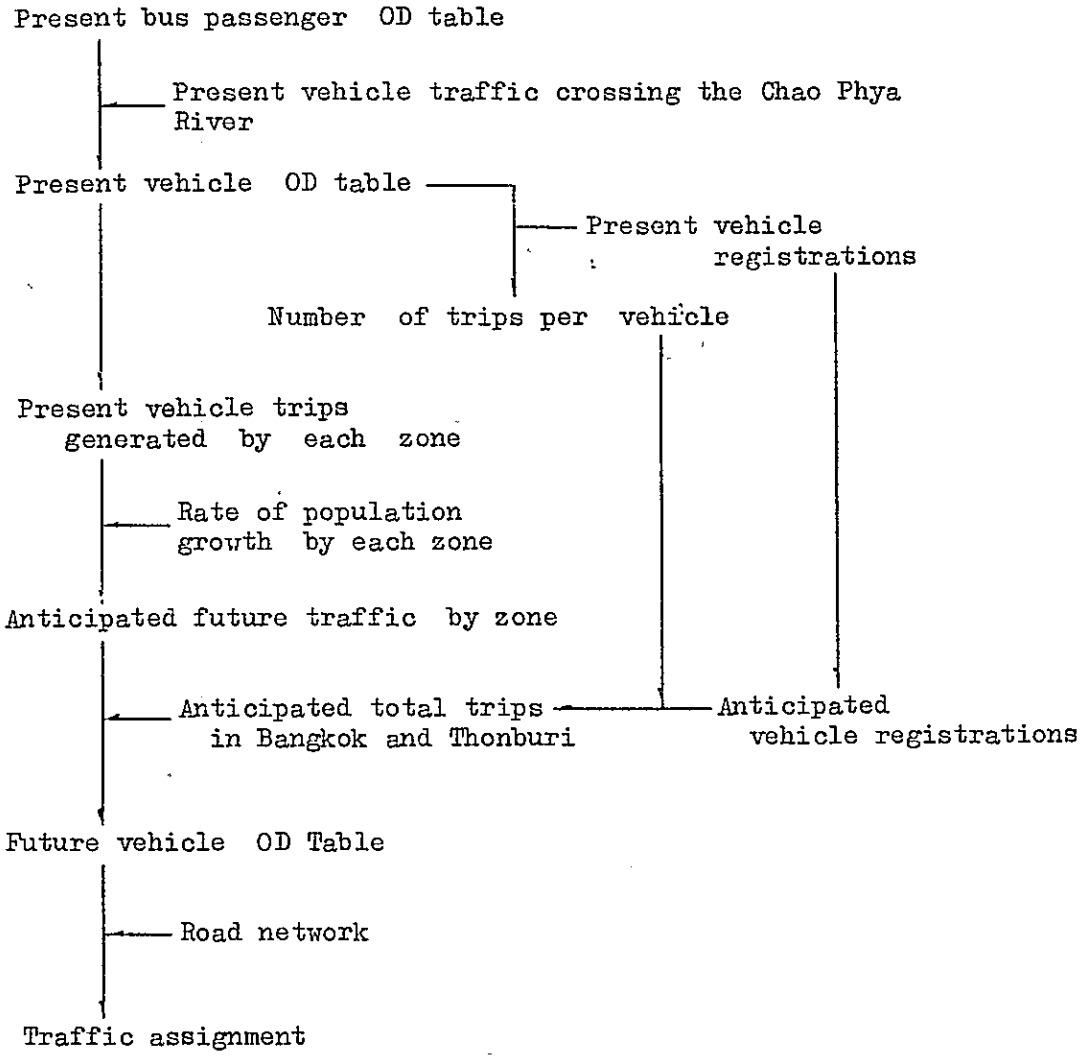
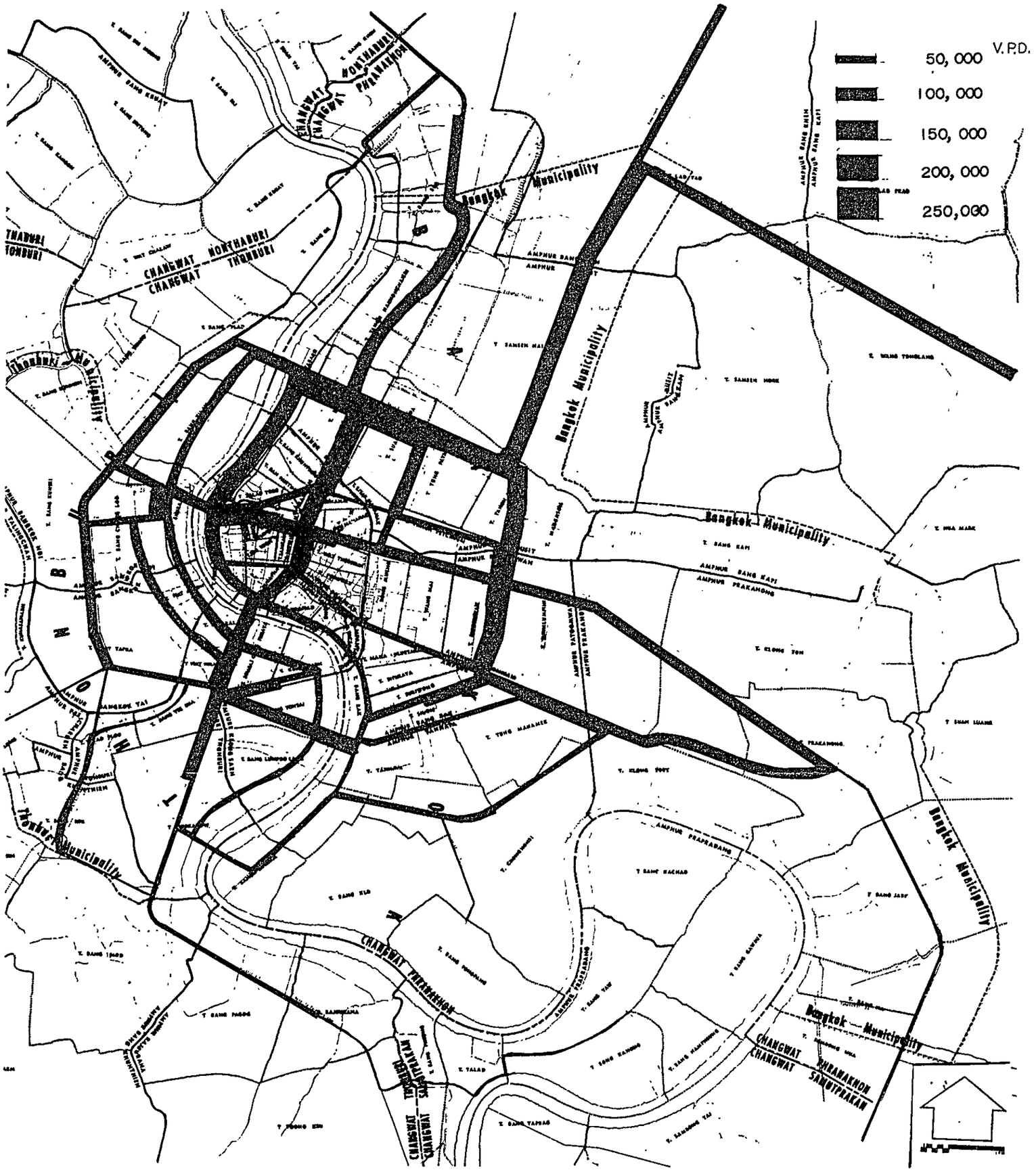
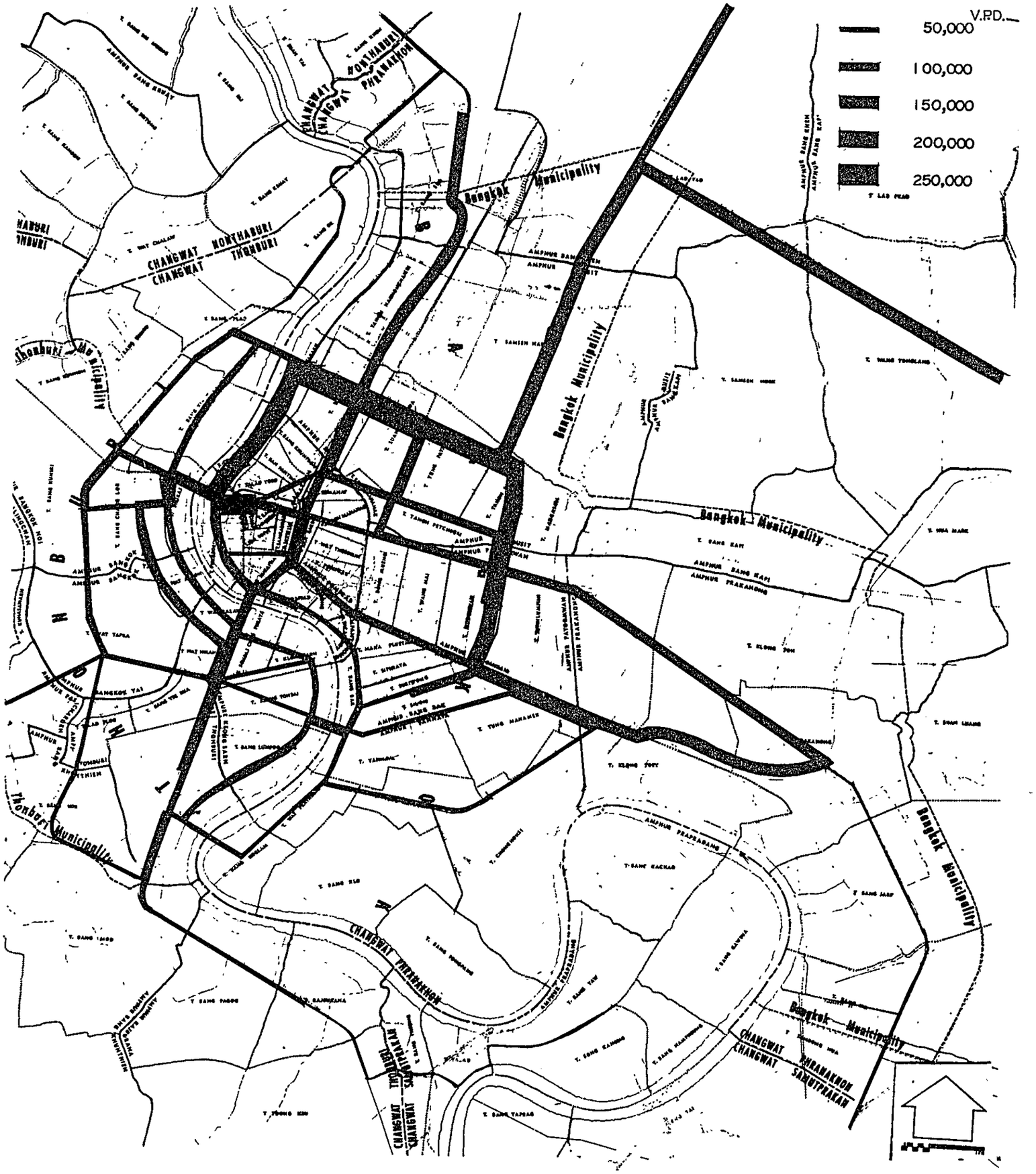


FIG. 3-2 TRAFFIC FLOW IN 1975



Note: For convenience of computations, two or three roads extending in the same direction are shown as one roadway. Since a main emphasis is placed on the forecasting of traffic volume on the bridge and its access roads, there may be slight inaccuracy the traffic volume of other roads.

FIG. 3-3 TRAFFIC FLOW IN 1990



Note: For convenience of computations, two or three roads extending in the same direction are shown as one roadway. Since a main emphasis is placed in the forecasting of traffic volume on the bridge and its access roads, there may be slight inaccuracy the traffic volume of other roads.

Section 4. Structure to Cross the Chao Phya River

It seems posible to construct a river bottom tunnel or a bridge over the river for connecting Bangkok and Thonburi. It is concluded d that a bridge is preferable to a tunnel for the following reasons.

1. River bottom tunnel

Merit 1. Traffic is free from the navigation of ships.

Demirit 1. Construction cost is exceptionally high.
2. Maintenance cost including illumination, ventilation and drainage is very high.
3. A long approach is necessary (total length of tunnel will come up to 1,800 m.) and connection with the Charoen Nakorn Road is impossible.
4. Traffic capacity is restricted by ventilation.

2. Bridge

Merit 1. Construction cost is lower than that of tunnel.

Demirit 1. In case of fixed type, a long approach is required. (Total length of bridge and approach approx. 1,700 m.)
2. In case of fixed type, connection with the Charoen Nakhon Road becomes impossible and the construction cost becomes higher.
3. In case of movable type, traffic is influenced by the navigation of ships.

Section 5. Comparision of Fixed and Movable Types of Bridge

The necessary clearance below the bridge for navigation will be 40m, taking the height of mast of ship as 30 m, and adding tidal range, waving and some allowance. The height of road surface above the M. S. L. will be about 42 m. These figures were settled after our consultation with those officials of the Department of Public and Municipal Works, Ministry of interior, Thailand.

It will not be impossible to construct a fixed bridge from the engineering standpoint, but it is considered not appropriate from the under-mentioned reasons.

1. In case of a fixed type, taking the gradient of the approach road as 5 %, one side of approach is about 735 m. long and the length of both approaches will be 1,470 m. and adding 220 m. width of the Chao Phya River, the total length reaches 1,690 m, so that it is required to construct a bridge of very large scale. In this case, the super-structure does not always require large amount of construction cost by selecting a proper type of bridge, but it is easily understood that the cost of sub-structure will increase considerably as the structure is very high. As the approach is long, the cost of land will become an important item.

   According to rough estimate with the clearance of 30 m. below the bridge, the construction cost will be almost the same for the fixed and the movable bridge.

2. Next comes the ploblem of appearance of a bridge.
   Although the bridge itself of 40 m. height holds its fine appearrance, the high structure in the air will spoil the fine scenery of Bangkok as a whole. We are afraid such a high super-structure does not mach with those famous and fine cathedrals and temples in a historical areas of Bangkok.

From the two vital reasons we can not recommend a fixed type bridge. We now turn the movable bridge. We know well that the movable bridge is preferable, but we can not miss one vital drawback of it. The bridge of this type, built for the purpose of alleviating the traffic congestion, might result adversely, when the traffic will increase between Bangkok and Thonburi.

For the movable bridge, however, its moving operation will not be required so often for the navigation of ships at present. In the near future, it will not be required at all and the road traffic is not interrupted.

Section 6. Selection of the Type of Bridge and the Estimate of Construction Cost

The width of the Chao Phya River at the suggested construction sites of bridge, one from Thonburi side to the Silom Road of Bangkok side and other from the Thonburi side to the Sathon Road of Bangkok side, is 220m., the same for both.

1. Main bridge

There are usually three types of movable bridge, that is, the bascule, the lift and the swing type. The tower of the lift type is necessary to be 50 m. high, where the clearance below the bridge is 40 m. Therefore this type is not recommendable for an expensive construction cost and a bad appearance.

It is required by officials of the Department of Public and Municipal Works, Ministry of Interior, Thailand that the navigation channel is secured to be 60 m. wide.

In case of the swing type, therefore, massive pier is required to be constructed at the river center. The construction cost will become more expensive and this type is not recommendable.

The bascule type will be superior. In this case, the motors, machines and equipment to drive the movable girder shall be installed on the pier. Consequenctly, the pier becomes somewhat larger and more massive but this type is considered most suitable for the conditions of the site. The use of steel plate or steel grid is advisable for the floor part of main span, to save the weight of moving parts. The up-to-date slender box type was planned, and the truss type is low in cost but is out of mode for the main girder. The longer girder of Langer type has been taken into consideration for the side span. This type is one of the stiffened arch and costs cheaper in construction of a bridge exceeding 80 m. in length and it gives a good appearance. The five span bridge, which two piers are added to at the center of both side spans, was taken into consideration, but as the soil condition of the site is not satisfactory, we consider the three span type to be favorable.

Main bridges in various cases are shown in Fig. 6-1 to 6-4. The 3 span bridge of the bascule type is shown in Fig. 6-1, the 5 span one of the bascule type in Fig. 6-2, the 3 span one of the lift type in Fig. 6-3 and the 5 span one of the lift type in Fig. 6-4.

2. Approach bridge

Now compare the approach bridges connecting to the Silom Road and to the Sathon Road.

The approach bridge connecting to the Sathon Road should fly over the Charoen Krung Road, judged from the present traffic congestion on the Charoen Krung Road. On the contrary, the approach connecting to the Silom Road should intersect the Charoen Krung Road at the same grade. These have been already described in Section 1.

It is desirable that at Thonburi the main road astrides the Charoen Nakhon Road and the ramps are connected to it.

The sub-structure of the approach road is not so high and the construction cost will be low. It is not favorable to adopt a large span. According to our rough estimate, the 20 m - 25 m long span will be the most economical for either concrete, pre-stressed concrete or steel bridge. Taking this into account, in almost all cases we planed a combination of simple girders, two span continuous girders and/or three span continuous girders with a span of 22.5 m. Where the portion astrides the Charoen Nakorn Road, the width of the road forced us to choose the span of 35 m. For the approach bridge, there is not so much difference in construction cost between the pre-stressed concrete and the steel bridge. The adoption of pre-stressed concrete is recommendable from the standpoint of the policy of Thailand to utilize the local material as much as possible.

For the foundation, we have no question about the use of precast concrete pile.

We have made up a skelton plan of main span and approach bridge. Fig. 6-5 shows the bridge connected to the Silom Road and Fig. 6-6 does one connected to the Sathon Road. The type and the span of main bridge are the same in both the cases.

The latter bridge is 46 m. longer in total length than the former one. Since the approach part of the latter will be constructed over the existing canal, the cost of sub-structure will be somewhat higher. The comparioson of the rough estimate of construction cost is shwon in Table 6-1.

Such estimate had been compiled before accurate survey and exploration of soil were carried out and some ammendments in them will be unavoidable.

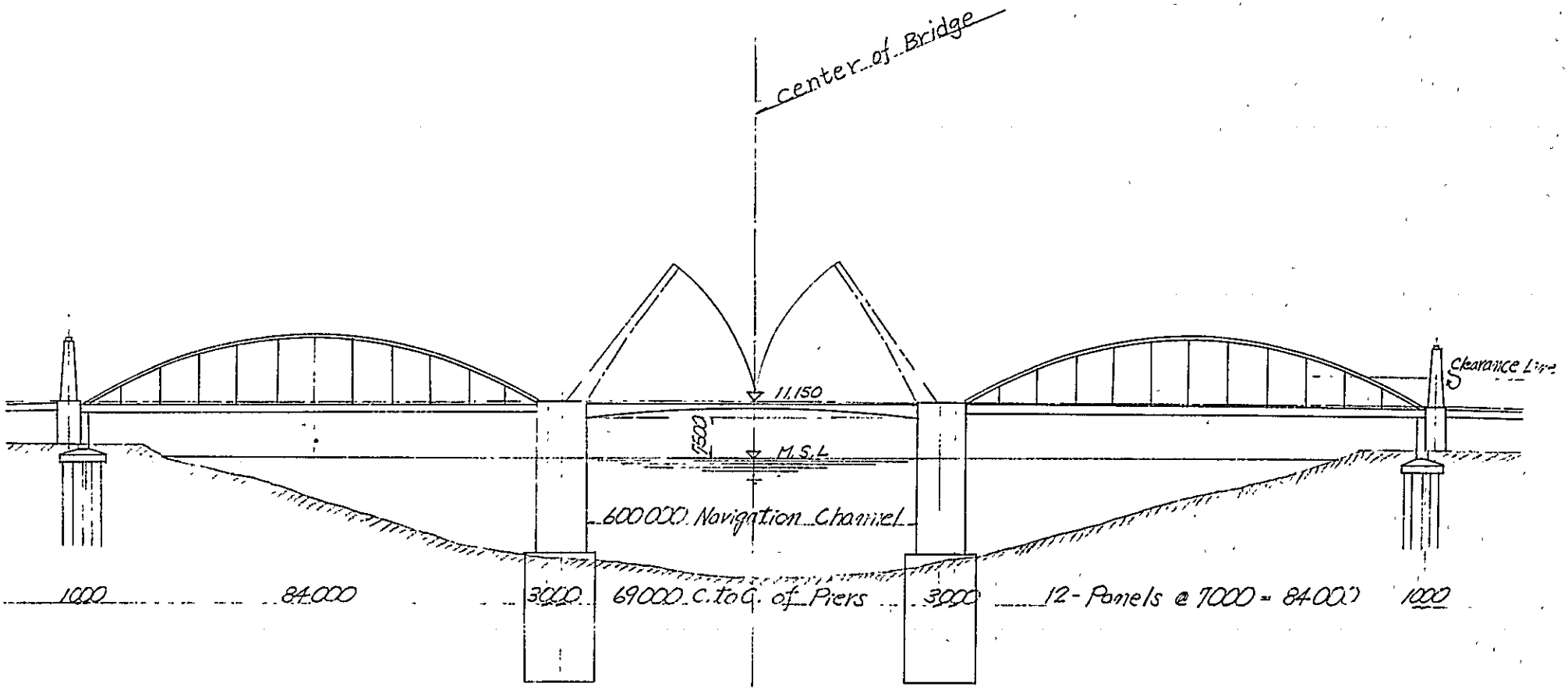


Fig 6-1 The 3 Span Bridge of the Bascule Type

Note: All dimensions are shown in mm.
Scale 1:1000

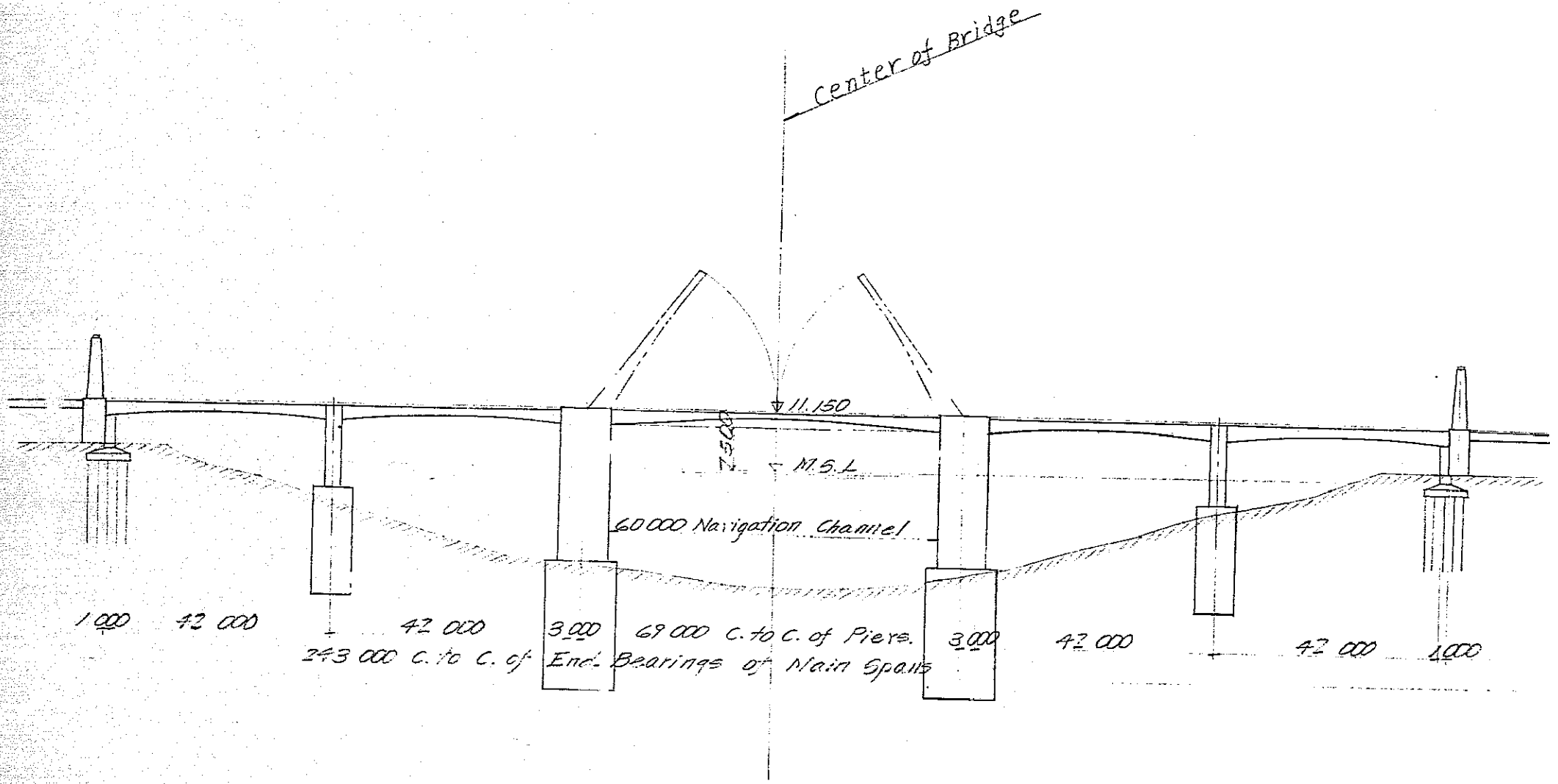


Fig. 6-2 The 5 Span Bridge of the Bascule Type

Note : All dimension are shown in mm.
Scale 1 : 1000

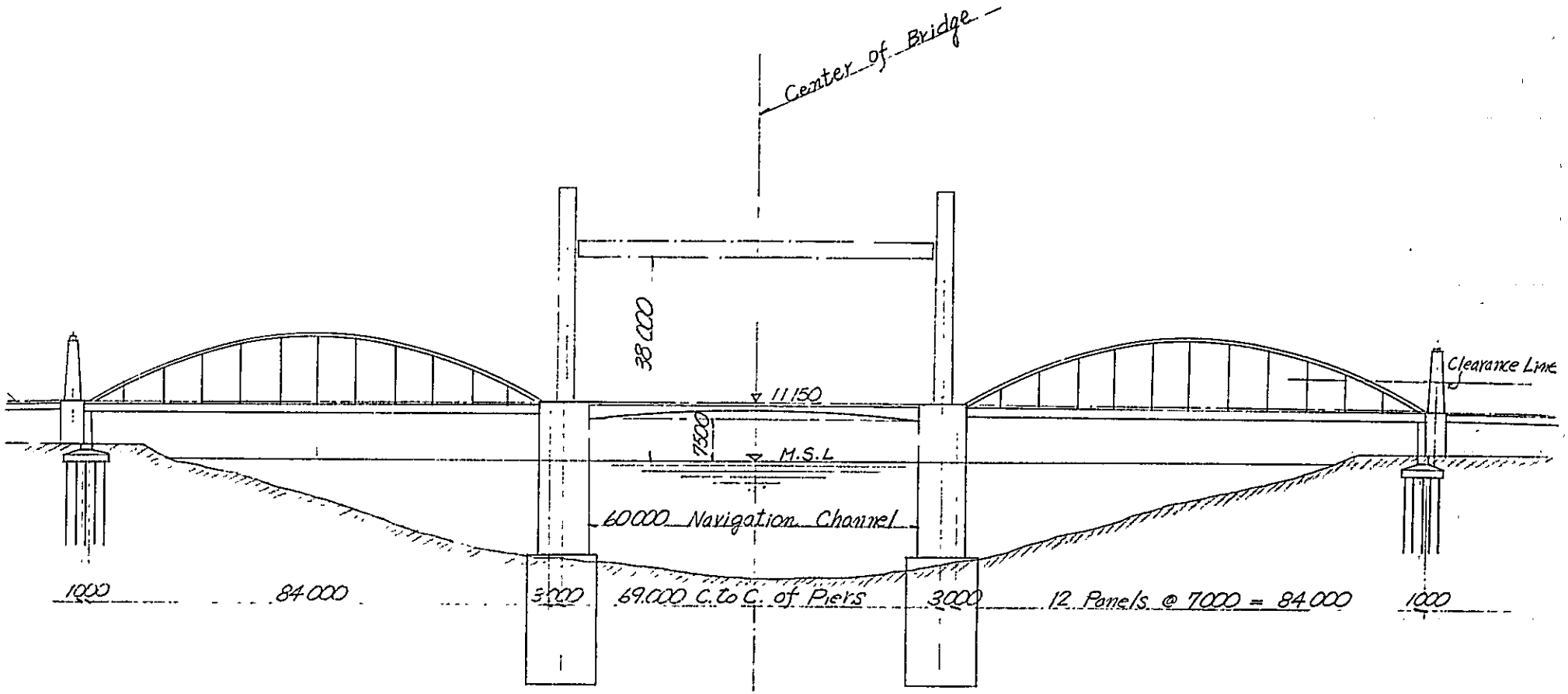


Fig 6-3 The 3 Span Bridge of the Lift Type

Note: All dimensions are shown in mm.
Scale 1:1000

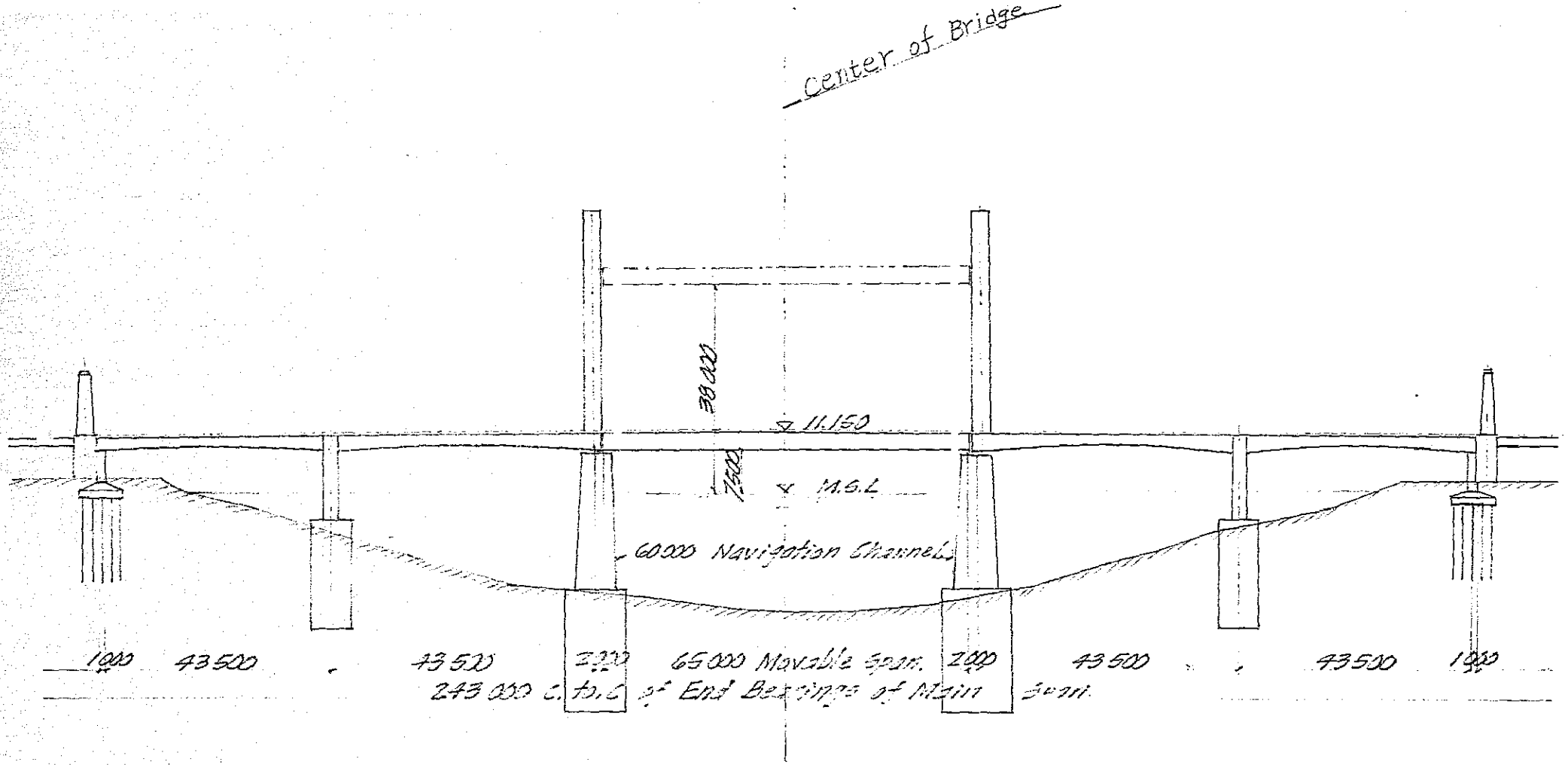
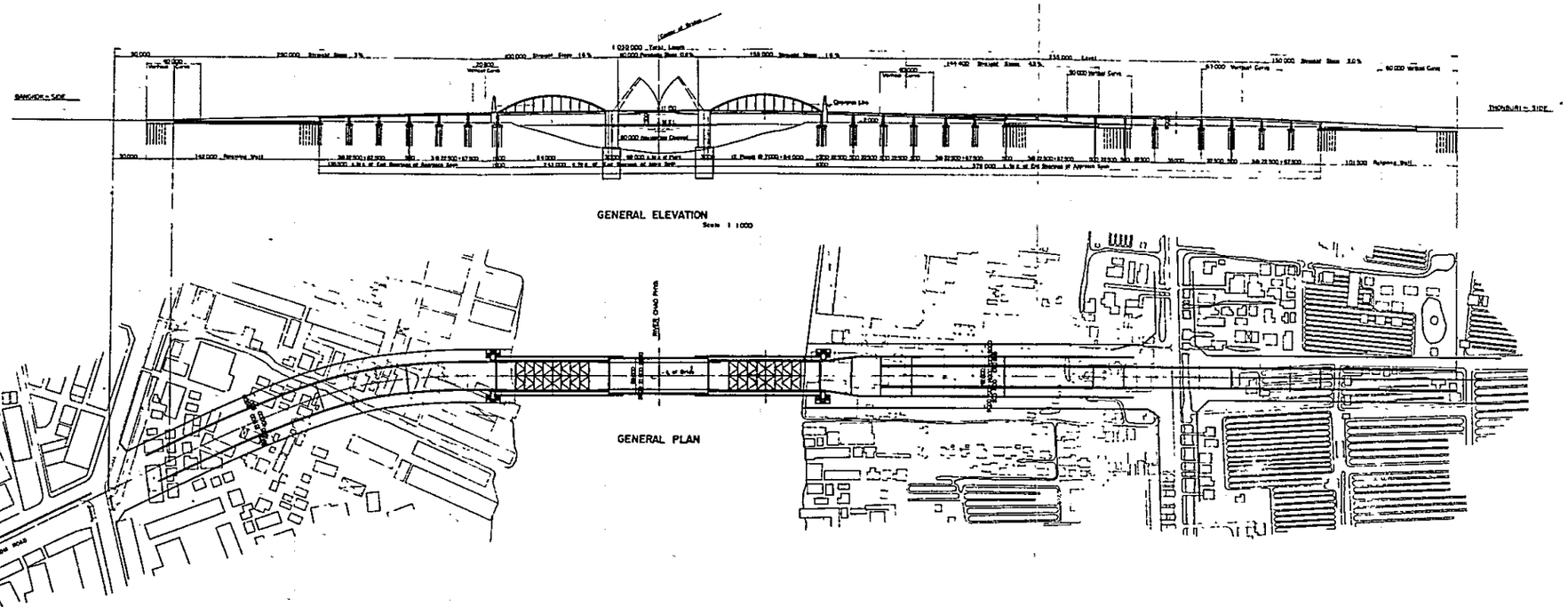


Fig 6-4 The 5 Span Bridge of the Life Type.

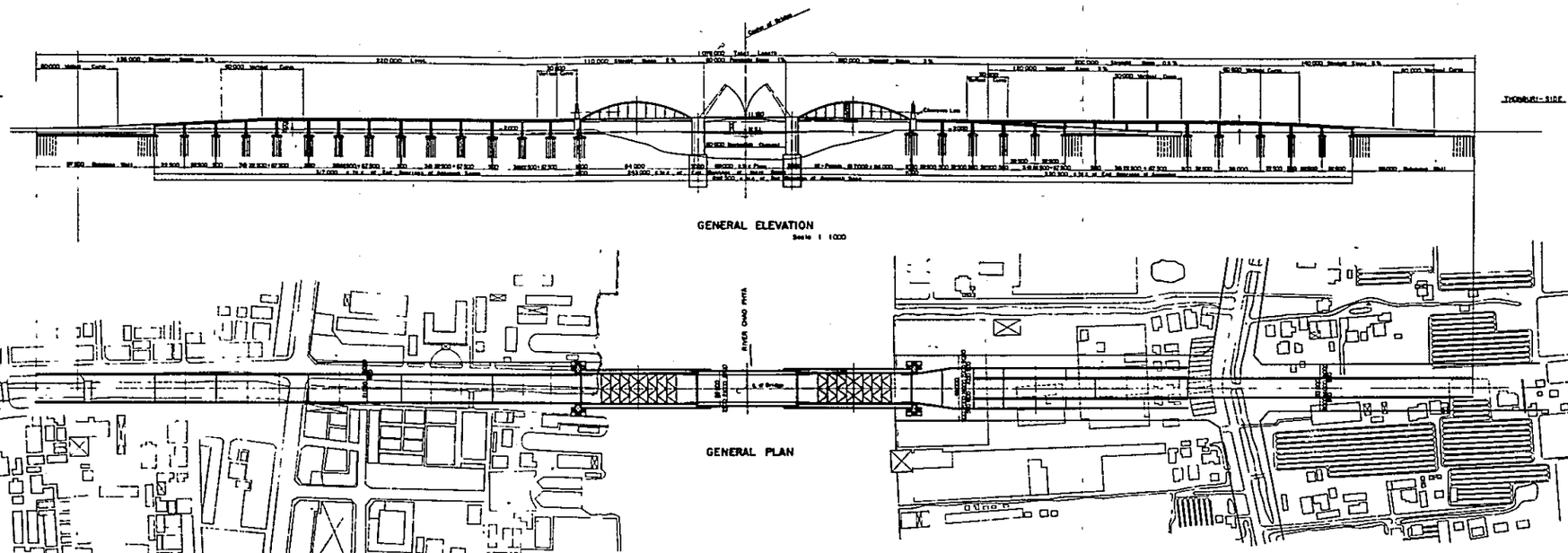
Note · All dimensions are shown in mm.
Scale 1:1000



GENERAL ELEVATION
Scale 1:1000

GENERAL PLAN

GENERAL VIEW
OF
BANGKOK-THONBURI BRIDGE
CONNECTED TO THE SILOM ROAD
FIG 6-5



GENERAL ELEVATION
Scale 1 : 1000

GENERAL PLAN

GENERAL VIEW
OF
BANGOK-THONBURI BRIDGE
CONNECTED TO THE SATHON ROAD
FIG. 6-6

NOTES
All Dimensions are shown in mm
Scale 1 : 1000

GRAPHIC SCALE

Table 6 - 1, Rough Cost Estimation

Unit: Million Bahts

ITEM			SITE	SILOM ROAD				SATHON ROAD			
			TYPE	BASCULE		LIFT		BASCULE		LIFT	
			SPAN	3 (Fig.6-1)	5 (Fig.6-2)	3 (Fig.6-3)	5 (Fig.6-4)	3 (Fig.6-1)	5 (Fig.6-2)	3 (Fig.6-3)	5 (Fig.6-4)
BRIDGE STRUCTURES	MAIN SPAN	SUPER-STRUCTURE		33.3	27.8	38.2	32.7	33.3	27.8	38.2	32.7
		SUB-STRUCTURE		32.1	40.8	27.9	36.6	32.1	40.8	27.9	36.6
		TOTAL		65.4	68.6	66.1	69.3	65.4	68.6	66.1	69.3
	BANGKOK-SIDE APPROACH	SUPER-STRUCTURE		3.7	3.7	3.7	3.7	8.5	8.5	8.5	8.5
		SUB-STRUCTURE		3.6	3.6	3.6	3.6	9.0	9.0	9.0	9.0
		TOTAL		7.3	7.3	7.3	7.3	17.5	17.5	17.5	17.5
	THONBURI-SIDE APPROACH	SUPER-STRUCTURE		9.0	9.0	9.0	9.0	8.0	8.0	8.0	8.0
		SUB-STRUCTURE		10.3	10.3	10.3	10.3	9.1	9.1	9.1	9.1
		TOTAL		19.3	19.3	19.3	19.3	17.1	17.1	17.1	17.1
	TOTAL			92.0	95.2	92.7	95.9	100.0	103.2	100.7	103.9
LAND	BANGKOK-SIDE			32.0	32.0	32.0	32.0				
	THONBURI-SIDE			13.0	13.0	13.0	13.0	11.0	11.0	11.0	11.0
	TOTAL			45.0	45.0	45.0	45.0	11.0	11.0	11.0	11.0
GRAND TOTAL				137.0	140.2	137.7	140.9	111.0	114.2	111.7	114.9

Section 7. Surveys Required for Preparing the Feasibility Report

The following serveys and informations are necessary to design the second Bangkok-Thonburi bridge and its approach, to estimate the construction cost and to prepare the feasibility report.

1. The topographic and sounding survey on the vicinity of the proposed bridge site and the survey on the right-of-way of existing roads and buildings in this area
2. The soil exploration in the Chao Phya River and the approach areas
3. Informations about fundamental road and city plans
4. Basic informations regarding to materials and equipments necessary to estimate the construction cost and to prepair a working schedule including sources, ways of transportation, unit costs and so on
5. Basic Surveys for Traffic Forecast

   It is proposed that the following surveys are taken into serious consideration, to make a real traffic forecast.

   Group No. 1 of Surveys
   This group contains basic surveys necessary to understanding the present status of traffic in Bangkok and Thonburi. Therefore, surveys described herein must be initiated within one or two years from now.

   (1) Traffic Observation

   In this survey, the volume of traffic is measured by installing automatic traffic counter in key sections for road network, so as to find out hourly, daily, and seasonal change in the volume of traffic. It will also be necessary to observe the traffic volume at least for a week continuously at each season in order to find modified coefficient of the automatic traffic counter and to know the compositions of vehicular type. This manual counting shall include checking traffic at various points of roadway and also that at intersections by direction of vehicular movement.

(2) Vehicle OD Survey

The vehicle OD survey is essential to understanding the movement of vehicular traffic for the proper forecast of traffic volume. Survey items shall include type of vehicles, origin, destination, travel time, purpose of travel, load of passengers or cargo, etc. This survey may be performed on a normal week day. And the survey needs be carried out in conjunction with a door-to-door vehicle owner survey and a road interview. These surveys are of extremely intricate nature, requiring considerable time, expenses and efforts. They must be performed most carefully.

Group No. 2 of Surveys

While the Group No. 1 of Surveys consists of survey principally performed on vehicular traffic, the No. 2 centers around surveys on factors affecting vehicular traffic, and the future planning thereof. Therefore, these surveys will be an extremely far-reaching and extensive ones embracing not only traffic plan, but also new city planning and economic planning. Estimated time required for such a survey would run to 3 to 5 years.

(1) Economic Statistics

Check in regard to population, daytime population, workers hired by industry, industrial gross product, sales amount, and service amount, in unit of the smallest administrative division, Tambol.

(2) Land Use Map

This will cover a detailed checkup of the present extent of land use, types of building, structures, facilities, etc. located and size thereof.

(3) Present Road Map

This will cover a survey on extensions of each section of roadway in both Bangkok and Thonburi, width of road (driveway and sidewalk), condition of roadway (either paved or unpaved, and types thereof), the presence or absence of structures, types of intersections (signal type, rotary type, etc.), and the like.

All these will be shown in maps. This survey shall also include a survey on existing roads and the right-of-way.

(4) Condition of Other Means of Transportation

Vehicular traffic has an intimate relationships with other means of transportation. It is necessary, therefore, to make a survey on routes of other means of transportation (including railway, ships, aircraft, etc.), the number of flight or cruise available and users, the points of origin and destination, the purpose of trips, etc.

(5) Person Trip Survey

The person trip survey has direct bearing with the foregoing surveys, and it is an OD survey on the trips of persons. It is necessary to perform this survey in order to analysis the traffic itself and give a clear concept about the position of vehicular traffic among all means of transportation. This survey, incidentally, is important not only from the standpoint of vehicular traffic flow, but also for ensuring the well-developed plan of other means of transportation.

(6) Future Road Plan, Traffic Plan, City Plan, and Economic Plan

It is highly desirable to grasp the present status of items (1) through (5) above and at the same time to know the future concept thereof. Future planning can be worked out by making such surveys as these. The Government of Thailand is, therefore, requested to furnish us with data that might become available in connection with these planning to enable us to fulfill the task to satisfaction.

(7) Vehicular Movement Survey

This survey covers a firsthand observation of vehicular movement so as to find the traffic capacity of road or road intersections, the relationship between traffic volume and vehicle running speed, as well as the basis of traffic controls

concerning speed limit, signal and channelization. The observation shall be carried out with an aid of 16-mm memo-motion picture camera, video tape recorder, and radar speed meter.

All the foregoing surveys must be performed time and again in order to ensure accuracy of forecasting.

Needless to say, all these surveyes, even if performed once, will undoubtly be far better than the total absence of surveys.

It is added that these surveys on a long-term regular basis will contribute greatly towards making an accurate forecast of future traffic.