8.1.4 Investigation for Soil Condition

After reviewing the detailed soil investigations for Sathorn Bridge, New Memorial Bridge, Pathumthani and New Nonthaburi Bridges, it was recognized that there are no substantial differences among the configurations and physical characteristics of the soil strata along the Chao Phraya River involving the above four bridges. The RAMA VI Bridge, also, is located in the area. Therefore the same soil conditions can be assumed for the New RAMA VI Bridge as for the existing four bridges.

The soil profile shown in Fig. 8.1, which has been borrowed from the previous survey results, will be used for outline design in Phase 1.

8-2 DESIGN OF ROAD AND INTERSECTION

Design of roads and intersections have been carried out using the 1/1600 scale drawings obtained in Chapter 7.

Right of way on the Bangkok side has been determined by the number of lanes for the intersection neighborhood. Right of way in the Intersection for Wongsawang Road has been composed basically of 2 lane plus Busbay for one direction. Widening of Wongsawang Road can only be carried out on the south side because the north side commercial and residential facilities have been densely developed. The elevation is set as that of existing roadway. The busbay has been so designed as to serve for present and future uses and additional busbays are installed for the buses going to central Bangkok and also Thonburi.

As the distance between ramp ways and intersection is too short, the queue lengths could become a longer. To solve this problem, the number of lanes has been increased on the rampway section.

On the Thonburi side, design of roads and intersections have been carried out according to the alternatives studied in Chapter 7.

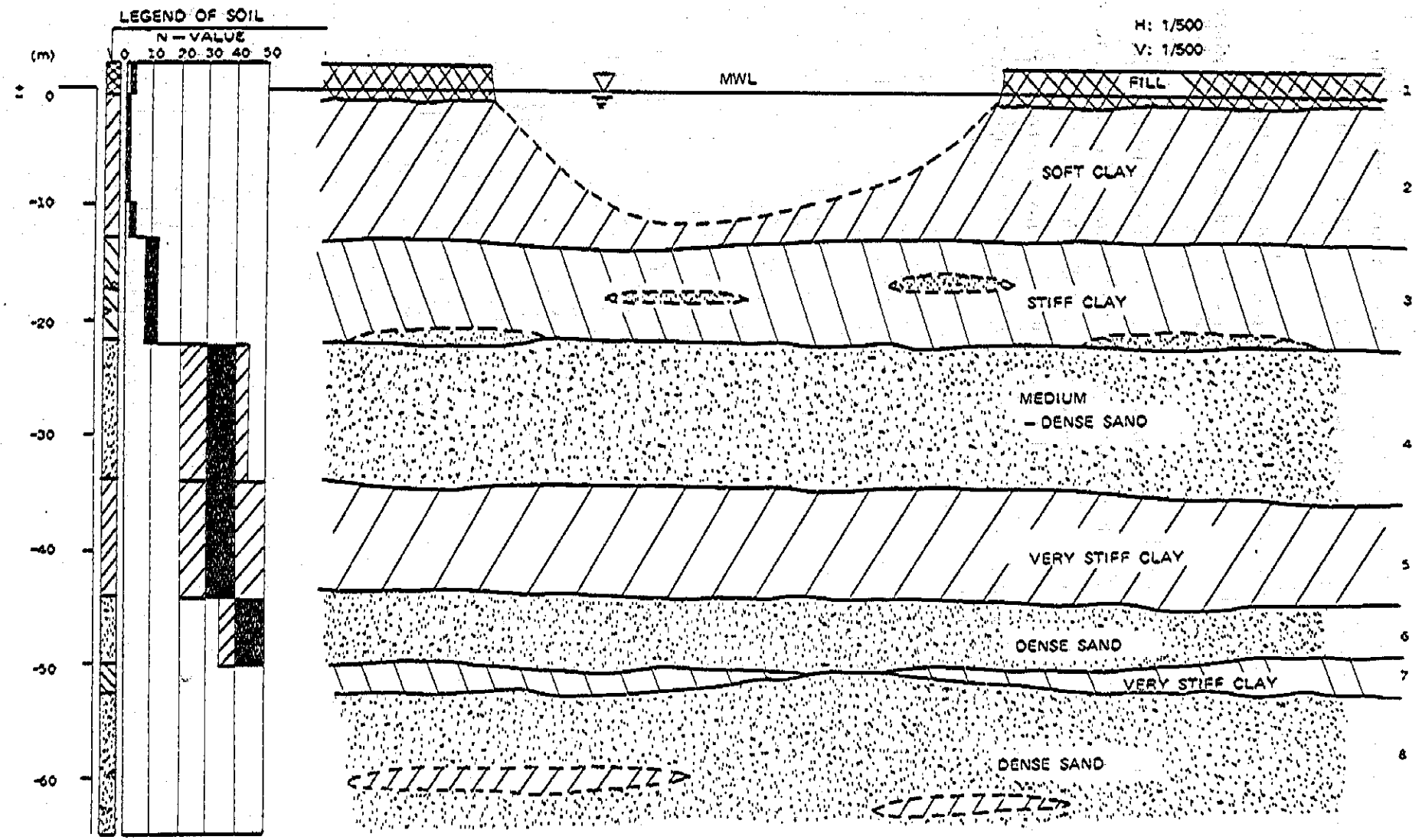


FIG. 8–1 PROBABLE SOIL PROFILE FOR RAMA VI BRIDGE

Smooth alignment for the Middle Ring Road and simple configurations for intersections are the two basic design principles.

A busbay is to be installed at a new location for Alternative II A and II B because use of the existing busbay is difficult.

For Alternative III, the busbay can be left as almost the same location. The traffic volume will not vary, because the existing road way can be used as it as. All of these designs are shown in Fig. 8-2 to Fig. 8-5. The whole route of the road including intersection is given in 1/1600 scale drawing attached in Fig. 7-10 to 7-12.

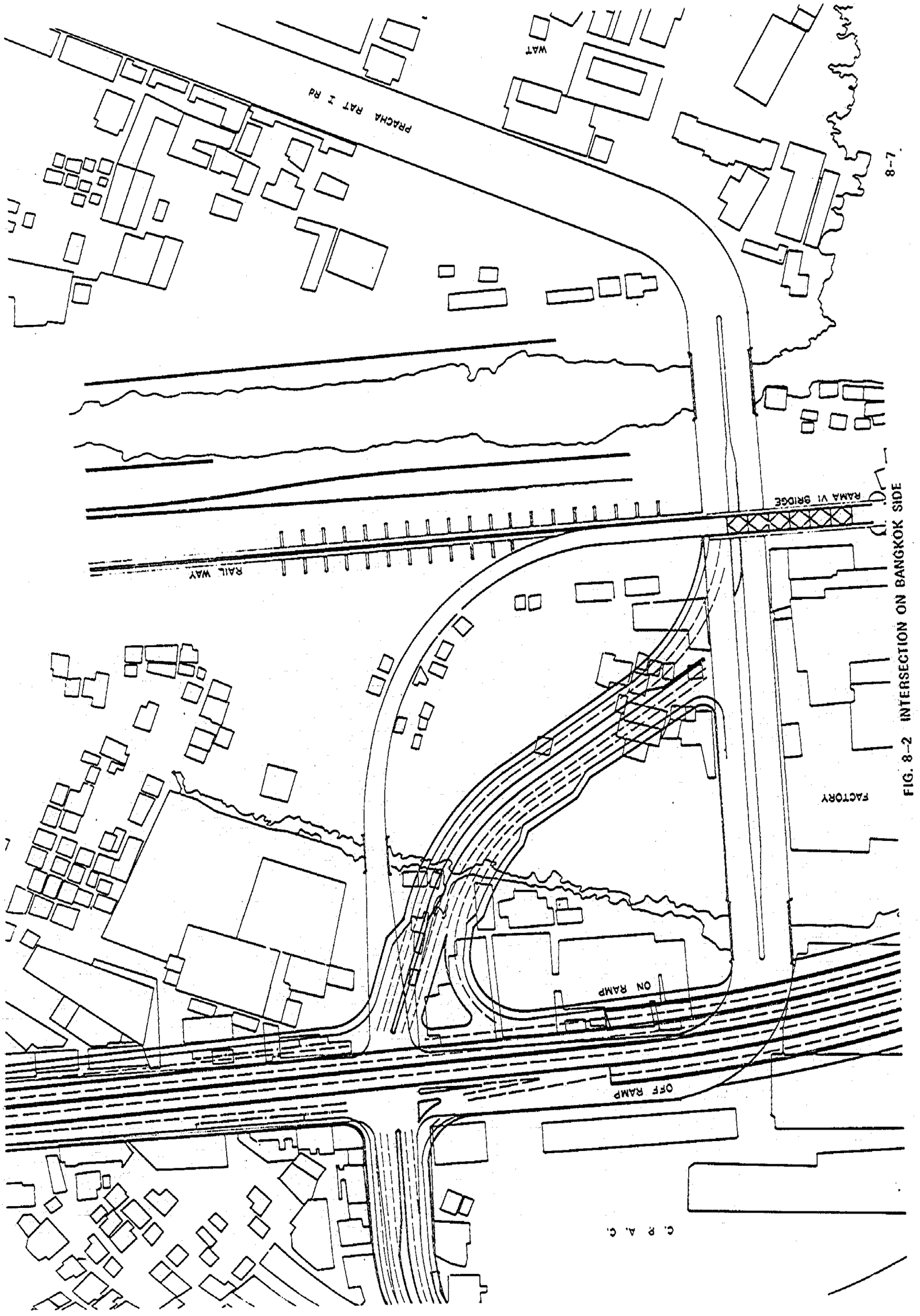


FIG. 8-2 INTERSECTION ON BANGKOK SIDE

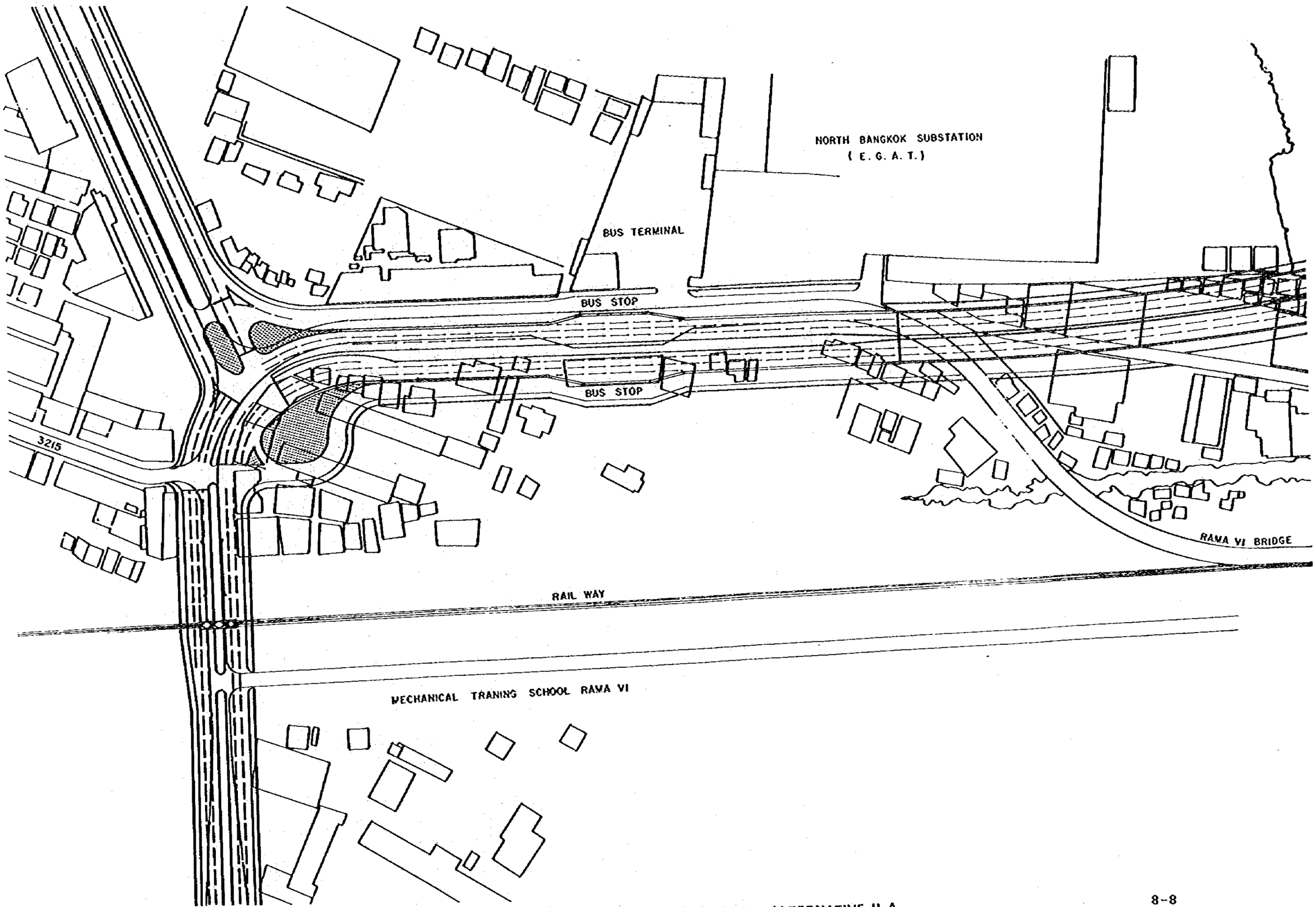


FIG. 8-3 INTERSECTION ON THONBURI SIDE : ALTERNATIVE II A

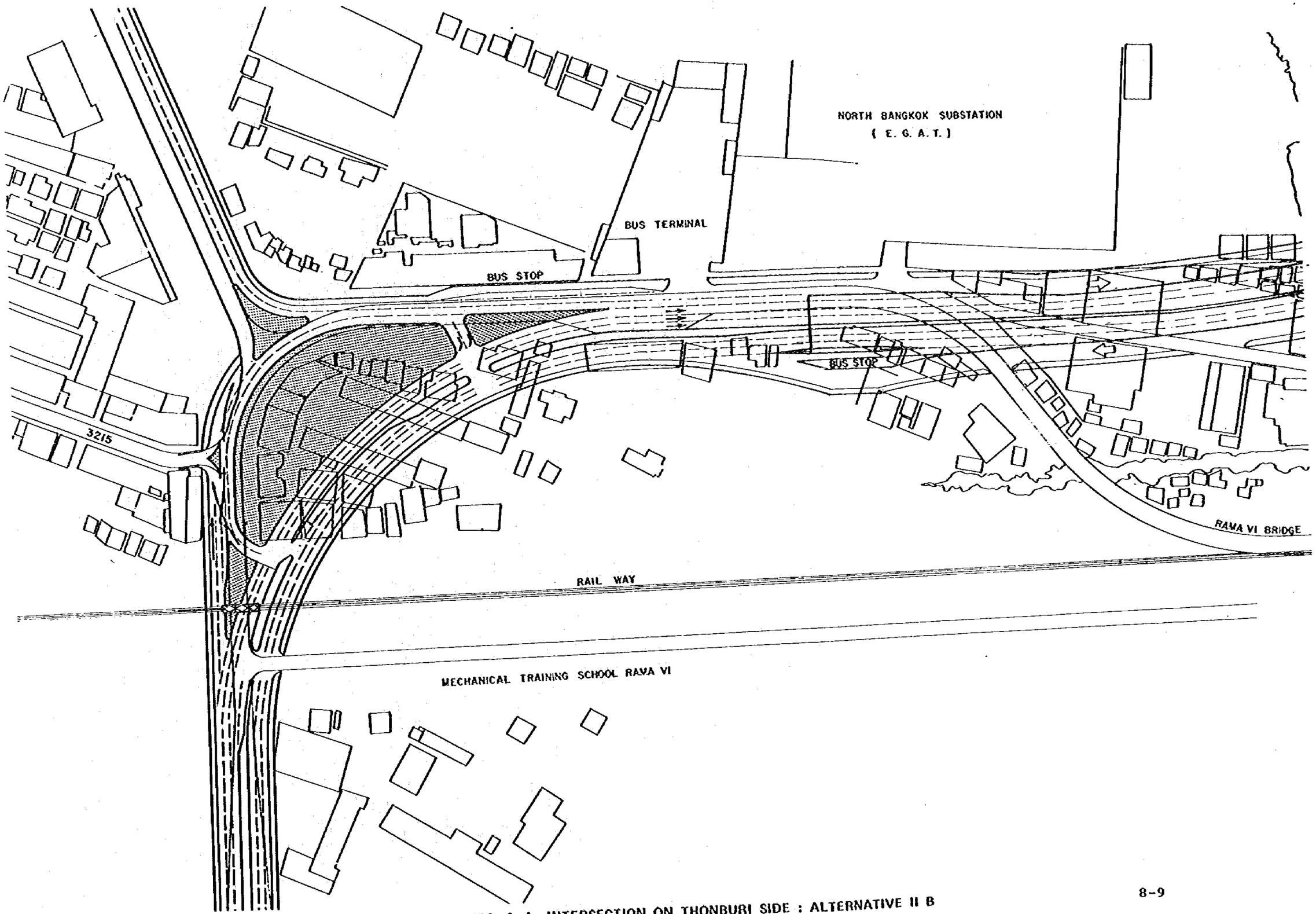


FIG. 8-4 INTERSECTION ON THONBURI SIDE : ALTERNATIVE II B

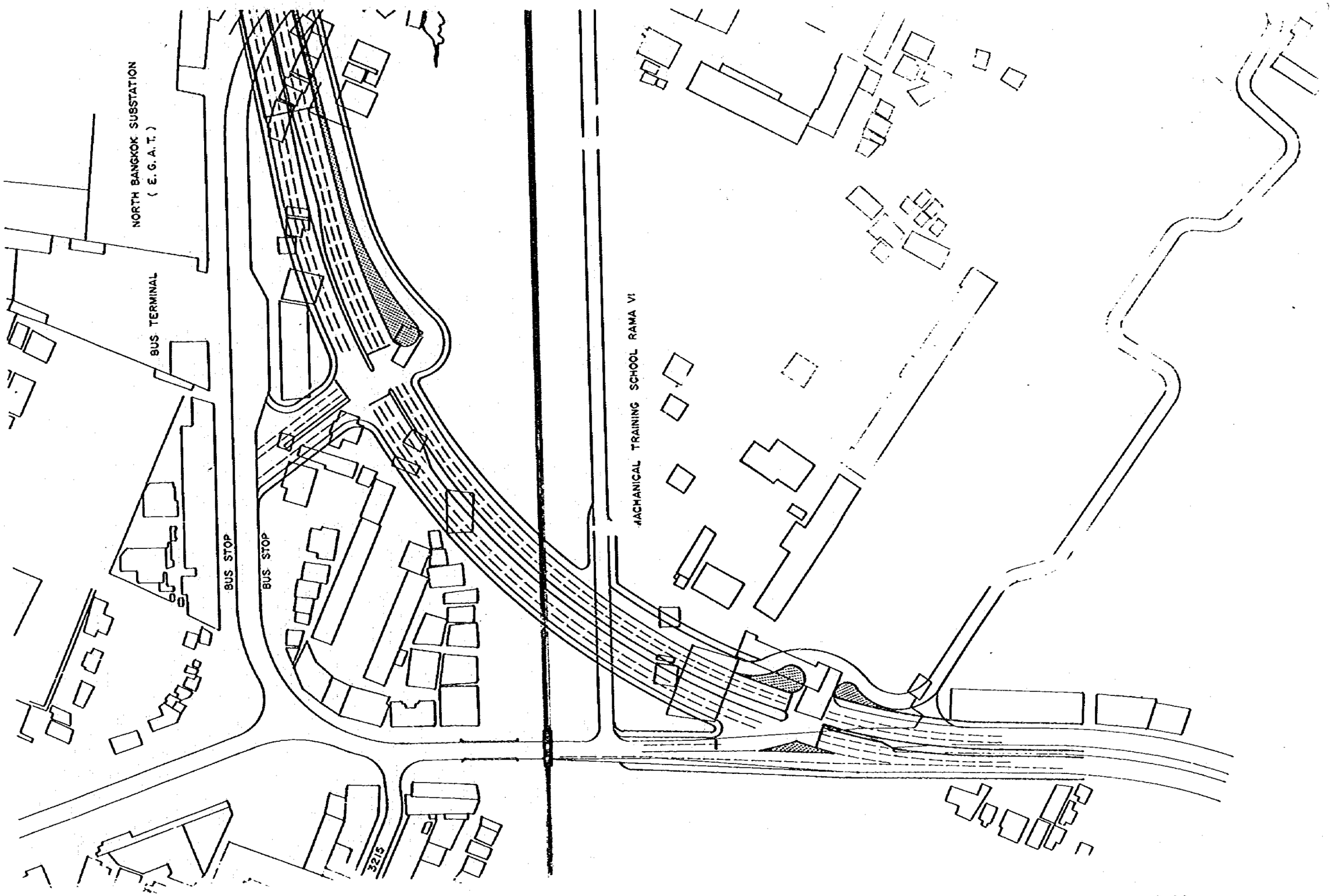


FIG. 8-5 INTERSECTION ON THONBURI SIDE : ALTERNATIVE III

8-3 MAIN BRIDGES

The horizontal and vertical alignment of the main bridge is given as a part of the optimum route alignment studies in Chapter 7. In this chapter, possible alternatives in terms of bridge structure will be investigated in accordance with the optimum route alignment.

A prestressed concrete design has been adopted for the proposed bridge, in view of previously built or planned bridges across Chao Phraya River since they have been so designed as to use more domestic materials and less imported ones.

8.3.1 Span Arrangement

The width of Chao Phraya River at the site is approximately 280 meters. The total length of the main bridge including the width of pile caps of substructure at both banks has been determined as 290 meters.

The horizontal alignment of the proposed bridge has no chaice but be askew to the centerline of the river for any conceivable alignment, and also is not parallel with the alignment of the existing RAMA VI Bridge.

Furthermore as both the existing and proposed bridges are located on a curved section of the river, so a navigational tail of barges dragged by a tugboat would not coincide with centerline of the river.

Hence a minimum horizontal clearance of 70 meters, instead of 60 meters specified by navigational requirements, should be considered as appropriate in the studies of span arrangement of the proposed bridge.

With the above design conditions of 290 meters as the total length and 70 meters for navigational clearance, the following three alternatives in terms of span arragement have been conceived for the design of the prestressed concrete bridge.

Alt. 1: 5-span arrangement
290 m = 44+61+80+61+44

Alt. 2: 4-span arrangement
290 m = 60+85+85+60

Alt. 3: 3-span arrangement
290 m = 85+120+85

The three alternatives of proposed span arrangement compared with that of the existing bridge are shown in Fig. 8.6.

As seen in Fig. 8.6, the navigational passage of Alt. 2 bridge and that of the existing bridge do not follow the same course. Barges dragged by tug boat navigating almost parallel with the Thalweg would be forced to change their direction during the short distance of about 150 meters between the two bridges.

As convoys of barges with more than 150 meters in length are frequently observed in the Chao Phraya River, this deviation in the navigational course would be highly inconvenient and can be considered to be a fatal defect for the design of a bridge. On this reason, the plan of Alt. 2 can be eliminated from our study.

As for the Alt. 1, it can be said that no fatal defect can be found in this case, as only a slight disturbance in navigation could be expected during substructure construction.

A slight elongation of 5 meters in the central span will enable the necessary width for navigation to be maintained during construction, although it results in an unfavorable structural arrangement.

In order to compare construction costs for Alt. 1 and Alt. 3, the following design conditions have been assumed.

1) In both cases, the width of actual bridge surface is expanded by about 9 meters from the bridge center towards Bangkok side in order to provide rampways. In this estimation of cost, however, it is assumed that no change would take place in the constant bridge width of 29.25 meters.

2) Superstructure is assumed to be a prestressed concrete box girder constructed by an in-situ-concrete cantilevering method.

3) As for the foundations, in-situ-concrete bored pile by reverse circulation drilling would be adopted. Piles of length 45.0 meters and diameter 1.5 meters would be used with an allowable bearing capacity of 600 ton. A result of the comparison of construction costs for both the alternatives has been obtained after estimating the quantities of major materials in an outline design.

	Alt. 1	Alt. 3
		(in million baht)
Superstructure	119	136
Sub structure	86	81
Total cost	205	217

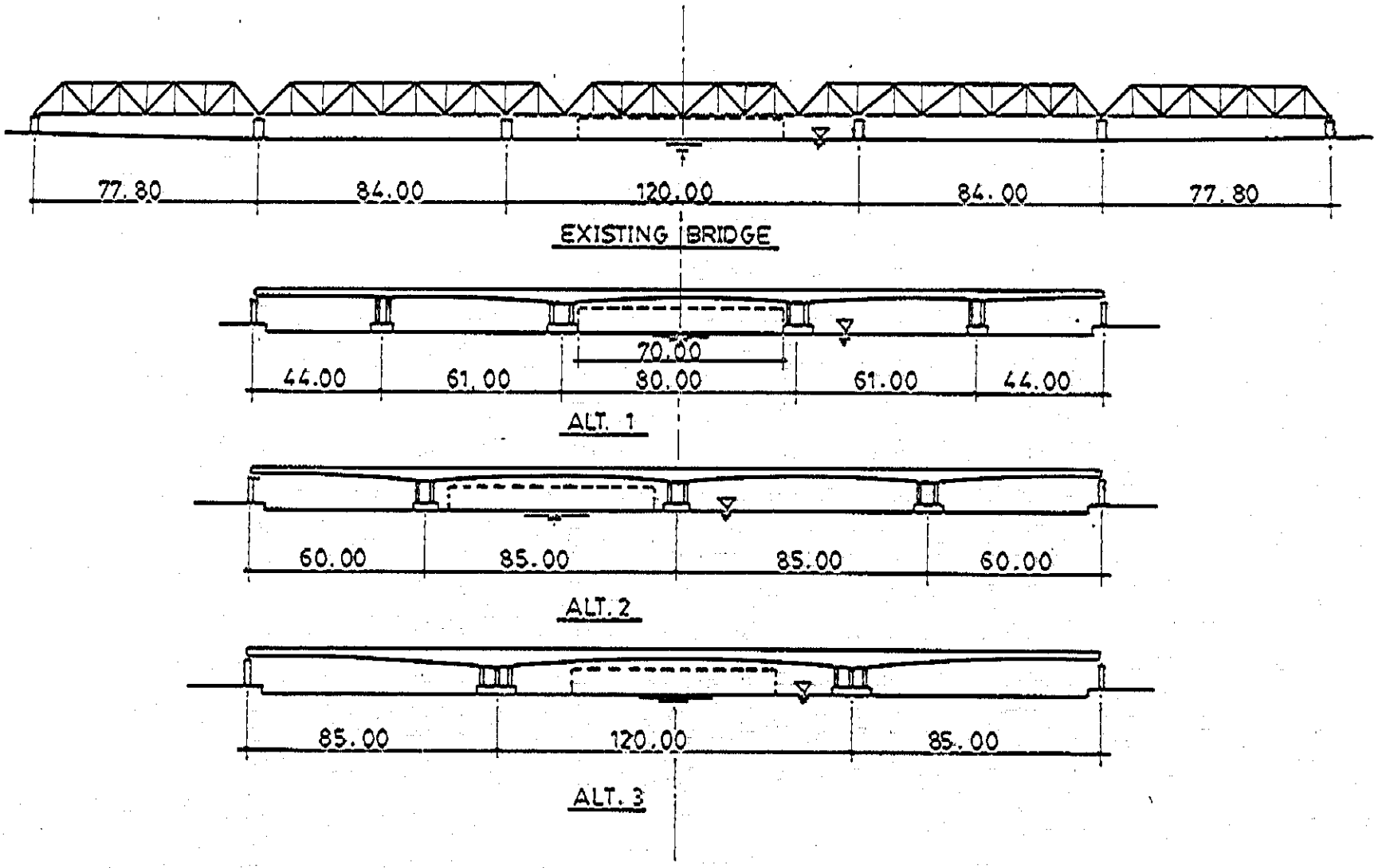


FIG. 8–6 ALTERNATIVES FOR SPAN ARRANGEMENT

The cost for alternative 3 exceeds that of Alternative 1 by 12 million baht, which equals about 6% of total cost of the latter.

However, in spite of its higher cost, alternative 3 with its three spans would be a more preferable alternative for the following reasons:

1) As the distance between both the new and the old bridges is very close and small, Alternative 3 is far better a solution aesthetically, having an almost identical span arrangement.

2) Having a wider central span in Alternative 3, navigation can be more safely maintained during construction. Being constructed in a curved section of the river, this is an important and substantial merit.

3) The difference of 12 million baht in construction cost can be regarded as negligible in terms of total cost.

8.3.2 Structural Type

SUPERSTRUCTURE

In the case of prestressed concrete bridges with a span length of up to 150 - 160 meters, it is generally admitted that boxgirder bridge type by cantilevering method is superior due to lower cost and easier construction.

In this project, a bridge type having a shallower girder depth can be regarded as a more effective design, because with thinner girders, it is possible to build a shorter rampway or to lessen the vertical gradient of the ramps, thus achieving lower costs and improved vertical alignment for the rampways.

Only two other structural types except the Box girder type, have been studied as alternatives of bridge type.

One is a cable-stayed concrete girder bridge, which is generally suitable for bridges with span lengths of more than 150 - 160 meters. Another is the concrete sail bridge

which, with its somewhat peculiar shape, also fits for the span length of the proposed bridge.

SUBSTRUCTURE

As a reliable bearing stratum for the substructure can only be located at the depth of 40 meters below MSL, the foundation structure also must be sunk down to approximately 45 meters below MSL.

Sinking of open caissons through hard clay stratum is considered to be very difficult work, and the pneumatic caisson method also cannot be used for deeper stratum such as in this case.

Only in-situ-concrete piles by reverse circulation drilling method can be utilized for the foundation structure.

This method has been practiced in many cases in Thailand and equipment and skilled labor can be mobilized abundantly.

SPAN ARRANGEMENT

With regard to the optimum span arrangement for Alternative 3 described in 8.3.1, somewhat different span lengths have to be adopted for each of the two structural types.

Both the span arrangements, however, are quite satisfactory, in regard to the design conditions stated in the previous section.

A more detailed cost estimate has been prepared for each of the three bridge types, taking the changes in width of bridge into considerations in the out-line design.

General views and cross sections of each type are shown in Fig. 8.7 to Fig. 8.9. Cross sections for the cable-stayed type are the same as the sail type bridge except for the concrete sail.
Comparisons are given in Table 8.1.

As described in the comparison table, Box girder type bridge can be applied for each alternative of alignment while Concrete sail and Cable-stayed type can be adopted only for alignment Alternative 3 which has almost straight alignment.

Costs for the Box-girder type and the Concrete sail type are almost similar and it is difficult to select the optimum type from the main bridge cost only.

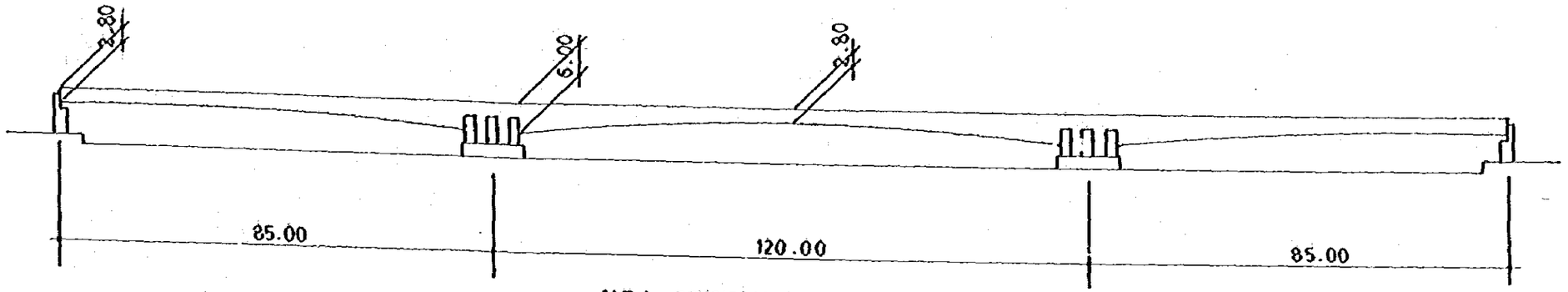
Therefore, the selection of bridge type has to be made after the viewing costs of viaducts and approach roads, and also those of land acquisition and compensation for each case of alignment and bridge type combination.

8-4 VIADUCT

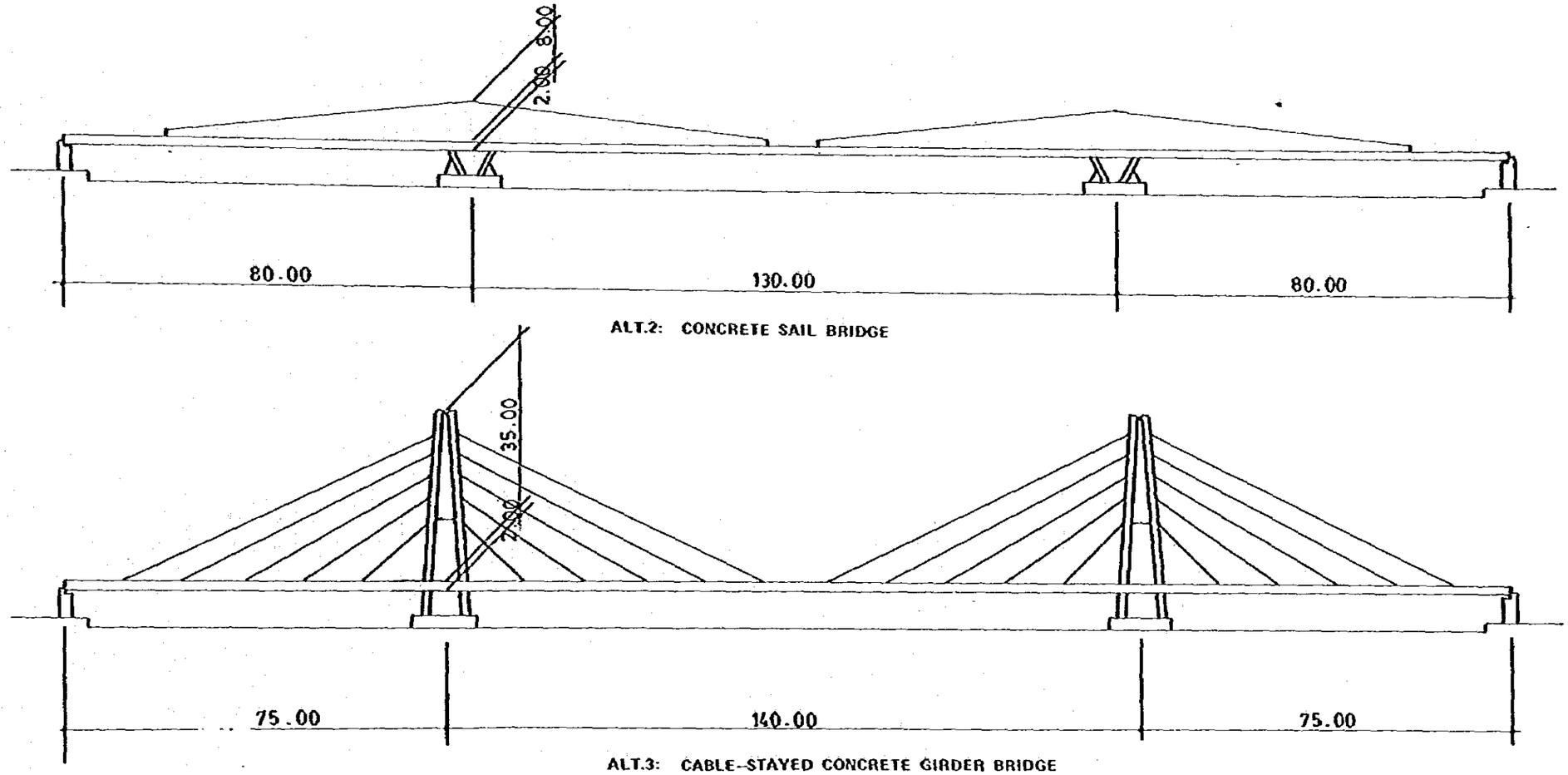
8.4.1 Highway Viaduct

On the Bangkok side of the bridge, a viaduct has been proposed to cross the Pibul Songkhram - Wongsawang Intersection.

As the flyover viaduct goes through a busy commercial area, emphasis must be placed during designing the appearance of the viaduct structure so as not to give an unpleasant view to pedestrians or inhabitants, especially in looking-up at the viaduct structures.



ALT. 1: BOXGIRDER BRIDGE



ALT.2: CONCRETE SAIL BRIDGE

ALT.3: CABLE-STAYED CONCRETE GIRDER BRIDGE

FIG. 8-7 TYPES OF MAIN BRIDGE

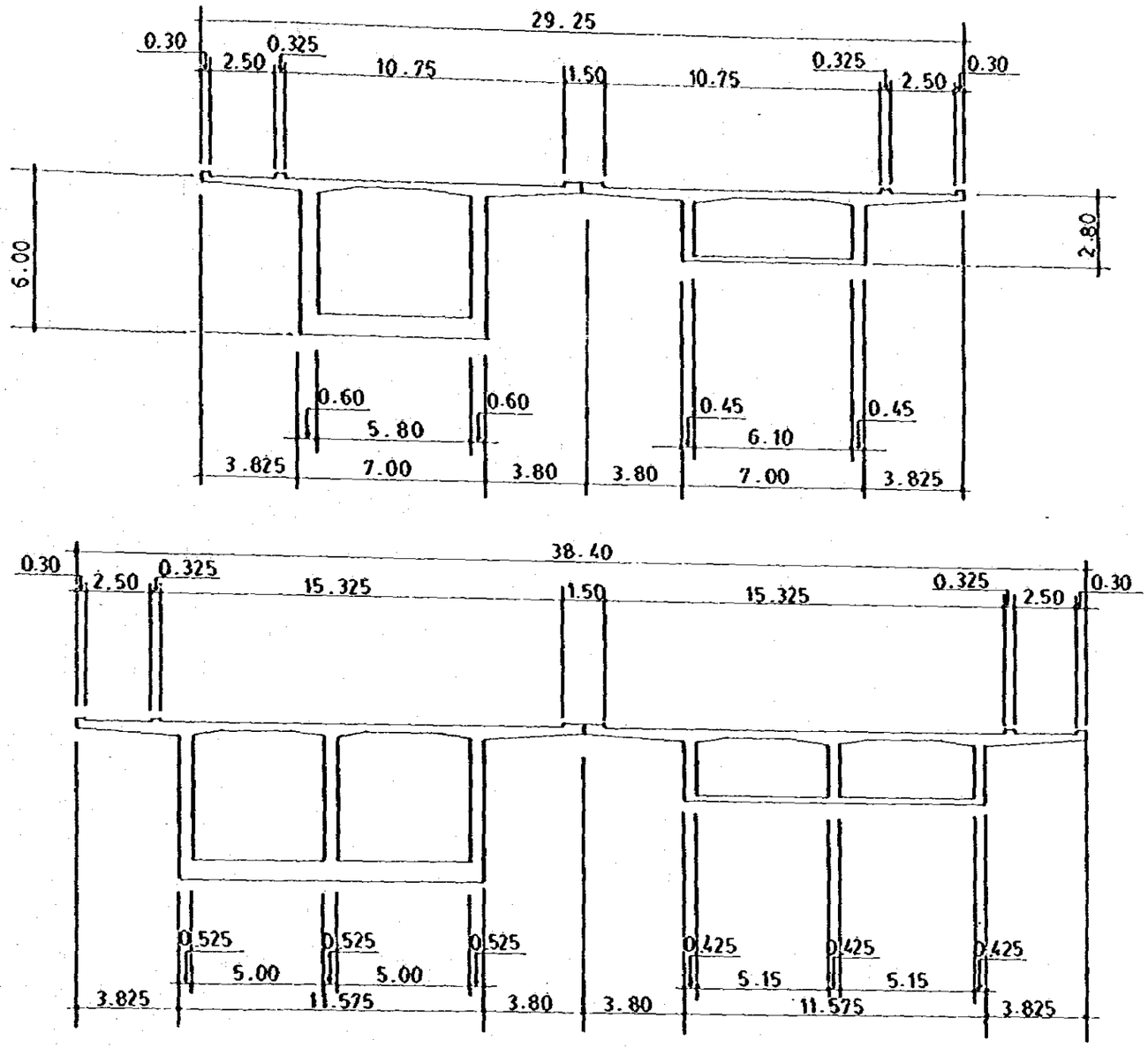
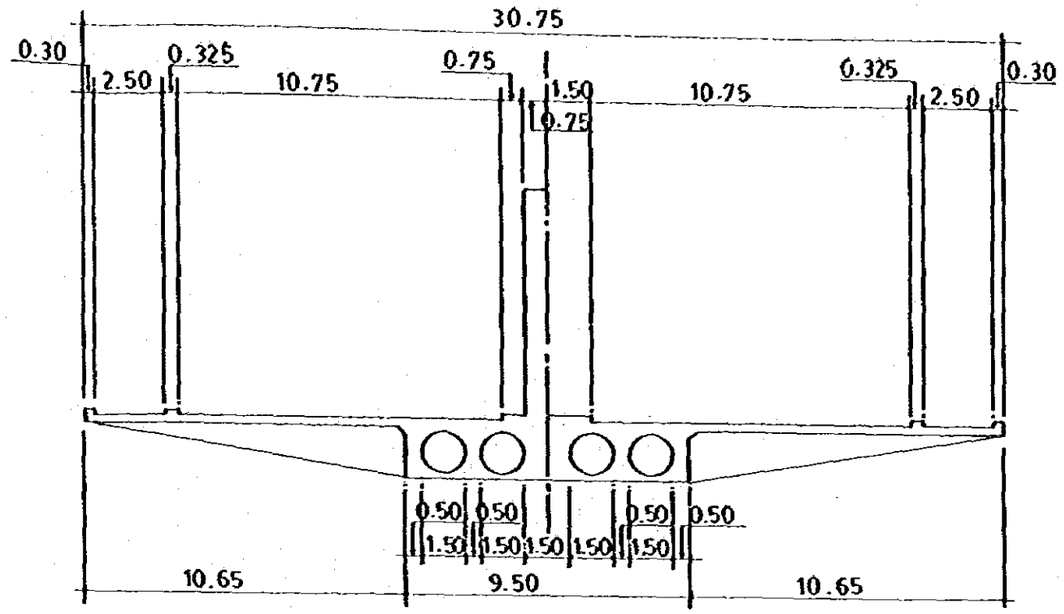


FIG. 8-8 CROSS SECTION OF BOX GIRDER BRIDGE



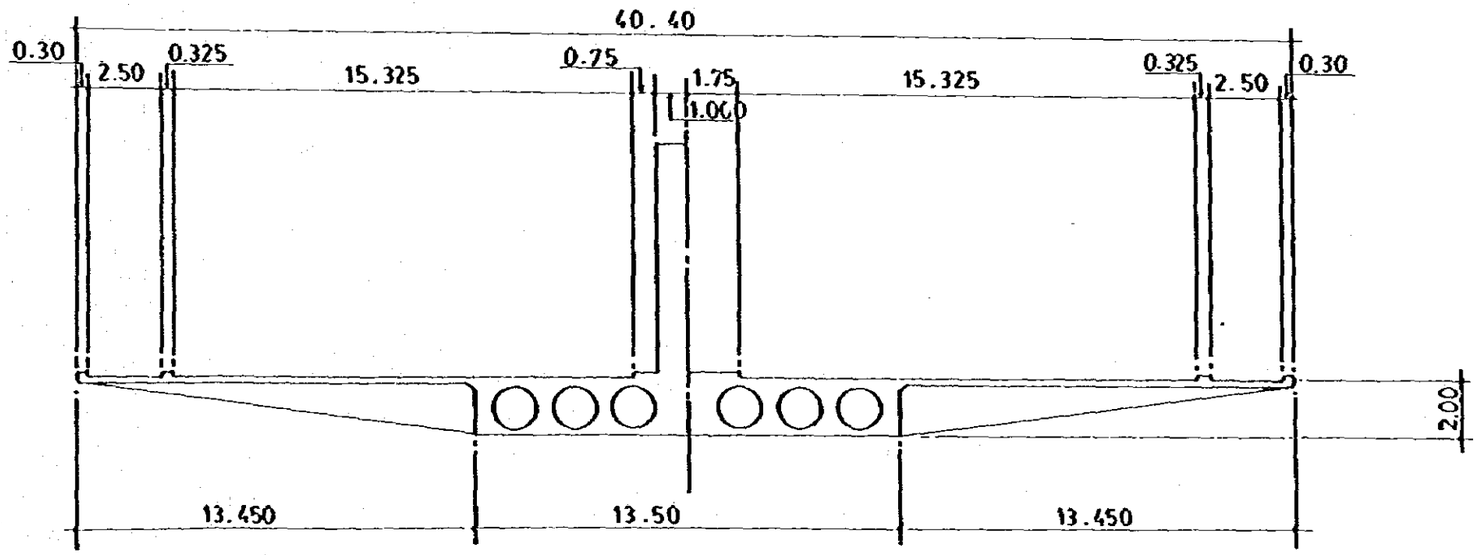


FIG. 8-9 CROSS SECTION OF CONCRETE SAIL BRIDGE

TABLE 8-1 ALTERNATIVES OF BRIDGE TYPE

	Alt.1: Box Girder Bridge	Alt.2: Concrete Sail Bridge	Alt.3: Cable-stayed Concrete Girder Bridge
Charactertics of Structure	- Possible for any horizontal and vertical alignment - High elevation of road surface due to large girder depth	- Impossible for bridge with small horizontal curve radius - Low elevation of roadway due to small girder depth	- Impossible for horizontally curve bridge - Low elevation of roadway due to small girder depth
Construction method	- Constructed by conventional cantilevering erection - Considerable merit of stage construction because the out-bound and inbound lanes are built with seperated main girders	- Constructed by conventional cantilevering erection - Little merit of stage construction because whole lanes are carried by single main girder	- High technology required for construction although main girder constructed by conventional cantilevering method - Ditto as left
Quantities of Materials	- Concrete Tck= 400kg/cm^2 = 9260^{m3} - Concrete Tck= 240 " = 3810^{m3} - Prestressing bar = 695^{t} - Prestressing wire = 0 - Reinforcing bar = 1310^{t} - Ø 1.5^{M} Bored Pile = 3240^{m}	= 8940^{m3} = 3414^{m3} = 671^{t} = 0 = 1240^{t} = 3060^{m}	= 7610^{m3} = 3240^{m3} = 529^{t} = 128^{t} = 1085^{t} = 2835^{m}
Construction Cost	Superstructure 157^{MB} Substructure 97 Total 254	Superstructure 160^{MB} Substructure 92 Total 252	Superstructure 190 Substructure 85 Total 275
Approach	- Long approach due to high elevation of roadway on the main bridge	- Short of approach or smaller grade possible due to lower elevation of carriage-way on the main bridge	- Ditto as left
Appearance	- Poor aesthetical conformity between existing trussed girder bridge and new deck box girder bridge	- Harmonious Appearance of both through type bridges - Oppressive feeling to driver travelling on innermost lane by concrete sail wall	- Ditto as left - Slender and light appearance

Since it is necessary to provide waiting zones for right-turning vehicles under the viaduct, and also to maintain sufficient sight distance, (a traffic signal will be installed at the Intersection) slender piers at long spacings are more preferable as design.

Under these conditions, a mushroom type prestressed concrete structure, as shown in Fig. 8.10, can be considered as the most appropriate viaduct design.

For the section adjacent to the flyover section, a one-leg mushroom type pier and longer span will not be necessary. Also if rampways diverging from the end of the main bridge were designed so as to join on to the surface streets under the viaduct, the right of way can be reduced substantially.

As a solution, a reinforced concrete voided also has been adopted, with cross sections shown in Fig. 8.10, having a span length of 16 - 18 meters. A cantilever slab configuration at both ends of the cross section is similar to that of the flyover section and also has the same girder depths, resulting in an aesthetically harmonious appearance. Having a span length of 3.25 meters for the cantilever slab, one lane of rampway can be installed under the slab.

The viaduct portion of the rampways and also of the Thonburi side approach will have same cross section as the Bangkok side approach, in order to achieve more repetitious forms and falsework and subsequently more economy.

Cross sections for each section are shown in Fig. 8.10.

For the section with vertical clearance of less than 2.5m, abutment structure and transition structure will be adopted. These are of the same design used for all new bridges recently designed in Bangkok.

In Fig. 8.11 various structural types in design of viaduct including those of main bridge are described.

For the foundation of the viaduct, precast concrete piles 20m long have been adopted, as for all viaducts built in Bangkok.

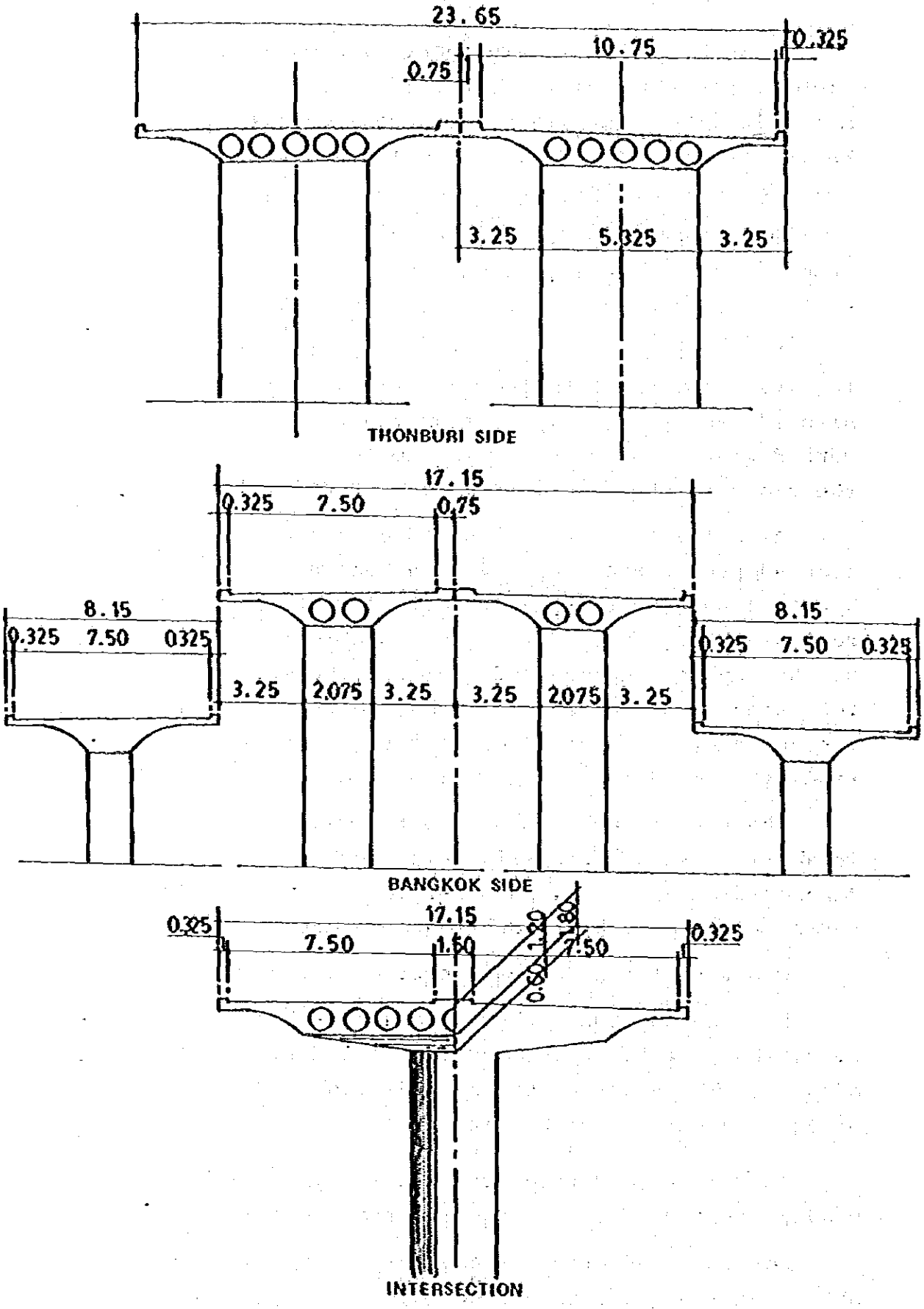
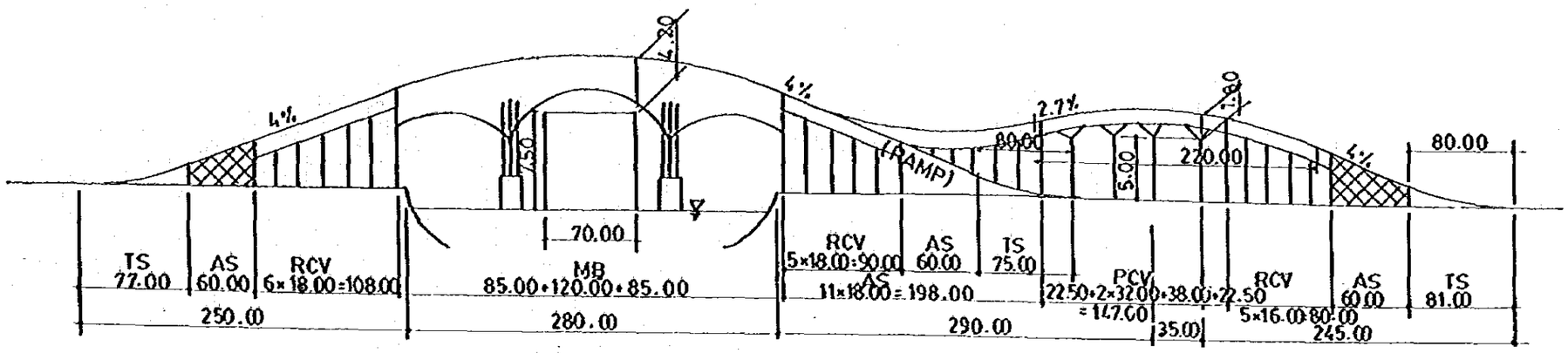
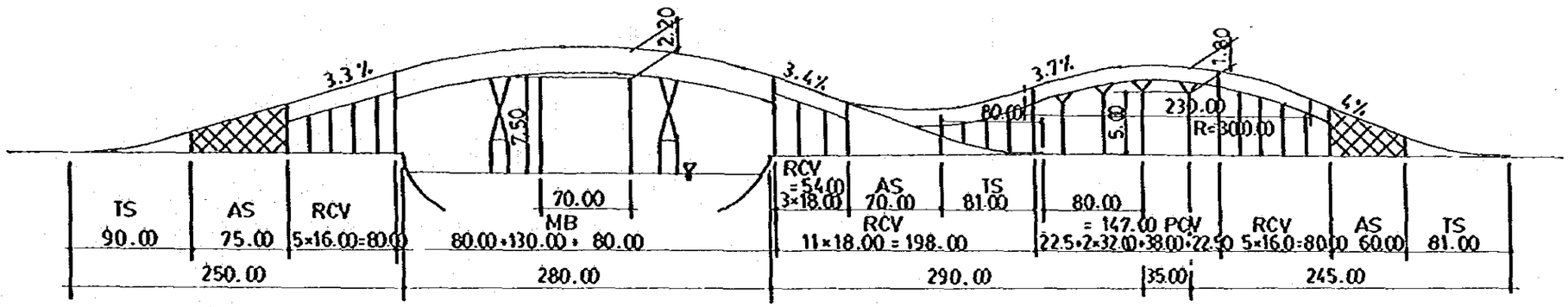


FIG. 8-10 CROSS SECTION OF APPROACH VIADUCT



CASE 1 : MAIN BRIDGE - DECK TYPE



CASE 2 : MAIN BRIDGE - THROUGH TYPE

LEGEND

TS: TRANSITION STRUCTURE
AS: ABUTMENT STRUCTURE
RCV: REINFORCED CONCRETE VIADUCT
PCV: PRESTRESSED CONCRETE VIADUCT
MB: MAIN BRIDGE

FIG. 8-11 ARRANGEMENT OF EACH STRUCTURE FOR VIADUCT

8.4.2 Railway Viaduct

All route alternatives cross the railway, necessitating construction of a railway viaduct, which brings forth the following engineering problems.

1) The difference in elevation between the railway and the roadway is very small and, to attain necessary vertical clearance for the roadway, the viaduct has to be a through-type railway bridge which is more expensive than deck type bridge.

2) It is impossible to halt either railway or highway traffic for the sake of construction.

Therefore a highly complicated construction procedure has to be adopted in the construction of the viaduct.

a) Select the time of a day when train traffic is most sparse.

b) H-shaped steel piles are driven through the embankment into a bearing stratum, without touching any rails, sleepers or ballast bed.

The piles are to be used for trench timbering during construction and in a later stage to be utilized as the foundation of the viaduct.

c) After driving all the piles, stringers and cross beams (which directly support the sleepers) are connected to the H-shaped piles.

d) At this stage work can proceed within the site area surrounded by the H-shaped piles, without hindering railway traffic, by excavating the embankment and inserting sheathing plates between the adjacent H-piles, thus building the substructure of the viaduct.

e) Girders are manufactured alongside the railway track at the finally proposed elevation, then a sliding bed is prepared beforehand, spanning the manufacturing bed and constructed abutment or piers. Finally the girder will be transferred to the specified position for complete erection.

In any of the route alternatives, piers of the railway viaduct can be built on median strip of roadway. Spans of viaduct can be arranged as:

Route ALT. II A	17.5 + 17.5 = 35.0 m
Route ALT. II B	15.0 + 15.0 + 15.0 = 45.0 m
Route ALT. III	25.0 + 25.0 = 50.0 m

In Fig. 8.12 is shown cross section of through type prestressed concrete railway bridge having spans of 25 meters.

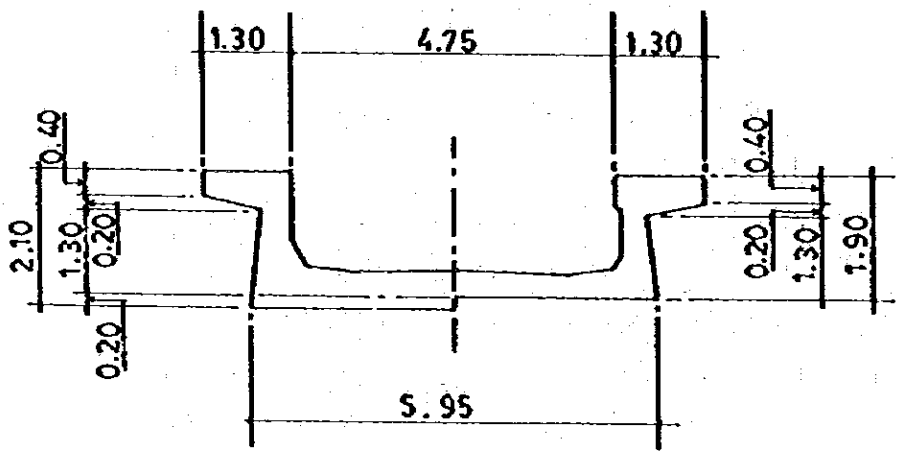


FIG. 8–12 SECTION OF P.C. GIRDER FOR RAILWAY VIADUCT

8-5 TENTATIVE COST ESTIMATE

The construction and maintenance costs are one of the basic inputs for Chapter 9 Economic Evaluation, and some of the figures mentioned in this section have previously been utilized in section 8.3, Main Bridge.

The costs mentioned in this section are based on August 1981 prices without allowances for future inflation as this format is required for the Economic Evaluation of Chapter 9.

8.5.1 Unit Costs

Unit costs for each construction item has been established using basic cost elements such as labour, materials, equipment, overhead, profit etc.

In computing the unit costs it has been assumed that all construction work will be contracted to general contractors by international tender. Estimates for each of the various alternatives of route and Main Bridge Type available have been produced and the proportion of local and foreign expenditure contained within the total cost of each item have been differentiated.

The local currency component includes the costs of:

- Domestic materials and supplies of which the country is a net exporter.
- Wages of local personnel.
- Overhead and profit of local firms.
- Local taxes.

The foreign currency component includes the cost of:

- Imported equipment, materials and supplies
- Imported materials of which the country is a net importer.
- Wages of expatriate personnel.
- Overhead and profit of foreign firms.

In determining the unit costs of each work item, the labour cost, equipment cost, material cost etc. for the item have been accumulated to obtain the direct unit cost. To this direct cost a percentage has been added to cover indirect costs such as overheads, profits, general site expenses, business tax, interest etc. Various percentage between 18 and 25% are added depending upon the item. Finally the resulting total unit costs have been compared against recent actual figures for construction work in Thailand.

In this section the cost of any Thai tax or duty on imported equipment and materials is included. However the Economic Evaluation requires these taxes and duties to be disregarded.

1) Basic Costs of Materials

Extensive inquiries with regard to the basic cost of materials have been executed. The unit costs of the major construction materials are shown in Table 8.2. The imported materials are based on the CIF Bangkok price whereas those of local materials are based on the market prices in Bangkok.

2) Basic Costs of Labour

The unit labour costs are based on the actual costs prevailing in Bangkok. Table 8.3 shows the costs by major labour classifications.

3) Unit Cost by Work Items

This direct unit costs have been determined from the basic costs outlined above and a percentage to cover indirect costs added. The unit costs thus obtained have then been compared with similar items in recent tender bids and adjustments have been made wherever necessary.

In comparing unit costs data from the New Memorial Bridge project, which has been just contracted, and

Pathumthani and Nonthaburi Bridge projects, which the cost of estimation was performed last year, have been used.

The construction items have been subdivided into road construction, bridges, culverts and miscellaneous and are shown in Tables 8.4 to 8.6 respectively.

To estimate separately for each item the breakdown of costs and taxes is a difficult task and it is not likely that the results would be of a very high accuracy as every factor cannot be accounted for each item. Therefore a detailed breakdown has been carried out and the average for selected representing items has been calculated. The average figures obtained have been applied to other similar items. The errors involved in this procedure are likely to be minimal and this method is considered superior to carrying out an approximate breakdown on every item.

Table 8.2 Unit Cost of Major Materials (Baht)

Major Material	Unit	F.C. *1 Component	L.C. *2 Component		Total
			NET	TAX	
Fuel (Diesel Oil)	Lit.	7.24	-	1.48	8.72
Reinforcing Bar (Deformed)	ton	2880	5180	580	8,640
Prestressing Tendon	ton	18170	-	1,380	19,550
Fine Aggregate	m^3	-	141		150
Coarse Aggregate	m^3	-	74		80
Cement	ton	129	1130		1,399
60/70 Bitumen	ton	4760	-		5,160

NOTE : F.C. ..... Foreign Currency
L.C. ..... Local Currency

Table 8.3 Labour Costs (Baht/hour)

Item	F.C. Component	L.C. Component		Total
		NET	TAX	
1) Foreign Labour				
Senior Supervisor	269.1	-	75.9	345.0
Supervisor	193.2	-	36.8	230.0
2) Local Labour				
Class I Supervisory Staff				
General Foreman, Foremen, Heavy Equipment Operator, Survey Party Chief	-	26.1	1.4	27.5
Class II High Skilled				
Equipment Operator, Laboratory Supervisor, Mechanic	-	20.9	1.1	22.0
Class III Skilled (A)				
Carpenter, Steelworker, Mason Labour, Welder	-	15.7	0.8	16.5
Class IV Skilled (B)				
Truck Driver, Pick up, Jeep Driver	-	13.1	0.7	13.8
Class V Unskilled				
Common Labour	-	7.9	0.4	8.3

The estimated labour rates include social benefit, insurance, travel costs, sick leave, etc.

Table 8.4 Road Construction - Unit Costs (Baht)

Description	Unit	Foreign	Local		Total
			NET	TAX	Unit Cost
Clearing and Removal of Existing Structure	m^2	5.91	5.91	1.18	13.00
Excavation and Embankment	m^2	4.95	4.96	1.09	11.00
Embankment Fill of Sand/Clay	m^3				
Selected Material Improved Subgarde	m^3	117.60	93.60	34.80	146.00
Laterite Subbase	m^3	108.20	86.60	31.20	226.00
Crushed Rock Base	m^3	203.00	161.00	60.00	424.00
Bituminous Prime Cost	m^2	6.80	5.40	2.00	14.20
Asphaltic Concrete Surface 50 mm thick	m^2	52.10	41.20	15.20	108.50
Double Surface Treatment	m^2	30.30	24.10	8.90	63.30

Table 8.5 Bridges - Unit Costs (Baht)

Item	Unit	Foreign	Local		Total
			NET	TAX	Unit Cost
Concrete	m^3	167	1,286	217	1,670
Slide Brg. 500 t	each	127,300	122,300	37,400	287,000
Sliding Hinge	each	208,100	72,100	179,800	460,000
Expansion Jnt.	m	31,300	25,600	17,100	65,400
Steel Form	m^2	703	1,056	261	2,020
Deformed Bar	t	4,890	9,290	2,120	16,300
Prestressing stands..12-T12.7	t	37,200	25,900	9,400	72,500
P.S, wire ...Ø 7 (stay cable)	t	210,000	51,000	39,000	300,000
P.S. bar ....Ø 32	t	46,100	32,100	11,700	89,900
Ø 1.5m C.I. Bored Pile	m	13,500	6,500	3,000	23,000
Ø 0.60m P.C. Pile	m	230	680	110	1,020
0.35m Sq. P.C. Pile	m	130	450	90	670

Table 8.6 Miscellaneous - Unit Costs (Baht)

Description	Foreign	Local		Total Unit Cost
		NET	TAX	
Steel Guard Rail	550	170	100	820 ฿/m
Street Lighting (180W, 12 m single bracket pole)	9,010	2,540	1,450	13,000 ฿/each
Traffic Signal	308,000	97,000	55,000	460,000 ฿/set
Pavement Marking	130	40	20	190 ฿/m^2

The percentage breakdowns used are shown below:

Item	Foreign	Local	Tax	Total
Earthwork	45	45	10	100
Pavement	48	38	14	100
Bridges	43	44	13	100
Culverts	43	44	13	100
Miscellaneous	67	21	12	100

8.5.2 Land Acquisition and Compensation

In the influenced area of this project, there exist many factories, office buildings, stores, a power generating plant of EGAT and residences.

Prices of land acquisition and compensation have been investigated with assistance from PWD, local government and the Metropolitan Electricity Authority (MEA).

As accurate data have not been collected at the stage of preparing the report, approximate data obtained through investigation have to be used as a substitute in this report.

As the compensation amount for relocating the electric cables across the river will be a considerable sum, another extra alternative has been investigated, in which the

horizontal alignment of the main bridge is so moved slightly southward so that the relocation of the cables will not be necessary. In this case compensation for the factories and buildings will be increased, and the sum of land acquisition cost and compensations amount will be more expensive than as in Alt. III. Therefore the extra alternative has been deleted as an unfavorable plan.

The summary of these estimates are shown below and unit prices of major items are given in Table 8.7.

Land Acquisition and Compensation

(in million baht)

	Land Acquisition	Compensation
ALT. II A	38	187.4
ALT. II B	53	203.0
ALT. III	51	143.6
ALT. extra	45	174.0

Table 8.7 Land Acquisition Cost and Compensation

UNIT COST FOR LAND ACQUISITION

Location	Unit	Unit Cost	Remarks
Thonburi side	฿/s.m	1,000	Right of way
Bangkok side	฿/s.m	1,500	Right of way

COMPENSATION FOR HIGHTENSION ELECTRIC CABLES, FACTORIES, BRICK - BUILDINGS AND HOUSES

Description	Unit	Unit Cost	
Removing of cables across the river	฿/L.S	35,000,000	$\binom{69\ KV}{12\ KV}$, 1 circuit, including new cable
Construction of New cables on land	฿/k.m.	2,000,000	$\binom{69\ KV}{12\ KV}$, 1 circuit, including poles and other
Factories	฿/each	5,000,000 -15,000,000	Plywood or iron work or match factory
Brick Buildings	฿/S.M.	2,500 - 2,800	including compensation for business
Houses	฿/S.M.	1,540	including compensation for removal

8.5.3 Construction Cost

Construction Costs for the feasibility study use has been estimated on the basis of calculated quantities and unit prices obtained in outline design.

1) Cost of Roadway

For each route alternative, rehabilitation or improvement of existing roads is involved. It is, therefore, imperative to eliminate nuisance for the present traffic during construction of roads and viaducts.

In widening of road way, which is necessary for all parts of the existing roads, the widened section has to be first completed and then after transfering of traffic to the newly built lane, the existing roadway can be reconstructed. These staged construction processes necessitate a higher than usual cost and has been reflected in this cost estimate.

In Alternative I, as the railway has to be reconstructed at the same location as the existing railway viaduct, an extraordinary high cost has resulted in order to maintain railway and highway traffic during the works. The additional cost has been included in the cost of railway viaduct cost.

2) Main Bridge and Viaduct

In case of the Main bridge and viaducts, the construction cost of the structures has been calculated based on unit rates and quantities obtained in outline desing.

As described above in 1), construction of the railway viaduct results in additional cost due to stage construction.

3) Overall Cost

The initial construction cost estimates cannot account for every single item required for the construction, and a contingency sum of 10% has been added to cover unbilled items and necessary revision of outline design.

Administrative costs of the PWD and the consultants supervision fees have been assumed to amount the 7% of the total contract sum.

The total costs calculated for each alternative route and for the main bridge are summarized in Table 8.8 and breakdown of foreign and local portions of costs in Table 8.9.

8-6 TENTATIVE MAINTENANCE COST ESTIMATE

Maintenance has been defined as "the preserving and keeping of each type of roadway, roadside, structure, and facility as nearly as possible in its original condition as constructed or as subsequently improved, and the operation of road facilities and services to provide satisfactory and safe transportation". The maintenance costs comprise the costs of yearly maintenance of road and structures and the costs for resurfacing the entire road periodically.

The approach roads are to be of bituminous surfacing with double seal surface treatment. Routine maintenenance will therefore comprise mainly cleaning and repairing costs.

Cleaning costs include such items as cleaning the road surface, cleaning drains and culverts, cleaning traffic signs and other road facilities and the cutting and Watering of grass and shrubs. Routine repair costs comprise minor repairs to the road surface and making good any minor damage to road furniture etc. Annual repainting of junction markings has also been included under this general heading.

Table 8.8 Summary of Overall Cost

Million Baht

Alternatives of route	Alt.II-A	Alt.II-B	Alt. III		
Alternatives of Main-bridge	Alt. 1	Alt. 1	Alt. 1	Alt. 2	Alt. 3
Contract Sum	494.4	498.5	499.8	492.2	515.2
Main Bridge	(254.0)	(254.0)	(254.0)	(252.0)	(275.0)
Highway Viaduct	(156.4)	(156.4)	(156.4)	(150.8)	(150.8)
Railway Viaduct	(9.0)	(9.1)	(10.4)	(10.4)	(10.4)
Road Work	(75.3)	(79.0)	(79.0)	(79.0)	(79.0)
Land Acquisition	38.0	53.0	51.0	51.0	51.0
Compensation	187.4	203.0	143.6	143.6	143.6
Physical Contingency	72.0	75.5	69.4	68.7	71.0
Administrative cost including Consultants Fee	34.0	34.9	35.0	34.5	36.1
Total Project Amount	826.7	864.9	798.8	790.0	8169

Table 8.9 Breakdown of Foreign and Local Currency Portions of Costs

Million Baht

Alternative		Foreign	Local Currency		Total
Route	Bridge	Currency	Net	Tax	
Alt.II-A	Alt. 1	318.9	416.9	90.9	826.7
Alt.II-B	Alt. 1	325.7	444.9	94.3	864.9
Alt.III	Alt. 1	310.2	399.1	89.5	798.8
	Alt. 2	306.0	395.5	88.5	790.0
	Alt. 3	318.2	407.2	91.5	816.9

The bridges are to be of concrete construction and should be relatively maintenance free. Routine maintenance is therefore confined to the costs of electricity for lighting, cleaning and minor repairs.

Cleaning of lighting structures, guard and hand rails, expansion joints, drainage facilities and metal bearing will be necessary.

Routine minor repairs to light fittings, guard rails and the running surface may also be required.

Periodic maintenance to the road surface has been assumed to comprise of a bituminous overlay every 7 years with repainting of the hand rails, guard rails and other road furniture at the same time.

In the case of the main bridges a major overhaul and cleaning of the bearings and expansion joints has been assumed at a 7 year interval.

The cost of the above operations is summarised below, and a contingency of 10% are also included under "others".

Yearly Maintenance Cost - Million Baht

Item	Cost
Electricity	11.00
Cleaning	0.06
Repair Cost	0.05
Others	1.11
Total	12.22

Periodic Maintenance Cost - Million Baht

Item	Cost
Overlay	3.91
Painting	3.00
Repair Cost	0.82
Other	0.77
Total	8.50

8-7 CONSTRUCTION SCHEDULE

A conventional cast-in-sutu method will be used in the construction of the proposed main bridge partly because of the asymmetrical cross section of the Bangkok side span.

The method has been practiced in many cases of bridge construction in Thailand and has been regarded as most reliable and economical on account of availability of material and equipment.

A time schedule for construction of this project is given in Fig. 8.13. This schedule has been planned so as to achieve maximum repetition of use of expensive equipment and machinery such as the crawler crane, reverse circulation drilling rigs, travelling scaffolding for cantilevering process and false works and forms in order to reduce construction cost.

Assuming that a notice to proceed could be issued after six months from the start of land acquisition, the whole construction including roadways and bridges would be completed in 30 months ($2^1/2$ years) after a notice to proceed.

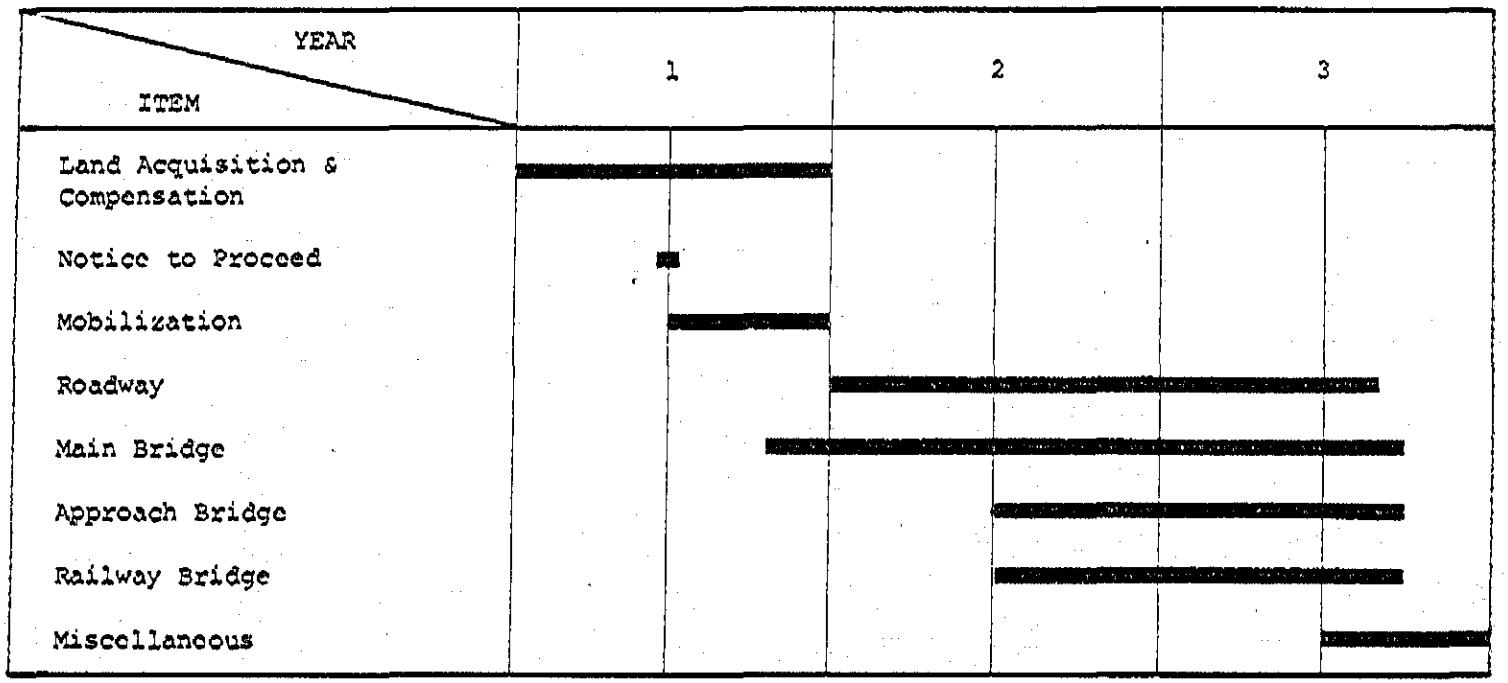


FIG. 8-13 CONSTRUCTION SCHEDULE

CHAPTER 9

TENTATIVE ECONOMIC EVALUATION

CHAPTER 9 TENTATIVE ECONOMIC EVALUATION

9-1 DEFINITION OF BENEFIT

Completion of a new traffic project brings forth various impacts to its affected area. The effect can be defined as the difference with and without scenario. It is, however, almost impossible to investigate full effects in advance. According to nature of the project, it is universally admitted to estimate benefit of the project by calculating automobile relevant effects. Since the present project is not construction of a new bridge but improvement of the existing bridge in nature, from the time of identification it has been approached from the point of view in effect that the capacity of volume and traffic treatment ability of the present bridge would become insufficient in near future.

The present study, therefore, has to follow these view points and as the investigation progressed, it is strongly recognized that this project plays an important keyrole in solving congestion of urban traffic around the wide area involving Bangkok, Thonburi and Nonthaburi.

From this reason, future benefit should have been measured by simulating all possible link-node conditions in both cases of with and without project on overall traffic network in the wide area over the three changwats.

For the present study, this method has been considered impossible because of unavailability of necessary data, therefore, benefit has been estimated using a conventional method quantifying available data as much as possible.

As regard with the effects for which quantification are difficult, they are to be described only qualitatively after calculation of economic evaluation.

The following items are to be exempted from benefit estimation on this study.

a) Effect of elimination or mitigation of congestion for other bridges and road networks due to the limited traffic study.
b) Economic loss, due to 12-ton load limit of the present RAMA VI Bridge.
c) Effect of economic development stimulated by closer linkage of three changwats of Bangkok, Thonburi and Nonthaburi.

Accordingly, direct benefits will be the total of the following items.

1) Traffic, proper to RAMA VI Bridge
   a) Reduction (or increase) in vehicle operating costs, due to shorter (or longer) travel distance.
   b) Reduced (or increased) v.o.c., due to difference of running speed in the Project Area.
   c) Decrease in time-loss due to mitigation of traffic congestion with and without project.

2) Diverted Traffic (with project passing RAMA VI Bridge and without project passing other bridges)
   d) Difference subtracting v.o.c. via without project route from v.o.c. via with project route.
   e) Reduced travel time compared by using project route without using project route.

3) Induced Traffic
   Induced traffic is calculated in traffic forecast against the total of 1). As for the theory of transport economics, the benefits of induced traffic is halved as of normal traffic.

4) Reduced Maintenance Cost
   Benefit is calculated as the difference of maintenance costs of present and new bridges.

5) Savings from the loss to use detour

It is estimated that Middle Ring Road will have more than 50,000 traffic at the date of opening. Supposing construction of New RAMA VI Bridge is rejected, present RAMA VI Bridge would be the bottleneck of traffic. Then quite a substantial amount of traffic is supposed to be detoured.

The difference of distance and necessary time by given possible speeds between utlitizing New RAMA VI Bridge and those of detour are considered as the benefit of this project.

9-2 ESTIMATE OF ECONOMIC BENEFIT

9-2-1 Vehicle Operating Costs

Vehicle Operating Cost components enumerated in this analysis are calculated on the basis of bench mark speed of vehicles. The bench mark speed is considered as the normal or average speed of vehicles, provided the traffic volume has not reached at a level of congestion and subsequent slowing down of traffic.

The speed of 50 kilometers per hour is adopted as the bench mark speed. In computing cost per kilometer in the below stated items, the case of running at bench mark speed has been assumed. In the calculation of actual benefits, this bench mark speed is revised according to a supposed running speed. It can generally be said that vehicle operating cost becomes minimum at adopted bench mark speed. Nevertheless, in calculation of Depreciation and Interest Cost, actual running speed are taken into accounts.

a) Vehicle Operating Cost components.
Among the vehicle operating costs, the following items are taken into accounts to form the total vehicle operating Cost.

i) Running Costs:
- Fuel consumption
- Engine oil consumption
- Tyre wear
- Maintenance cost on spare parts
- Maintenance labour cost
- Vehicle depreciation
- Crew costs (commercial vehicles only)

ii) Standing Costs:
- Interests cost of vehicle
- Overhead cost

The calculation of the above items is based on mid 1981 price and economic bases excluding taxes and duties imposed.

Financial and Interest costs have been exempted, since in this study only economic analysis is conducted.

b) Representative Vehicle

After observing of traffic on the streets of G.B.A. and interviewing with automobile dealers the following vehicles have been selected to represent the group of vehicles.

Passenger car ..... Toyota Corona, Datsun 1500 with about a 1000 cc. engine, approx. 80 Hp.

Light Truck ..... Toyota Hilux, Nissan 1300 with a load capacity of 1.0 ton

Heavy Truck ..... Isuzu two 80 H_J with an engine of 6,100 cc. 130 Hp.

Light Bus ..... Isuzu Faster

Heavy Bus ..... Isuzu BD 61 with the an engine of 6,400 cc. 140 Hp.

c) Fuel and Engine Oil

The fuel and engine oil consumption of each representative vehicle at the bench mark speed are as follows.

Table 9-1 Fuel and Engine Oil Consumption

Vehicle Type	Fuel consumption L/ 1000 Km	Oil consumption L/ 1000 Km
Passenger Car	90	1.0
Light Truck	130	1.3
Heavy Truck	220	2.2
Light Bus	130	1.3
Heavy Bus	170	2.2

Note: Estimated, based on "Outer Bangkok Ring Road Study", "Road User Costs in Thailand, 1974" and several Japanese studies.

The prices of fuel and engine oil in Bangkok are studied as follows:

Table 9-2 Fuel and Engine Oil Price

Baht / Litre, Mid 1981 price

Cost Items	Retail Price	Tax & Duty	Economic Cost
Gasoline: Regular	11.40	2.02	9.38
Super	11.90	2.02	9.88
Diesel	7.39	0.32	7.07
Engine Oil	30.00	1.56	28.44

Note: .... Following "Outer Ring Road Study", 1978.

Passenger cars in Bangkok consume 20% of regular and 80% of super gasoline, therefore, an average economic cost of the gasonline is to be 9.78 Baht/liter.

Table 9-3 Economic Cost of Fuel & Oil per Km by Vehicle Types

Baht/Km, Mid 1981 price

ITEMS	Passenger Car	Light Truck	Heavy Truck	Light Bus	Heavy Bus
Fuel	0.88	0.92	1.56	0.92	1.20
Oil	0.03	0.04	0.06	0.04	0.06

d) Tyre Wear

The tyre wear cost is calculated as shown in Table 9-4.

e) Maintenance cost for spare parts and labour

By making reference to the report of "Quantification of Road User savings" by Jan de Weille, following costs calculations are adopted as shown in Table 9-5. The average maintenance labour cost per hour, including salary, tools, overheads etc. is assumed to be 30 Baht/hour.

Table 9-4 Tyre Wear

Baht, Mid 1981 price

Vehicle Type	Tyre life time (x1000 km)	No.of Tyre	Retail Price /tyre	Tax & Duty	Economic Cost/ tyre	Economic Cost /km vehicle
Passenger Car	30	4	599	76	523	0.07
Light Truck	40	4	1,100	140	960	0.10
Heavy Truck	50	10	3,034	385	2,649	0.53
Light bus	40	4	1,100	140	960	0.10
Heavy bus	50	6	4,304	547	3,757	0.45

Note: business tax 7.7% and estimated 5.0% import duty of materials.

Table 9-5 Maintenance Cost

Baht, Mid 1981 price

Vehicle Type	Necessary hours of labour /1000 Km	Parts consump-tion	Labour Costs /1000Km	Parts Costs /1000Km	Total Costs /Km
Passenger Car	1.34	0.13	40.20	99.94	0.14
Light Truck	1.59	0.14	47.70	80.24	0.13
Heavy Truck	3.45	0.08	103.50	100.47	0.20
Light Bus	1.59	0.14	47.70	72.29	0.12
Heavy Bus	3.45	0.08	103.50	183.55	0.29

Note:1 as for economic cost of vehicle per 1,000 km.

f) Crew Cost

Crew cost is calculated only for commercial vehicle and is listed as follows.

Table 9-6 Crew hours and Cost Rate

Baht, Mid 1981 price

Vehicle Type	Crew Number		Annual working hour per crew	Annual Mileage 1,000Km	Average Crew hours /1,000 Km	Hourly wage		Crew Cost/km
	Driver	Assis-tant & conductor				Driver	Assis-tant & conductor	
Light Truck	1	0	2,000	25	25	15	-	0.38
Heavy Truck	1	1	2,000	70	28.57	17	11	0.80
Light Bus	1	1	2,000	40	25	15	10	0.63
Heavy Bus	1	1	2,000	70	28.57	20	11	0.89

Source: Bangkok Mass Transit Authority & Outer Bangkok, Ring Road Report.

g) Depreciation Cost

The depreciation cost is estimated, based on an average year-round speed of the representative vehicle.

By the travel speed survey in the study area, the average year round speeds were assumed to be 45 km/h for passenger car, 40 km/h for light truck and light bus and 35 km/h for heavy truck and bus.

Depreciation costs of vehicle is calculated as shown below 9-7.

Table 9-7 Depreciation Costs of Vehicle

Baht, Mid 1981 Price

Vehicle Type	Average *1 year-round speed, K/H	Average Mileage *2 1,000Km	Average Service Life *3	Life time mileage 1,000 Km	Economic Cost of the vehicle*4	Depreciation cost at the average speed /km
Passenger car	45	18	8	144	110,700	0.77
Light Truck	40	25	7	175	100,300	0.57
Heavy Truck	35	70	6	420	527,480	1.26
Light Bus	40	40	6	240	123,919	0.52
Heavy Bus	35	70	6	420	963,636	2.29

Note: *1 : By the survey of road traffic in Study Area
*2 : Adjusted from the data of "Road User Costs in Thailand, 1974" by Ministry of Communications
*3 : MISSION ESTIMATES
*4 : By Interviews with the dealers

h) Interest Cost

The interest cost is calculated only for the opportunity cost of fund to purchase a vehicle, since the v.o.c. is calculated, based on economic term, not on financial term. The interest rate to purchase a vehicle is used to be 14% a.m..

Among 14%, 7% is considered as financial items of fund, consequently 7% is assumed as the opportunity cost of fund.

The interest cost is calculated as follows.

$$\text{Market price of a vehicle} \times 0.14 \times 0.5^{*1} \times 0.5^{*2} / \text{annual average mileage}$$

whereas, market price of representative vehicles are:

Passenger car	246,000	Baht
Light truck	118,000	"
Heavy truck	620,565	"
Light bus	145,787	"
Heavy bus	1,133,689	"

NOTE: *1... Average residual value of a vehicle as a total of the nation

*2 .. Ratio of opportunity cost of fund to total financial cost

Table 9-8 Interest Cost (Opportunity Cost of Fund)

Baht, Mid 1981 price

Passenger car	Light truck	Heavy truck	Light bus	Heavy bus
0.48	0.17	0.31	0.13	0.57

i) Overhead Cost

The overhead cost is considered, consisting of other cost components such as rent for a building, labour cost of administration personnel, etc.

This means that overhead cost differs due to the size and type of management. Therefore, the overhead cost is assumed to be 7% of running cost for passenger car, light truck and light bus, while 10% for heavy truck and heavy bus. These ratios seem smaller than usual, since only for economic items, without financial items.

Table 9-9 Overhead Cost

Baht, Mid 1981 price

Passenger Car	Light truck	Heavy truck	Light bus	Heavy bus
0.17	0.16	0.47	0.17	0.58

J) Total Vehicle Operating Costs

(e) By adding all the items of a) through i), vehicle operating cost has been calculated as Table 9-10.

Table 9-10 Total Vehicle Operating Costs

Baht, Mid 1981 price

Passenger Car	Light truck	Heavy truck	Light bus	Heavy bus
2.54	2.47	5.19	2.63	6.33

k) Conversion Rate of V.O.C. by 50 km/h Bench Mark.

The v.o.c. calculated in the previous clause of j) is the v.o.c. at bench mark speed. In order to estimate v.o.c. at various speeds, the following method is used.

The following report has been used as the basis of calculation.

Economic Costs by speeds at August 1976.
"Standardization of Vehicle Operating Costs for Thailand", by Vallentine, Laurie and Davids. R.O.P.

In the above report vehicle operating costs have been estimated by various kilometer/hour. basis. The v.o.c. obtained in this study have been converted into the v.o.c. at the speed of 48 km/hr stated in the above report and using

relative proportion of v.o.c. at different speeds in the report, v.o.c.s for this study have been computed by each km/hr.

As road condition, Grade 1 has been adopted which assumes well maintained surfaced roads in the study area.
It is generally recognized that differences in road condition affect only negligibly to v.o.c.s in the study area.

Table 9-11 Vehicle Operating Costs by Speed

Baht, Mid 1981 price

Km/h / Types of vehicle	10	16	24	32	40	48	56	64	72	80
Passenger car	2.73	2.64	2.59	2.56	2.53	2.54	2.57	2.61	2.66	2.73
Light truck	4.94	3.83	3.32	2.88	2.63	2.47	2.38	2.30	2.33	2.37
Heavy truck	11.36	9.11	7.12	6.13	5.54	5.19	4.95	4.14	4.93	5.02
Light bus	5.15	4.28	3.49	3.04	2.79	2.63	2.55	2.47	2.51	2.57
Heavy bus	14.55	11.55	8.92	7.62	6.82	6.33	5.97	5.89	5.80	5.82

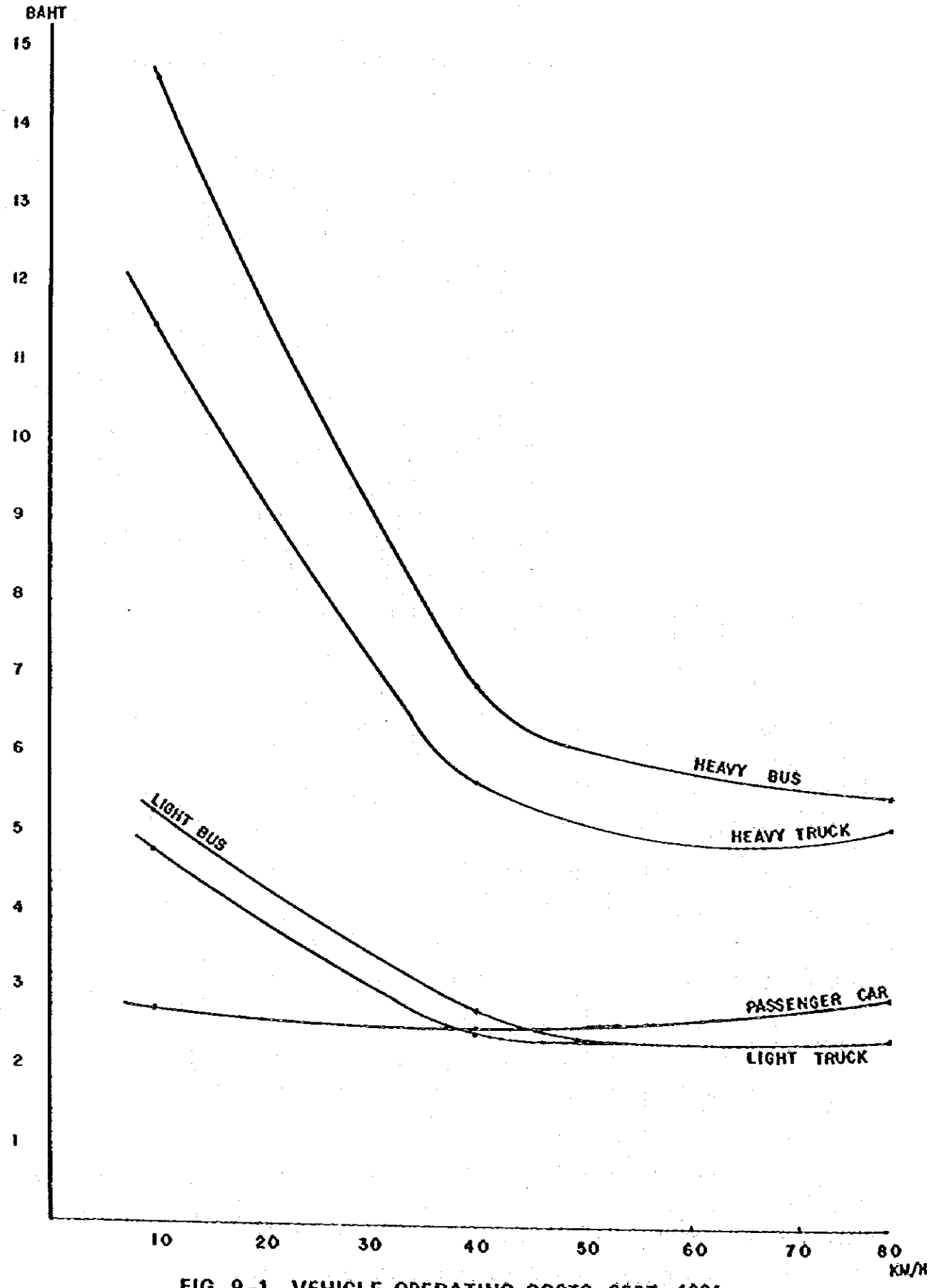


FIG. 9-1 VEHICLE OPERATING COSTS, SEPT. 1981

9-2-2 Time Value of Travel

In the calculation of time value, the categories of private vehicle passengers and public transportation passengers have been further devided into 3 stages.

This is to identify a theory of transport economy that time value relies both on income and purpose of trip.

a) First stage

As the first stage, method used here is basically a Gross Domestic Income per capita approach. A reduction in travel time during working hours would enable employers to utilize the manpower released for additional productive purposes.

Divisions made in categories do not suggest an existence of dual income sturucture among users of buses and those of private cars and taxi, but only implies the fact that traffic users have a choice of selecting higher travel time value or lower travel time value depending on their circumstances and that analysis can be made on the assumption that the two different time values do exist in society as a whole.

The following method of calculation has been adopted.

i) Time value of private vehicle passengers.

$$= \frac{\text{Ratio of non agriculture in G.D.P.}}{\text{Ratio of non agricultural Population}} \Big/ \text{Anual average working hour}$$

whereas, Ratio of non-agriculture in G.D.P 71.5%

Ratio of non-agricultural population 37.5%

G.D.P / capita 630 US dollar

(at exchange rate of baht 22.8/dollar)

Anual average working hour 1920 hours.

Hence,

Time value of private vehicle passengers

$$= 630 \times 22.8^{baht} \times \frac{0.715}{0.375} / 1920 = 14.23^{baht}$$

Note: This time value represents time value based on non-agricultural per capita G.D.P. Agricultural sector is exempted, since it has not been fully in market based economy in national economy.

ii) Time value of public transport passengers

= G.D.P per capita / Anual average working hours

Hence,

Time value of public transport passengers

$$= 630 \times 22.8^{baht}/1920 = 7.48^{baht}$$

b) Second stage

It is well known that Basic time value calculated in the previous first stage will vary depending on its classification of working hour and non-working hour as well as on its trip purposes, namely, business or non-business.

Since reliable data to amend the above deviation is unavailable in Thailand, as a second best method, the following simple method has been used.

Namely

the basic value is multiplied by factor of 1.5 and that of non working hour by factor of 0.75 in order to calculate the value for working hour

and business trips which can be applied as working hour are assumed as 50% for private vehicle passengers and, hence, also 50% for non business trip.

On the other hand, in public transport passenger category working hour relevant business trips are assumed as 40%

and that of non-business trip as 60%.

Based on these assumption, revision factors against the basic value are:

For private vehicle passengers	1.125
For public transport passengers	1.05

Therefore, revised time values are:

For private vehicle passengers	16.01 Baht
For public transport passengers	7.85 Baht

c) Third stage

At this stage, travel time value per vehicle for passenger car and bus (heavy and light) will be calculated on the basis of average number of passengers obtained from traffic survey.

Average number of passengers for passenger cars is set as 1.75 persons excluding the driver of taxi. For buses, number of passengers is 38.4 persons for heavy buses and 8.2 persons for light bus.

Therefore time values are calculated as:

Private car and Taxi	16.01 baht x 1.75 = 28.02 baht/veh/hr.
Heavy Bus	7.85 baht x 38.4 = 301.44 baht/veh/hr.
Light & Medium Bus	7.85 baht x 8.2 = 64.37 baht/veh/hr.

In this study, as a basis of calculating benefits, value of travel time saving is referred to the above per vehicle/hour value.

As regards with future time value, an increase of time value could be expected due to partial increase of income. Nevertheless, in this study, a traditional method has been adopted ignoring uncertain factors. The purpose

of this study is the economic feasibility, therefore only mid 1981 price is used for estimating cost and benefit even for future.

9-2-3 Q/V condition

Travel time surveys have been conducted for the section including the present RAMA VI bridge and its approaches, in order to obtain data regarding with the relation between traffic volume and speed and also with maximum traffic capacity per hour on the present bridge.

The survey result and its analysis have been described in section 4-5-2.

According to the data, normal traffic flow has been observed for traffic volume of up to 900 veh/hr. and its speed is 33 km/hr. For traffic of between 900 - 1,100 veh/hr, congestion takes place resulting in reduction of speed. Above 1,100 veh/hr, complete traffic jam occurs with its speed of as low as 17 km/hr. Traffic condition does not change above this traffic volume, so it can be considered that maximum traffic volume is attained at 1,200 veh/hr.

The relation of traffic volume and its speed can be described as below:

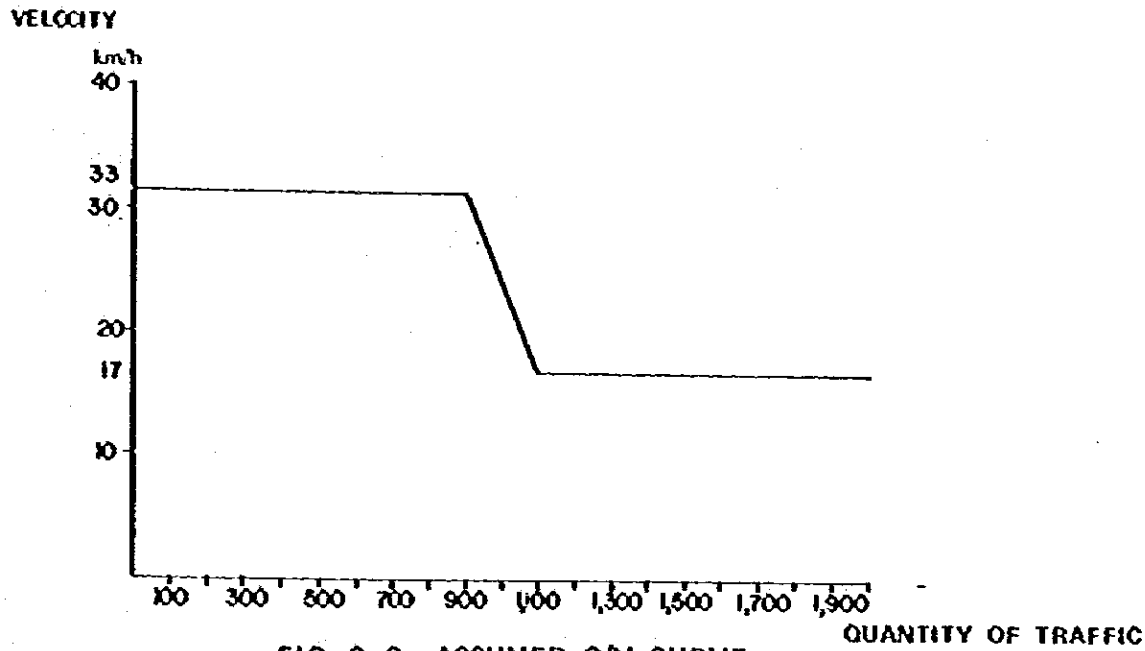


FIG. 9-2 ASSUMED Q/V CURVE

Traveling time for the 1.5 Km distance are:

0 - 900 veh/hr. $\quad 60 \text{ min.} \times \frac{1.53}{33} = 2^{\text{min}}\ 47^{\text{sec}}$

900 - 1,100 veh/hr. $60 \text{ min.} \times \frac{1.53}{17} = 6^{\text{min}}\ 13^{\text{sec}}$

Hence, time difference between normal and congested conditions is

$$6^{\text{min}}\ 13^{\text{sec}} - 2^{\text{min}}\ 47^{\text{sec}} = 3^{\text{min}}\ 26^{\text{sec}}$$

Accordingly, time loss per vehicle during congestion can be estimated as 3 min. 26 sec., and at intermediate point between normal and congested states as 1 min. 46 sec.

Traffic volume counted during the time exceeding 900 veh/hr has been regarded as time loss afflicted traffic. Nevertheless for each time that the Q-V curve exceeds the 900 veh/hr line, time loss is calculated as half for the traffic of 200 vehicles among exceeding 900 veh/hr traffic.

The relation can be expressed below.

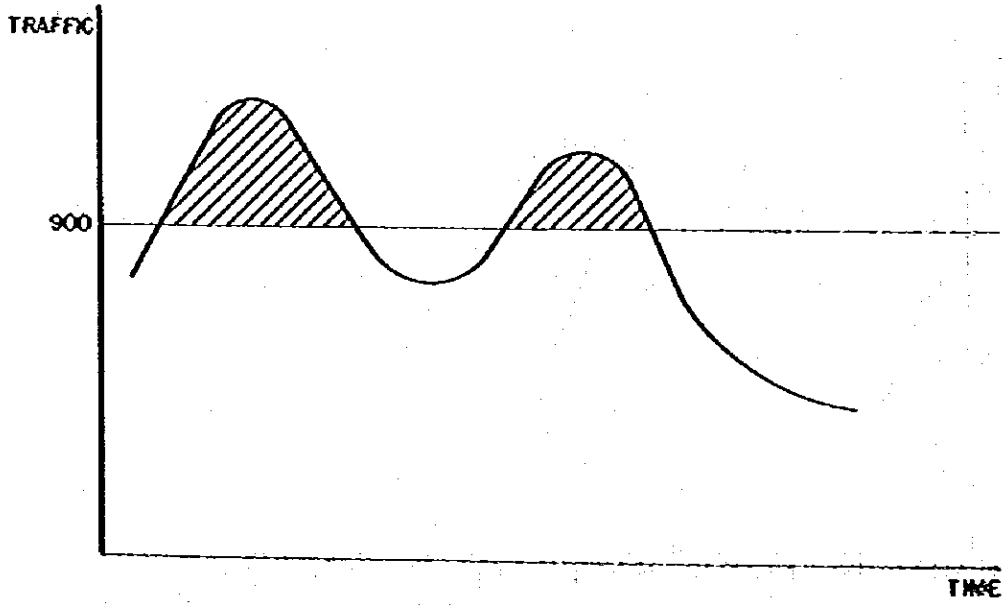


Fig. 9-3 TRAFFIC CONGESTION

Thus calculated traffic volume (by classified vehicle) is multiplied by time loss and again multiplied by time value calculated in 9-2-2 to estimate total amounts.

The value obtained above is regarded as the total time loss due to total congestion and calculated as benefit for the new bridge.

9-2-4 Benefit based on diverted traffic

Benefits of diverted traffic calculated in traffic forecast which uses the new RAMA VI Bridge with project case and other bridges without project case will be estimated in the following items.

a) For each zone-pairs difference of distances between the centers of each traffic generating zones and attracting zones in each case of diverted and non-diverted, will be multiplied by v.o.c. at the speed of 24 Km/hr.

b) For each zone-pairs difference of time distances between the centers of each generating zones and attracting zones in each case of diverted and non-diverted, will be multiplied by time value of travel.

Remarks: i) Time distance is calculated by travel time combination of average speeds and distances by links.

ii) Benefits by time distance is for passenger cars only. Buses are not taken into accounts for diversion and trucks are ignored, since having calculated crew cost in v.o.c..

iii) In the section of main bridge and its approaches 40 Km/hr is assumed instead of the design speed of 60-80 Km/hr.

Effects of reduced congestion on other bridges due to diversion has not be analyzed in this study, because on each of existing bridge, the degree of congestion is so severe that the congested conditions will not be altered in spite of diversion, and also survey of congestion condition is not specified in field survey of the present study.

9-2-5 Maintenance cost savings

The present study project is not a new bridge construction but rather a bridge improvement.

Maintenance situation has been described in 3-7 which is being far below from maintaining a required service level. For users of the present bridge, there must be great loss in their safety and trafficabilities.

In this analysis, benefits are to be calculated on a basis of cost of ideal maintenance.

Maintenance benefits are defined as to be the difference of maintenance cost with and without project.

As the project contains both bridge and road section. Benefit calculation has been carried out as follows.

1) As regards with road section, in the case with project the length can be reduced. The economy of maintenance can be thus attained.

2) As for bridge section, since the bridge has been deteriorated, substantial amount of cost is anually necessary to maintain a safe and satisfactory service level. On the other hand, the new bridge could be relatively maintenance free due to its concrete structure. Routine maintenance is, therefore, confined to be only the costs of electricity for lighting, cleaning and minor repair. Hence the cost is supposed cheaper than those for the old bridge, and the difference can be regarded as benefits.

All of these items has been totaled and estimated as benefits.

9-2-6 Aggregation of benefit

Benefit table is formulated through the benefit calculation with the traffic table (Appendix 9-1), based on the future traffic study in Chapter 5,and the definition of the benefit calculation.

The differences of traffic table to the future traffic study table are as follows:

a) Future traffic is calculated until 2013 with the same growth rate as of 1990 - 2000.
b) Traffic of each year is projected, based on the studied traffic of settled year with the fix rate.

1) Benefit from the differences of the project distance with and without scenario.

$$T_{ti} \times (2.54 \quad 2.63 \quad 6.33 \quad 2.43 \quad 5.19)' \times 365 \times 0.36$$

whereas, T : traffic, proper to RAMA VI Bridge
t : 1984 - 2013
i : 1 for passenger car
2 for light & medium bus, 3 for heavy bus
4 for light & medium truck, 5 for heavy truck

second paragraph : v.o.c. at 40 km/hr
365 : number of days in a year
0.36: distance differential with and without project
T_{ti} : 30 x 5 matrix.

2) Benefit from the difference of v.o.c. at different running speeds with and without project.

$$T_{ti} \times (0.11 \quad 1.5 \quad 4.33 \quad 1.2 \quad 3.57)' \times 365 \times 1.8$$

where second paragraph : difference between

v.o.c.s at 40 km/hr and 16 km/hr
1.8 : present project distance, km

3) Benefit from the solution of congestion

$$T_{ti} \times (28.02 \quad 64.37 \quad 301.44)' \times 365 \times \frac{3.43}{60} \times k$$

whereas, second paragraph : time value vector
for passenger car. L & M Bus H. Bus
3.43 : average loss time of congestion in minute in 100
k : congestion index, calculated as

$$k = T_t \times \frac{1}{2} \times 0.85 \times \frac{1}{16} \times \frac{1}{1500}$$

4) Benefit from the difference of the project distances with and without project for induced traffic.

$$T'_{ti} \times (2.54 \quad 2.63 \quad 6.33 \quad 2.47 \quad 5.19)' \times 365 \times 0.36 \times 0.5$$

where, T'_{ti} : induced traffic
0.5 : 50% of traffic, proper to RAMA VI Bridge benefit.

5) Benefit from the difference of v.o.c.s at different running speeds with and without project for induced traffic.

$$T'_{ti} \times (0.11 \quad 1.5 \quad 4.73 \quad 1.2 \quad 3.57)' \times 365 \times 1.8 \times 0.5$$

6) Benefit from the solution of congestion for induced traffic

$$T_{ti} \times (28.02 \quad 64.37 \quad 301.44)' \times 365 \times \frac{3.43}{60} \times 0.5 \times k$$

7) Benefit from the longer distance of the traffic necessary to run detour.

$$T_{ti} \times (2.64 \quad 4.28 \quad 11.58 \quad 3.85 \quad 9.11)' \times 365 \times 0.25 \times 1.9$$

where , second paragraph : v.o.c. at 16 km/hr, supposed traffic speed to run detour

0.25 : ratio of middle ring road traffic among total traffic

1.9 : longer distance than to run RAMA VI Bridge.

8) Benefit from the time loss to run detour

$$T_{ti} \times (28.02 \quad 63.37 \quad 301.44)' \times 365 \times \frac{9.3}{60} \times 0.25$$

where , $\frac{9.3}{60}$: time loss in minutes in 100.

Table 9-12 Benefit Table

Thousand BAHT, Mid 1981 price

Project Year	Calendar Year	Traffic, Proper to Rama VI Bridge		Diverted Traffic		Induced Traffic		TOTAL	Discounted @ 12%
		V.O.C. Savings	Time Savings	V.O.C. Savings	Time Savings	V.O.C. Savings	Time Savings		
4	1984	71800	21000	21200	31700	2200	3200	151100	107500
5	1985	72200	21300	26500	33800	2200	3200	165200	105000
6	1986	72500	21600	31300	46300	2200	3200	177700	100800
7	1987	72800	21900	34500	51700	2200	3200	186300	94400
8	1988	73100	22200	38600	57900	2200	3200	197200	87200
9	1989	73400	22500	44300	66400	2200	3200	212000	5600
10	1990	73700	22800	32500	48800	2200	3200	183200	66100
11	1991	74000	23100	34500	51700	2200	3200	188700	60800
12	1992	74300	23400	39600	59300	2200	3200	202000	58100
13	1993	74600	23700	43400	65200	2200	3200	212300	54300
14	1994	74900	24000	47600	71300	2200	3200	223200	51200
15	1995	75200	24300	50900	76400	2200	3200	232200	47500
16	1996	75500	24600	54400	81700	2200	3200	241600	44100
17	1997	25800	24900	58200	87200	2200	3200	251500	41000
18	1998	76100	25200	62000	93100	2200	3200	261800	38100
19	1999	76400	25500	66100	99200	2200	3200	272600	35400
20	2000	76700	25800	70400	105600	2200	3200	283900	33000
21	2001	76800	25900	75000	112600	2200	3200	295700	30700
22	2002	76900	26000	79900	119900	2200	3200	308100	28550
23	2003	77000	26100	85000	127600	2200	3200	321100	26500
24	2004	77100	26200	90400	135600	2200	3200	334700	24700
25	2005	77200	26300	96000	144100	2200	3200	349000	23000
26	2006	77300	26400	101900	152900	2200	3200	363700	21450
27	2007	77400	26500	109200	162200	2200	3200	379700	19950
28	2008	77500	26600	114600	171900	2200	3200	396000	18600
29	2009	77600	26700	121400	182200	2200	3200	413300	17300
30	2010	77700	26800	126200	189200	2200	3200	425300	15900
31	2011	77800	26900	136100	204100	2200	3200	450300	15000
32	2012	77900	27000	144000	215950	2200	3200	470200	14000
33	2013	78000	27100	152200	228300	2200	3200	491000	13100
Total		2,269,200	742,300	2,186,900	3,280,400	66,000	96,000	8,640,800	1,380,900

9-3 ESTIMATE OF ECONOMIC COST

9-3-1 Exemption of transfer portion

It is necessary to exempt the transfer payment portion from financial cost to estimate economic cost of the project. Necessary items to be considered as follows:

a) Tax and Duty

Financial cost is estimated, based on the market price, mid 1981 price.

Therefore, tax and duty portion of each items, which constitute total financial cost are to be exempted as to their tax rates.

Table 9-13 Rates of local tax

	%
Clearing and Grubbing	9.1
Earth Excavation	9.9
Embankment	9.6
Embankment, Selected material	10.8
Soil Aggregate Subbase	10.8
Crushed Stone Base	6.7
Soil Aggregate Shoulder	10.8
Prime Coat and SBST	5.5
Asphalt Concrete	5.5
Pipe Culvert	8.7
Box Culvert	10.0
Super Structure of main Bridge	13.0
Prestressed Concrete Viaduct	13.0
Prestressed concrete Railway	17.0

Source: Custom duty table, Department of Business Economic and the interviews with Government Officer thereof.

Import duty is ignored as the any of items can be produced domestically, however such commodities as petroleum products and energy are produced from imported raw materials.

b) Other transfers

Other items constitute the total financial cost except direct construction cost and tax (incl. duty) are land acquisition, compensation for factories, gas stand, electric cable, housing, small scale business, physical contingency and consultant fee, while agricultural land and plants are negligible.

Land acquisition is considered as transfer payment in this report. Although there is a theory to include land acquisition cost in economic cost, since the difference of land opportunity cost before and after the project is the economic loss if the difference being negative, but here the new project is always considered as the positive difference, that is the reason why the projects are implemented. Therefore, land acquisition cost is not included in economic cost of this study.

- Land acquisition M^2

  850 baht for Thonburi side

  1275 baht for Bangkok side

Compensation for housing, gas tower including transmission and cable and production facilities of factories are only to be considered as the economic cost after adjusted by tax and duty portion to the total economic cost.

Table 9-14 Compensation cost

Mid 1981 price

.Housing	0.4 Million baht for one house
.Gas stand	10 Million baht
.Production facilities of factory	51 Million baht in total
.Business	6.8 Million baht in total
.Reconstruction of Electric tower and cable	55 Million baht

c) Shadow price

The possibility that shadow price should be used to adjust the value of inputs to reflect their real cost was considered, but was not found appropriate in present circumstances.

There is minimum wage law in Thailand which provides a minimum wage of 54 Baht/day for unskilled labor. Although it is possible to hire around and below the wage in up-country side, greater Bangkok Area where rates are slightly higher than commonly paid. Therefore, unskilled labor is not shadow priced. There is a free market in skilled labor.

There are controls on foreign exchange transactions. Permission is normally obtainable for all reasonable purposes and no black market exists in foreign exchange, so shadow pricing for the foreign exchange component of the cost is not used. Ratio of foreign currency portion and domestic carrency portion is about equal.

9-3-2 Inflationary Construction Cost During the Implementation Period

As the economic cost benefit analysis is the comparison between economic cost and economic benefit, based on the initial year, it should not be considered the inflationary price rising, both in cost estimate and benefit estimate. Nevertheless, it is the customary method to include the price-rising during the implementation priod only. 7% per a.n. is adopted in this report. This rate is considered appropriate rate judging from the analysis of Thailand G.D.P. deflator (See Appendix 2-1).

9-3-3 Economic Cost Table

Tentative Financial Cost is estimated as 799 million baht at mid 1981 price. (See Table 9-15)
Economic Cost is estimated, based on this tentative financial cost, after adjusted according to the table of tax rates, listed in Table 9-13.
However, physical contingency is estimated by the average of adjusting rates of construction,
compensation for production facilities including. housing etc. is considered economic cost by 100%,
administrative fee for economic cost is estimated as 50% of financial cost.

Total economic Cost is converted to the adjusted economic cost by 7% per a.n. price escalation based on initial year.
According to the tentative implementation schedule as discussed in 9-3-2.

Table 9-15 F.C., E.C., Adjusted E.C.

Million baht, Mid 1981 price

		1981		1982		Adjusted E.C.	1983		Adjusted E.C.
		F.C.*1	E.C.*2	F.C.	E.C.		F.C.	E.C.	
Construction Cost	Road	7.91	7.31	36.04	32.31	34.57	38.27	34.29	38.23
	Bridge	40.63	36.18	178.32	159.78	170.96	189.23	169.58	189.08
Administration Fee		12.13	11.53	11.12	10.57	11.30	11.12	10.57	11.73
Physical Contingency		17.19	15.40	16.19	14.50	15.51	16.18	14.50	16.08
Land Acquisition		51.57	2.00	0.00	0.00	0.00	0.00	0.00	0.00
Compensation		172.90	172.90	0.00	0.00	0.00	0.00	0.00	0.00
Total		302.33	243.32	241.67	217.16	232.34	254.80	228,94	255.12

NOTE: *1 F.C..... Financial cost
*2 E.C..... Economic cost

Maintenance cost of new RAMA VI Bridge becomes far higher than that of present RAMA VI bridge, since price escalation of the electricity cost influences the total cost. Therefore, the benefit through maintenance can not be calculated.

Table 9-16 Maintenance Cost of New RAMA VI Bridge

Million baht, mid 1981 price

Yearly		12.22
Electricity	(11.10)	
Others	(1.12)	
Periodical (each 7 years)		8.50
Overlay	(4.30)	
Painting	(3.30)	
Exp. Joint	(0.90)	

Residual value after the project life of 30 years, is adopted as 15% for road on adjusted economic cost and 32% for bridge on adjusted economic cost. 32% for bridge is calculated as the residual value at 30 years after opening to traffic use, considering 15% at 50 years.

Total 140.10 Million baht is considered to be minus component of cost items. (See Table 9-17)

9-3-4 Internal Rate of Return

Discounting the economic cost stream and economic benefit stream over a 30 years project life period. I.R.R. is calculated at 20.3%, which indicates the project is feasible as the 20.3% is higher than the nation's assumed opportunity cost of fund, 12%.

$$20\% + \frac{12498}{12498 + 27657} \times (21 - 20)\% = 20.3\%$$

(See Table 9-18)

Table 9-17 Economic Cost Table

Million Baht, Mid 1981 Price

Project Year	Calendar Year	Real Value	Discounted by 12% Value
1	1981	243.32	243.32
2	1982	232.34	207.45
3	1983	255.12	203.38
4	1984	12.22	8.70
5	1985	12.22	7.77
6	1986	12.22	6.93
7	1987	12.22	6.19
8	1988	12.22	5.53
9	1989	12.22	4.94
10	1990	20.72	7.47
11	1991	12.22	3.83
12	1992	12.22	3.51
13	1993	12.22	3.14
14	1994	12.22	2.80
15	1995	12.22	2.50
16	1996	12.22	2.23
17	1997	20.72	3.37
18	1998	12.22	1.78
19	1999	12.22	1.59
20	2000	12.22	1.42
21	2001	12.22	1.27
22	2002	12.22	1.13
23	2003	12.22	1.01
24	2004	20.72	1.53
25	2005	12.22	0.81
26	2006	12.22	0.72
27	2007	12.22	0.64
28	2008	12.22	0.57
29	2009	12.22	0.51
30	2010	12.22	0.46
31	2011	20.72	0.69
32	2012	12.22	0.36
33	2013	12.22 Δ140.10*	0.33 Δ3.73*
TOTAL		991.28	734.15

NOTE: ΔMINUS, * RESIDUAL VALUE

Table 9-18 Analytical Table for I.R.R.

Thousand Baht, Mid 1981 price

PROJECT YEAR	CALENDAR YEAR	COST			BENEFIT		
		REAL	DISCOUNTED BY 20%	DISCOUNTED BY 21%	REAL	DISCOUNTED BY 20%	DISCOUNTED BY 21%
1	1981	243320	243320	243320	0	0	0
2	1982	232340	193616	192016	0	0	0
3	1983	255120	177166	174250	0	0	0
4	1984	12220	7071	6897	151100	87442	85292
5	1985	12220	5893	5700	165200	79668	77067
6	1986	12220	4910	4711	177700	71413	68511
7	1987	12220	4092	3893	186300	62391	59360
8	1988	12220	3410	3217	197200	55034	55928
9	1989	12220	2841	2659	212000	49304	46137
10	1990	20720	4015	3726	183200	35505	32950
11	1991	12220	1973	1816	188700	30476	28049
12	1992	12220	1644	1501	202000	27186	24814
13	1993	12220	1370	1240	212300	23810	21553
14	1994	12220	1142	1025	223200	20861	18727
15	1995	12220	951	847	232200	18085	16101
16	1996	12220	793	700	241600	15681	13845
17	1997	20720	1120	981	251500	13603	11911
18	1998	12220	550	478	261800	11800	10247
19	1999	12220	458	395	272600	10239	8818
20	2000	12220	382	326	283900	8886	7590
21	2001	12220	318	270	295700	7713	6533
22	2002	12220	265	223	308100	6697	5625
23	2003	12220	221	184	321100	5816	4845
24	2004	20720	312	258	334700	5052	4174
25	2005	12220	153	125	349000	4390	3597
26	2006	12220	128	104	363900	3814	3099
27	2007	12220	106	86	379700	3316	2673
28	2008	12220	88	71	396000	2882	2304
29	2009	12220	74	58	413300	2507	1987
30	2010	12220	61	48	425300	2150	1690
31	2011	20720	87	68	450300	1896	1478
32	2012	12220	42	33	470200	1650	1276
33	2013	12220	35	27	491000	1436	1101
		-140100*	-409*	-314*			
TOTAL		991280	658216	650952	8640800	670714	623295

Note: * Residual Cost

9-4 TENTATIVE ECONOMIC EVALUATION

9-4-1 Net Present Value

To evaluate the project, N.P.V. is assessed with the differential between estimated economic cost stream and estimated economic benefit stream, each converted to initial year by 12%, which is assumed opportunity cost in Thailand.

Thousand BAHT, mid 1981 price

Present value of benefit		1,380,900
Present value of cost		734,150
N.P.V.	=	646,750

(See Table 9-12, 9-17)

N.P.V. is positive by wide difference, therefore the project is to be considered feasible.

Opportunity cost of fund in Thailand is not systematically approached. But it is supposed that the opportunity cost is as high as 12% since the stage of economy is on the upwards trend. Here, 12% is adopted as the generally admitted rate and also used in the reports of I.B.R.D. .

9-4-2 Sensitivity Test

To assess the project feasible or not in operational concept, two cases of sensitivity test are implemented.

One is the case of higher cost, due to the estimate variance of compensation, and other is the case of lower benefit, due to assumption date of Outer Ring Road construction.

a) The case of higher cost
There exists the possibility that the alignment of the project would shift a little to the North from the most probable site, in which case the compensation cost would differ, due to the existance of factory.

However, the calculation of I.R.R., using the higher estimate cost, shows that the I.R.R. is 18.2%, which percentage remains higher than the assumed opportunity cost of fund in Thailand, 12%.

(See Appendix 9-2)

b) The case of lower benefit

Traffic for this study is estimated, based on the assumption of opening date of Outer Ring Road, being 1990, although there exists the possibility of opening the road much ealier, during 1986 - 1989. Construction of Outer Ring Road would change the traffic flow and substantial amounts of traffic, now estimated to use the RAMA VI Bridge would divert to other routes. Here, calculation of I.R.R., using the benefit stream, based on the traffic estimate, reflecting opening of Outer Ring Road during 1986-1989, shows 19.5%, which is also higher than the assumed opportunity cost of fund in Thailand, 12%.

(See Appendix 9-3)

9-4-4 Unquantified Benefit

In this report, benefit is estimated through the quantification of clearly definitive items only. Therefore, it is considered that the benefit calculated is the lowest and reliable among other possible calculations.

The construction of RAMA VI Bridge provides many other benefits, which are not easy to quantify without artificial sophisticated methods.

These are as follows:

a) It should have been necessary to calculate the benefit for not only the project bridge, but also other bridges influenced by this project through the mitigation of traffic congestion. Although, the mitigation of traffic congestion on other bridges is neglected, there must be substantial amounts of benefit generated.

b) Present RAMA VI Bridge, due to the complicated alignment and road conditions, has the higher tendency to have traffic accident.
Construction of New Rama VI Bridge provides safer traffic flow.
Therefore, it is supposed that substantial amounts of benefit through the decrease of traffic accident.

c) 12 ton weight limit is imposed upon the present RAMA VI Bridge. Therefore, it should be a great impact on the rationalization of commodity flow by the abolishment of weight restriction.

d) In this report, benefit is calculated only through the automobils (more than 4 wheels car), but 45% of registered vehicle is the Motor Cycle in Thailand.
There must be substantial amount of benefit for motor-cycles also.

e) By using the present RAMA VI Bridge for vehicle traffic, it prohibites any improvement for Thailand National Railway.
National Railway will have free choice without considering the highway use of RAMA VI Bridge.

f) After the starting to use the Middle Ring Road and New RAMA VI Bridge, the RAMA VI Bridge becomes the corner stone of traffic for Thonburi side.
The opportunity cost of land near RAMA VI Bridge will increase and industries would be attracted, which gain higher value.

APPENDICES

APPENDIX 2-1 (1)

GROSS NATIONAL PRODUCT BY INDUSTRIAL ORIGIN AND NATIONAL INCOME AT CURRENT PRICES

BAHT

Line		1976		1977		1978		1979		1980	
		Millions of Baht	%	Millions of Baht	%	Millions of Baht	%	Millions of Baht	%	Millions of Baht	%
1	Agriculture.....	104,667	31.0	110,929	28.2	129,094	27.5	147,076	26.4	176,303	26.2
2	Crops	77,509	23.0	79,069	20.1	96,180	20.5	107,980	19.4	128,527	19.1
3	Livestock.....	12,354	3.6	14,409	3.6	13,503	2.9	16,954	3.1	23,455	3.5
4	Fisheries.....	9,792	2.9	12,456	3.2	13,806	2.8	13,017	2.3	13,710	2.0
5	Forestry.....	5,002	1.5	4,996	1.3	6,325	1.3	9,125	1.6	10,611	1.6
6	Mining and quarrying.....	5,174	1.5	8,139	2.1	10,610	2.2	12,614	2.3	14,444	2.1
7	Manufacturing.....	63,025	18.7	74,676	19.0	89,089	19.0	109,740	19.7	125,830	18.7
8	Construction.....	15,784	4.7	20,251	5.1	24,844	5.3	29,240	5.3	39,011	5.8
9	Electricity and water supply..	3,745	1.1	4,384	1.1	5,168	1.1	6,075	1.1	5,802	0.8
10	Transportation and communication.....	21,828	6.5	24,706	6.3	29,606	6.3	37,844	6.8	47,746	7.1
11	Wholesale and retail trade..	59,391	17.6	74,931	19.1	90,053	19.2	102,853	18.5	124,998	18.6
12	Banking, insurance and real estate...	16,075	4.8	19,537	5.0	24,624	5.2	31,396	5.6	39,021	5.8
13	Ownership of dwellings.....	4,840	1.4	5,272	1.3	5,826	1.2	6,297	1.1	7,312	1.1
14	Public administration and defence...	13,571	4.0	14,810	3.8	17,943	3.8	21,623	3.9	28,831	4.3
15	Services	29,545	8.7	35,395	9.0	43,095	9.2	51,482	9.3	64,434	9.5
16	Gross Domestic Product(GDP)	337,635	100.00	393,030	100.0	469,962	100.0	556,240	100.0	673,732	100.0
17	Plus: Net income from abroad..	- 1,261	-	- 2,014	-	- 5,402	-	- 9,791	-	-14,406	-
18	Gross National Product (GNP)	336,374	-	391,016	-	464,550	-	546,449	-	659,326	-
19	Less: Indirect taxes.....	33,438	-	43,717	-	51,733	-	60,903	-	71,083	-
20	Capital consumption allowances..	24,041	-	28,609	-	34,428	-	41,887	-	50,888	-
21	National Income.....	278,596	-	318,690	-	378,389	-	443,659	-	537,355	-
22	Per Capta GNP.....	7,830	-	8,879	-	10,300	-	11,843	-	13,977	-

APPENDIX 2-1(2)

GROSS NATIONAL PRODUCT BY INDUSTRIAL ORIGIN AND ITS GROWTH RATES AT 1972 PRICES

Line		1976	1977		1978		1979		1980*	
		Millions of Baht	Millions of Baht	Growth Rates	Millions of Baht	Growth Rates	Millions of Baht	Growth Rates	Millions of Baht	Growth Rates
1	Agriculture.....	65,898	65,537	-0.6	72,513	10.6	71,408	-1.5	73,924	3.5
2	Crops	49,013	46,794	-4.5	53,383	14.5	51,804	-3.3	53,942	4.1
3	Livestock.....	7,622	8,102	6.3	8,515	5.1	8,931	4.9	9,704	8.7
4	Fisheries.....	5,898	7,499	27.2	7,414	-1.1	7,281	-1.8	6,831	-6.2
5	Forestry.....	3,365	3,142	-6.6	3,001	-4.5	3,392	13.0	3,447	1.6
6	Mining and quarrying.....	2,906	3,526	21.3	4,104	16.4	4,531	10.4	4,896	8.0
7	Manufacturing.....	42,529	48,071	13.0	52,521	9.3	57,841	10.1	61,381	6.1
8	Construction.....	10,022	11,996	19.7	13,583	13.2	14,547	7.1	16,709	14.9
9	Electricity and water supply	3,642	4,144	13.8	4,500	8.6	5,178	15.1	5,813	12.3
10	Transportation and communi-cation..	13,366	14,474	8.3	16,205	12.0	17,663	9.0	18,996	7.5
11	Wholesale and retail trade..	38,821	41,213	6.2	43,658	5.9	45,497	4.2	47,049	3.4
12	Banking, insurance and real estate..	10,208	11,574	13.4	13,443	16.1	15,582	15.9	16,714	7.3
13	Ownership of dwellings.....	3,664	3,823	4.3	4,052	6.0	4,289	5.8	4,545	6.0
14	Public administration and defence.....	8,893	9,555	7.4	10,166	6.4	11,594	14.0	12,673	9.3
15	Services.....	21,276	23,260	9.3	26,352	13.3	28,777	9.2	31,676	10.1
16	Gross Domestic Product (GDP)	221,226	237,173	7.2	261,087	10.1	276,907	6.1	294,376	6.3
17	Plus: Net income from abroad...	-1,020	-1,575	-	-4,054	-	-7,010	-	-9,549	-
18	Gross National Product (GNP)	220,205	235,598	7.0	257,043	9.1	269,897	5.0	284,827	5.5
19	GDP Deflator.....	152.6	165.7	-	180.0	-	200.9	-	228.9	-

NOTE: * ..... PRELIMINARY ESTIMATE

APPENDIX 2 – 2
GOVERNMENT REVENUE

MILLION BAHT

ITEMS \ YEAR	1976 (%)	1977 (%)	1978 (%)	1979 (%)	1980 (%)	GROWTH RATE(%)
TOTAL REVENUE	43,602 (100)	54,064 (100)	65,208 (100)	78,175 (100)	95,775 (100)	21.7
TAXATION	39,260 (90.0)	49,391 (91.4)	60,252 (92.4)	73,637 (93.6)	88,473 (92.4)	22.7
OF WHICH INCOME TAXES	6,789 (15.6)	8,477 (15.7)	11,810 (18.1)	14,108 (17.9)	16,880 (17.6)	25.6
IMPORT & EXPORT DUTIES	10,860 (24.9)	14,142 (26.2)	16,627 (25.5)	20,306 (25.9)	22,842 (23.8)	20.4
BUSINESS TAXES	9,328 (21.4)	11,509 (21.3)	13,624 (20.9)	15,190 (19.3)	18,994 (19.3)	18.9
SELECTIVE SALES TAXES	8,705 (20.0)	10,316 (19.1)	12,045 (18.5)	16,265 (20.7)	21,308 (22.2)	25.1
OTHER TAXES	6,578 (15.1)	4,947 (9.2)	6,146 (9.4)	7,768 (9.9)	8,994 (9.4)	8.1
SALES & CHARGES	1,044 (2.4)	1,173 (2.2)	1,313 (2.0)	1,321 (1.7)	1,353 (1.4)	6.7
CONTRIBUTION FROM GOVERNMENT ENTER PRISES 2 DIVIDENTS	2,018 (4.6)	1,563 (2.9)	1,411 (2.2)	1,754 (2.2)	2,319 (2.4)	3.5
MISCELLANEOUS REVENUE & INCOMES	1,280 (2.9)	1,937 (3.6)	2,232 (3.4)	1,963 (2.5)	3,630 (3.4)	30.0

SOURCE : MONTHLY REPORT OF COMMERCE, 1981

APPENDIX 2-3

INTERNATIONAL BALANCE OF PAYMENT

MILLION BAHT

ITEMS \ YEAR	1975	1976	1977	1978	1979	1980
TRADE BALANCE	-20,161.2	-31,084.9	-25,598.8	-28,510.0	-47,063.1	-51,981.9
EXPORT (F.O.G)	44,364.5	60,361.2	70,462.8	82,250.8	106,891.2	132,095.1
IMPORT (C.I.F)	-64,525.7	-91,446.1	-96,061.6	-109,956.1	-153,163.5	-190,077.0
NON MENETARY	-	-	-56.8	-834.7	-470.8	
NET SERVICES	6,160.8	1,642.5	2,605.2	4,219.1	3,237.9	5,076
RECEIPTS	16,561.6	13,933.3	18,771.7	22,123.9	29,163.6	39,260.3
PAYMENTS	-10,350.8	-12,350.8	-12,366.5	-17,844.8	-25,925.7	-34,183.9
NET GOODS & SERVICES	-14,000.4	-9,442.4	-23,193.6	-24,260.9	-43,825.2	-52,905.5
UNREQUITED TRANSFERS	1,632.1	464.5	801.9	816.0	1,224.0	4,275.7
PRIVATE	1,134.5	100.8	443.5	328.0	461.9	1,529.9
GOVERNMENT	497.6	363.7	358.6	488.0	762.1	2,745.8
BALANCE ON GOODS, SERVICES & UNREQUITED TRANSFERS	-12,368.3	-8,977.9	-22,391.7	-23,444.9	-42,591.2	-48,629.8
CAPITAL MOVEMENT	7,154.7	9,263.6	13,566.9	14,858.3	33,766.8	50,068.3
DIRECT ENVESTMENT	1,744.8	1,614.1	2,163.8	3,010.8	1,047.7	3,815.8
OTHER PRIVATE LONG-TERM	3,554.2	2,501.2	5,138	6,059.1	20,603.9	33,086.2
OTHER PRIVATE SHORT-TERM	2,600.3	2,378.5	5,228.4	1,656.2	3,567.2	6,516.7
LOCAL GOVERNMENT PROJECT	-23.0	-33.1	-	-8.3	-	-
CENTRAL GOVERNMENT	-121.6	2,377	834.7	6,059.5	8,548.0	6,269.6
NET ERRORS SORISSIONS	1,155.6	-356.5	886.9	-4,711.4	485.8	3,214.4
OVERALL BALANCE	-2858.0	-52.8	-7,537.9	-13,296.0	-7,925.0	5,117.3

NOTE : ------ OUTFLOW

SOURCE : BANK OF THAILAND

APPENDIX 2 – 4

VALUE OF EXPORT BY PRINCIPAL COMMODITIES

MILLION BAHT

Commodities \ Year	1976		1977		1978		1979		1980		GROWTH RATE
RICE	8,603	14.2	13,382	18.8	10,425	12.6	15,592	14.4	19,505	14.6	22.7
RUBBER	5,297	8.7	6,164	8.7	8,030	9.7	12,351	8.8	12,400	9.3	23.7
TIN	2,972	4.9	4,541	6.4	7,229	8.7	9,253	8.6	11.347	8.5	39.8
MAIZE	5,676	9.3	3,345	4.7	4,275	5.1	5,643	5.2	7.296	5.5	6.4
TAPIOCA PRODUCTS	7,527	12.4	7,720	10.8	10,892	13.1	9,891	9.1	14,800	11.1	18.4
JUTE & KENAF	579	1.0	418	0.6	448	0.5	391	0.4	155	0.1	39.0
PRAWNS	1,347	2.2	1,170	1.6	1,500	1.8	2,372	2.2	1,959	1.5	9.8
TOBACCO LEAVES	699	1.1	924	1.3	1,160	1.4	1,243	1.2	1,376	1.0	18.5
SUGAR	6,843	11.3	7,445	10.5	3,969	4.8	4,797	4.4	2,975	2.2	23.1
MUNG BEANS	945	1.6	1,057	1.5	1,160	1.4	1,375	1.3	1,448	1.1	11.3
FLUORITE	267	0.4	230	0.3	206	0.2	252	0.2	314	0.2	4.1
SORGHUM	374	0.6	300	0.4	370	0.4	495	0.5	660	0.5	15.3
CEMENTS	378	0.6	217	0.3	34	0.1	33	0.1	48	0.1	67.5
TEAK	749	1.2	545	0.8	253	0.3	118	0.1	3	-	-
OTHER	18,541	30.5	23,740	33.3	33,114	39.9	44,393	41.0	58,961	44.2	33.5
TOTAL	60,797	100	71,198	100	83,065	100	108,179	100	133.247	100	21.7

SOURCE : BANK OF THAILAND

APPENDIX 3 - 1

NUMBER OF REGISTERED VEHICLE & TYPE IN THE COUNTRY 1975 - 1981

THOUSAND

TYPE OF VEHICLE	1975	1976	1977	1978	1979	1980	1981	GROWTH RATE (1975-1979)
PASSEBGER CARS	294.0 (28.2)	298.4 (26.1)	371.3 (23.8)	362.4 (23.9)	387.3 (23.1)	411.8 (39.1)	437.0 (21.7)	7.5
MOTORCYCLES	479.5 (46.5)	511.5 (44.7)	645.7 (46.5)	714.1 (51.4)	793.3 (47.3)	852.6 (46.8)	951.8 (47.5)	13.4
MOTOR TRICYCLES	6.4 (0.6)	8.1 (0.7)	8.6 (0.6)	8.6 (0.6)	9.0 (0.5)	9.4 (0.5)	9.8 (0.5)	8.9
BUSES	22.7 (2.2)	19.6 (1.7)	27.4 (2.0)	28.1 (2.0)	28.4 (1.7)	29.9 (1.6)	31.4 (1.6)	5.8
VANS & TRUCKS	238.1 (23.1)	285.2 (24.9)	345.5 (24.9)	368.4 (26.5)	417.2 (24.9)	468.5 (25.7)	519.8 (26.0)	15.1
OTHER	24.1 (2.3)	22.1 (1.9)	31.3 (2.2)	37.5 (2.5)	42.8 (2.5)	48.0 (2.6)	53.3 (2.7)	15.4
TOTAL	1061.2 (100)	1145.0 (100)	1389.7 (100)	1519.1 (100)	1678.0 (100)	1820.2 (100)	2003.1 (100)	12.1

NOTE : 1979 - 1981 ESTIMATED

SOURCE : REPORT OF 1979 , DEPARTMENT OF HIGHWAY , MINISTRY OF COMMUNICATION

APPENDIX 3-2

LENGTH OF NATIONAL AND PROVINCIAL HIGHWAYS OPEN TO TRAFFIC FISCAL YEAR 1973 - 1975

KM

FISCAL YEAR	TYPE OF SURFACE	NATIONAL HIGHWAYS			PROVINCIAL HIGHWAYS	GRAND TOTAL
		PRIMARY	SECONDARY	TOTAL		
1973	Concrete	70.5	9.2	89.2	8.1	92.3
	Asphalt	5,680.8	5,300.4	10,981.2	2,552.1	13,533.3
	Crushed rock & Soil Agg.	73.9	933.6	1,007.5	4,039.1	5,046.6
	Total	5,829.7	6,243.2	12,077.9	6,599.3	18,672.2
1974	Concrete	99.5	9.1	108.9	8.6	117.2
	Asphalt	5,890.2	5,750.7	11,640.9	3,016.7	14,657.6
	Crushed rock & Soil Agg.	72.6	674.2	746.8	3,985.7	4,732.5
	Total	6,062.3	6,434.0	12,496.8	7,011.0	19,507.3
1975	Concrete	94.7	38.8	133.5	8.6	142.2
	Asphalt	5,914.2	5,790.2	11,706.2	3,387.2	14,657.6
	Crushed rock & Soil Agg.	72.6	745.8	818.4	4,013.3	4,732.5
	Total	6,081.5	6,576.6	12,658.1	7,439.1	19,507.3
1976	Concrete	94.7	38.8	133.5	8.0	141.5
	Asphalt	5,828.2	6,006.8	11,835.0	4,267.6	16,186.6
	Crushed rock & Soil rock	72.6	679.3	751.5	4,601.1	5,353.0
	Total	5,935.5	6,724.9	12,720.4	8,876.7	21,681.1
1977	Concrete	94.7	38.9	133.6	7.9	141.5
	Asphalt	5,834.4	6,165.8	12,000.2	4,912.1	16,996.3
	Crushed rock & Soil rock	72.6	649.7	722.3	5,021.7	5,744.0
	Total	6,001.7	6,854.4	12,856.1	9,941.7	22,881.8
1978	Concrete	94.7	19.9	114.6	6.1	120.7
	Asphalt	6,044.3	6,519.5	12,563.8	6,203.4	18,851.2
	Crushed rock & Soil rock	72.5	475.0	547.5	5,546.4	6,093.9
	Total	6,211.5	7,014.4	13,225.9	11,755.9	25,065.8
1979	Concrete	111.9	41.5	153.4	20.4	173.8
	Asphalt	6,346.2	7,012.9	13,359.2	8,108.9	21,568.1
	Crushed rock & Soil rock	68.5	138.9	207.4	5,548.6	5,756.0
	Total	6,526.6	7,193.3	13,820.0	13,677.9	27,497.9

SOURCE : STATISTICE SECTION, PLANNING DIVISION, DEPARTMENT OF HIGHWAYS

APPENDIX 3 – 3

SELECTED INDICATIONS FOR GROSS-NATIONAL COMPARISON OF ROAD DENSITY

Country	Area (1000 km^2) (A)	Population (1000 persons) (P)	GNP (billion yen) (G)	Road Length (1000 km) (L)	Population Density (person/km^2) (P/A)	GNP Per Area (1000 yen/km^2) (G/A)	Road Density (m/km^2) (L/A)	Socio-economic intensity $\sqrt{(P/A)(G/A)}$
INDIA	3,288	586,266	19,509	895.0	178	5,933	272	32.50
INDONESIA	1,492	127,586	4,776	35.6	86	3,201	24	16.59
JAPAN	372	109,671	132,725	699.1	295	356,788	1,871	324.43
KOREA	98	33,459	4,242	44.2	341	43,286	451	121.49
MALAYSIA	330	11,650	2,211	19.4	35	6,700	59	15.31
PAKISTAN	804	68,214	2,589	33.2	85	3,220	41	16.54
PHILIPPINES	300	41,457	4,248	104.2	138	14.160	347	44.20
THAILAND	514	41,023	3,975	54.9 1/	80	7,733	108	24.87
DENMARK	43	5,045	9,840	65.7	117	228.837	1,528	163.63
FRANCE	547	52,507	86,382	794.0	96	157,920	1,452	123.13
WEST GERMANY	249	62,041	124,071	463.0	249	498,277	1,859	352.24
U.K.	244	55,968	56,928	366.7	229	233,311	1,503	231.14
ITALY	301	55,361	45,006	286.5	184	149,522	952	165.87
NATHERLAND	41	13,541	22,257	104.1	330	542,854	2,539	423.25
NORWAY	324	3,985	7,416	76.1	12	22,889	235	16.57
SWEDEN	450	8,161	18,303	97.4	18	40,673	216	27.06
BELGIUM	31	9,772	17,283	93.1	315	557,516	3,003	419.06
HUNGARY	93	10,478	11,817	99.8	113	127,065	1,073	119.82
SPAIN	505	35,225	19,002	315.0	70	37,628	624	51.32
SWITZERLAND	41	6,443	15,804	61.6	157	385,463	1,502	246.00
YOUGOSLAVIA	256	21,153	7,140	78.7	83	27,891	307	48.11
MEXICO	1,973	58,118	19,509	426.1	29	9,888	216	16.93
U.S.A.	9,363	211,909	419,400	6,140.9	23	44,793	656	32.10

NOTE : 1/ INCLUDING ARE ROADS UNDER DOH, ARD AND FWD
SOURCE: INTERNATIONAL ROAD FOUNDATION, 1977

APPENDIX 3 – 4

BUDGET COMPARISON OF THE GOVERNMENT TO THE DEPARTMENT OF HIGHWAY IN 1969–1979

MILLION BAHT

FISCAL YEAR	GOVERNMENT BUDGET	HIGHWAY BUDGET	RATIO IN PERCENTAGE
1969	23,960.0	2,611.9	10.9
1970	27,299.0	2,933.5	10.7
1971	28,645.0	3,052.1	10.7
1972	29,000.0	2,596.5	9.0
1973	32,030.0	2,845.5	8.9
1974	39,027.6	3,069.9	7.9
1975	50,500.0	3,745.0	7.4
1976	62,650.0	4,633.0	7.4
1977	68,790.0	4,444.4	6.5
1978	81,000.0	5,322.6	6.6
1979	92,000.0	6,177.4	6.7

SOURCE : FINANCE DIVISION, DEPARTMENT OF HIGHWAY

TRAFFIC COUNT ON RAMA VI BRIDGE

APPENDIX 4 – 1 (1)

OUTBOUND (FROM THONBURI TO BANGKOK)

JULY 2 1981 (THURSDAY)

HOUR	Pedestrain Bicycle	Motor-Cycle	Private Car	Taxi	Bus (Light) Medium	Bus (Heavy)	Truck (Light) Medium	Truck (Heavy)	Total Except Pedestrain & M/C
6.00-7.00	0	88	468	50	15	134	81	6	754
7.00-7.30	0	62	470	20	8	61	36	1	596
7.30-8.00	0	141	461	54	8	50	51	4	628
8.00-8.30	1	56	360	36	10	45	33	0	484
8.30-9.00	0	100	280	45	4	34	63	8	434
9.00-10.00	0	89	307	76	13	82	203	37	718
10.00-11.00	0	78	283	80	12	65	155	22	617
11.00-12.00	0	95	387	68	1	68	185	25	734
12.00-13.00	0	72	292	68	7	72	181	32	652
13.00-14.00	0	106	275	72	11	76	195	60	689
14.00-15.00	1	78	226	47	47	33	78	55	486
15.00-16.00	2	96	319	73	65	81	81	36	665
16.00-16.30	5	130	543	50	18	99	73	1	784
16.30-17.00									
17.00-17.30	8	103	410	61	27	75	67	3	672
17.30-18.00									
18.00-18.30	22	104	259	75	95	105	100	33	667
18.30-19.00									
19.00-20.00	0	96	438	88	37	62	37	6	668
20.00-21.00	2	71	145	58	31	60	47	11	362
21.00-22.00	0	47	146	49	14	41	30	13	293
TOTAL	41	1612	6088	1070	423	1263	1696	353	10893
22.00-23.00	0	17	36	27	1	9	1	15	89
23.00-24.00	2	24	75	73	4	18	9	18	197
24.00-1.00	0	14	46	42	2	7	13	15	125
1.00-2.00	5	4	16	33	3	1	10	11	74
2.00-3.00	2	5	6	30	0	0	20	7	63
3.00-4.00	2	1	16	13	6	2	5	4	46
4.00-5.00	8	4	7	16	16	9	5	14	67
5.00-6.00	12	5	25	15	30	40	8	21	139
TOTAL	31	74	227	249	62	86	71	105	800
GRAND TOTAL	72	1686	6315	1319	485	1349	1767	458	11693

INBOUND

HOUR	Pedestrain Bicycle	Motor-Cycle	Private Car	Taxi	Bus (Light) Medium	Bus (Heavy)	Truck (Light) Medium	Truck (Heavy)	Total Except Pedestrain & M/C
6.00-7.00	95	77	178	57	9	105	69	27	445
7.00-7.30	62	79	232	41	10	43	9	2	337
7.30-8.00	101	107	242	37	9	44	13	3	348
8.00-8.30	44	42	211	44	7	48	18	0	328
8.30-9.00	41	91	214	44	3	44	38	8	351
9.00-10.00	46	91	287	86	6	76	124	45	624
10.00-11.00	49	116	238	85	4	67	138	53	585
11.00-12.00	58	123	257	69	4	62	151	59	602
12.00-13.00	50	74	284	70	2	71	112	51	590
13.00-14.00	31	94	237	61	2	72	134	52	558
14.00-15.00	19	53	219	46	32	50	55	54	456
15.00-16.00	15	70	322	53	28	69	82	81	695
16.00-16.30	21	122	781	45	17	114	83	2	1042
16.30-17.00									
17.00-17.30	14	109	672	74	13	101	74	10	944
17.30-18.00									
18.00-18.30	17	89	376	73	32	98	70	51	700
18.30-19.00									
19.00-20.00	10	71	252	69	22	76	52	27	498
20.00-21.00	9	55	210	62	7	71	36	6	352
21.00-22.00	6	33	197	67	6	68	20	11	359
TOTAL	688	1496	5409	1083	213	1269	1278	542	9794
22.00-23.00	0	10	38	17	17	22	1	5	100
23.00-24.00	2	24	75	73	8	15	8	6	184
24.00-1.00	0	19	38	48	0	5	12	6	109
1.00-2.00	2	10	16	22	0	0	14	5	57
2.00-3.00	0	6	14	17	0	0	15	6	52
3.00-4.00	0	0	5	17	5	1	13	6	47
4.00-5.00	1	3	14	17	0	9	31	15	86
5.00-6.00	1	5	30	15	4	36	32	19	136
TOTAL	6	77	230	226	34	88	126	67	771
GRAND TOTAL	694	1573	5639	1309	247	1357	1404	609	10565

APPENDIX 4-1(2)

TRAFFIC COUNT ON KRUNGTHON BRIDGE

INBOUND (FROM THONBURI TO BANGKOK)

JULY 30 1981 (TUESDAY)

HOUR	MOTOR-CYCLE	PRIVATE CAR	TAXI	Bus			Truck			TOTAL EXCEPT M/C
				LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	
6.00-6.30	50	125	71	8	18	54	15	48	-	339
6.30-7.00	150	442	123	-	30	59	18	20	-	892
7.00-7.30	215	846	133	2	26	49	13	8	-	1077
7.30-8.00	171	810	111	1	26	46	10	-	2	1006
8.00-8.30	203	643	152	-	21	53	-	4	1	874
8.30-9.00	150	409	135	2	20	44	-	8	1	619
9.00-10.00	192	405	216	-	26	81	63	110	28	929
10.00-11.00	151	396	148	-	22	67	107	88	160	988
11.00-12.00	177	413	249	1	27	90	97	79	135	1091
12.00-13.00	152	349	183	-	19	60	45	67	192	915
13.00-14.00	253	416	186	-	14	58	67	67	54	862
14.00-15.00	338	413	194	-	29	71	61	64	16	848
15.00-16.00	194	542	244	-	29	88	62	52	2	1019
16.00-16.30	109	388	170	-	19	41	15	12	-	645
16.30-17.00	94	548	118	-	20	35	30	1	2	754
17.00-17.30	109	448	188	-	14	51	38	7	1	747
17.30-18.00	72	243	178	-	17	41	12	-	-	491
18.00-18.30	84	224	132	1	15	34	32	27	-	465
18.30-19.00	102	190	151	2	22	33	47	25	1	471
19.00-20.00	156	473	280	1	31	61	105	20	3	974
20.00-21.00	136	330	234	2	23	48	81	7	60	785
21.00-22.00	111	299	207	-	8	44	57	15	135	756
Total	3369	9543	3803	20	476	1208	975	729	793	17547
22.00-23.00	79	194	174	-	11	18	3	10	64	474
23.00-24.00	44	119	197	-	5	6	19	8	41	395
24.00-1.00	27	57	192	1	2	1	17	1	36	307
1.00-2.00	12	58	165	1	4	1	7	10	19	265
2.00-3.00	2	24	90	-	-	1	10	5	26	156
3.00-4.00	3	21	72	-	1	2	6	4	29	135
4.00-5.00	8	28	69	1	3	12	18	17	53	201
5.00-6.00	33	75	110	-	13	42	30	28	30	329
Total	208	577	1069	3	39	83	110	83	298	2262
Grand Total	3577	10120	4872	23	515	1291	1085	812	1091	19809

OUTBOUND

HOUR	MOTOR-CYCLE	PRIVATE CAR	TAXI	Bus			Truck			TOTAL EXCEPT M/C
				LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	
6.00-6.30	18	65	65	2	8	20	18	20	2	200
6.30-7.00	69	188	80	5	21	37	40	17	3	391
7.00-7.30	95	276	80	5	25	40	30	4	3	463
7.30-8.00	120	370	70	5	14	45	38	3	-	555
8.00-8.30	134	408	118	5	30	55	44	2	-	662
8.30-9.00	105	272	162	9	24	52	60	10	1	590
9.00-10.00	196	431	229	2	28	84	165	110	6	1055
10.00-11.00	167	397	215	1	30	78	176	87	64	1048
11.00-12.00	216	516	212	1	31	68	184	86	62	1160
12.00-13.00	106	236	145	8	31	85	130	70	55	760
13.00-14.00	175	360	210	7	29	68	155	77	58	964
14.00-15.00	191	457	209	2	21	82	169	71	126	1137
15.00-16.00	263	625	244	2	47	100	189	89	10	1306
16.00-16.30	179	571	157	6	41	93	98	7	-	973
16.30-17.00	162	700	88	7	30	36	82	13	5	961
17.00-17.30	195	608	131	9	37	57	101	2	-	945
17.30-18.00	213	504	172	4	21	58	95	7	-	861
18.00-18.30	118	370	120	16	18	35	2	38	-	599
18.30-19.00	115	372	113	8	19	42	2	24	-	580
19.00-20.00	273	702	330	127	43	83	7	31	3	1326
20.00-21.00	223	571	260	128	19	53	4	17	1	1053
21.00-22.00	167	550	275	88	26	35	4	9	56	1043
Total	3500	9549	3685	447	603	1306	1793	794	455	18632
22.00-23.00	117	305	227	68	8	29	4	6	36	683
23.00-24.00	59	127	225	22	2	12	1	4	71	464
24.00-1.00	33	127	218	24	4	-	2	3	48	426
1.00-2.00	18	80	165	7	3	-	3	1	36	295
2.00-3.00	18	54	177	6	2	-	2	2	44	287
3.00-4.00	8	18	58	9	2	-	1	4	29	121
4.00-5.00	2	17	63	11	4	3	2	6	27	133
5.00-6.00	22	39	121	32	8	30	1	9	48	288
Total	277	767	1254	179	33	74	16	35	339	2697
Grand Total	3777	10316	4939	626	636	1380	1809	829	794	21329

APPENDIX 4-1 (3)

TRAFFIC COUNT ON PRA PIN KLAO BRIDGE

JULY 6 1981 (MONDAY)

INBOUND (FROM THONBURI TO BANGKOK)

HOUR	MOTOR-CYCLE	PRIVATE CAR	TAXI	Bus			Truck			TOTAL EXCEPT M/C
				LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	
6.00-6.30	139	191	138	17	10	63	186	19	-	624
6.30-7.00	235	759	250	25	7	112	167	78	-	1398
7.00-7.30	335	1514	216	46	10	85	177	20	-	2068
7.30-8.00	463	1534	230	61	11	70	90	-	-	1996
8.00-8.30	581	1505	180	38	5	89	146	-	-	1963
30-9.00	447	1272	265	67	-	144	90	227	1	2066
9.00-[illegible].00	417	1184	445	19	-	30	405	267	-	2350
10.00-11.00	427	926	305	30	-	108	122	126	20	1637
11.00-12.00	402	919	335	36	-	106	86	65	6	1553
12.00-13.00	340	775	415	50	-	122	52	36	2	1452
13.00-14.00	418	1021	475	39	-	105	113	51	1	1805
14.00-15.00	412	981	295	11	52	112	177	136	11	1775
15.00-16.00	421	1105	170	28	52	120	195	98	1	1769
16.00-16.30	255	513	97	17	18	74	100	10	-	829
16.30-17.00	213	727	154	17	12	70	73	9	-	1062
17.00-17.30	236	671	235	13	13	70	75	2	-	1079
17.30-18.00	252	450	180	17	16	67	75	-	-	805
18.00-18.30	175	423	231	20	25	74	80	93	-	946
18.30-19.00	126	383	150	8	10	58	60	40	-	709
19.00-20.00	258	732	204	20	15	105	60	30	-	1166
20.00-21.00	262	574	249	10	16	70	55	22	30	1026
21.00-22.00	124	456	385	6	9	60	24	36	25	1001
Total	6938	18615	5604	595	281	1914	2608	1365	97	31079

OUTBOUND

HOUR	MOTOR-CYCLE	PRIVATE CAR	TAXI	Bus			Truck			TOTAL EXCEPT M/C
				LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	
6.00-6.30	48	106	106	6	7	53	30	27	2	337
6.30-7.00	120	270	188	24	2	60	30	27	-	601
7.00-7.30	81	603	148	35	-	60	30	5	-	881
7.30-8.00	140	724	55	36	6	60	30	10	-	921
8.00-8.30	190	764	180	41	10	60	60	4	-	1119
8.30-9.00	202	740	195	55	19	81	51	6	-	1147
9.00-10.00	500	640	457	42	26	102	195	137	-	1599
10.00-11.00	521	960	422	56	35	98	162	108	8	1849
11.00-12.00	360	1247	456	47	36	113	190	130	8	2227
12.00-13.00	522	1060	497	37	19	104	216	156	3	2092
13.00-14.00	273	1590	432	34	27	112	180	108	11	2494
14.00-15.00	507	1059	435	38	30	75	283	153	10	2085
15.00-16.00	273	1140	287	25	39	155	278	141	4	2069
16.00-16.30	282	1032	123	30	42	70	120	8	-	1425
16.30-17.00	353	1244	219	47	28	91	92	10	-	1731
17.00-17.30	261	1474	251	43	29	92	165	2	-	2056
17.30-18.00	416	1160	320	32	28	97	151	12	-	1800
18.00-18.30	259	834	305	36	8	100	94	99	-	1476
18.30-19.00	206	657	415	28	10	78	195	72	-	1455
19.00-20.00	471	1218	611	40	9	120	118	58	-	2174
20.00-21.00	345	1085	402	29	18	78	182	46	-	1840
21.00-22.00	228	768	377	20	27	73	60	17	46	1388
Total	6643	20375	6881	781	455	1932	2912	1336	92	34764

APPENDIX 4-1(4)

TRAFFIC COUNT ON MEMORIAL BRIDGE

JULY 6 1981 (MONDAY)

INBOUND (FROM THONBURI TO BANGKOK)

HOUR	MOTOR-CYCLE	PRIVATE CAR	TAXI	Bus			Truck			TOTAL EXCEPT M/C
				LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	
6.00-6.30	803	545	102	2	17	99	77	52	8	902
6.30-7.00	1093	709	128	8	65	150	81	54	1	1196
7.00-7.30	1289	747	138	7	37	130	64	12	3	1138
7.30-8.00	1333	750	142	15	53	145	80	8	-	1193
8.00-8.30	2250	817	180	10	36	117	63	10	2	1235
8.30-9.00	1607	770	293	15	42	117	104	20	3	1364
9.00-10.00	2026	1013	383	26	83	157	283	95	14	2054
10.00-11.00	1626	892	564	18	90	203	313	200	12	2292
11.00-12.00	1302	890	573	6	70	170	334	164	12	2219
12.00-13.00	1136	786	616	8	108	211	311	170	14	2224
13.00-14.00	1480	870	557	6	136	196	344	202	7	2318
14.00-15.00	1489	853	653	4	166	185	365	159	7	2392
15.00-16.00	1362	901	601	12	74	208	253	195	4	2248
16.00-16.30	869	320	209	6	36	89	88	23	-	771
16.30-17.00	722	415	103	5	33	105	55	38	-	834
17.00-17.30	723	315	157	1	15	128	59	26	1	702
17.30-18.00	736	353	113	3	24	124	73	24	5	719
18.00-18.30	712	480	239	4	51	152	130	50	2	1108
18.30-19.00	730	655	197	6	37	113	91	24	-	1123
19.00-20.00	1115	621	475	8	55	147	159	20	5	1472
20.00-21.00	841	583	460	3	67	144	141	76	5	1479
21.00-22.00	659	784	385	4	47	101	130	47	-	1498
Total	25903	15069	7330	177	1342	3191	3598	1669	105	32481

OUTBOUND

HOUR	MOTOR-CYCLE	PRIVATE CAR	TAXI	Bus			Truck			TOTAL EXCEPT M/C
				LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	
6.00-6.30	62	87	102	-	16	87	52	52	17	413
6.30-7.00	118	202	163	-	15	118	58	29	8	593
7.00-7.30	175	295	125	-	56	116	45	6	5	648
7.30-8.00	370	349	148	-	23	94	18	4	2	668
8.00-8.30	420	407	133	-	26	110	44	4	6	730
8.30-9.00	405	361	163	1	25	101	68	9	8	736
9.00-10.00	1125	577	328	1	153	293	175	30	13	1570
10.00-11.00	1200	647	428	7	157	191	302	133	24	1889
11.00-12.00	1350	532	350	6	126	178	301	162	14	1669
12.00-13.00	1256	658	465	14	90	185	348	169	11	1940
13.00-14.00	1290	650	459	10	107	193	349	170	15	1953
14.00-15.00	1240	657	381	8	174	198	332	148	9	1907
15.00-16.00	1529	690	477	5	166	225	317	162	16	2058
16.00-16.30	624	520	220	9	70	119	140	50	3	1131
16.30-17.00	814	495	187	1	63	115	115	44	1	1021
17.00-17.30	696	609	173	4	53	104	74	25	1	1043
17.30-18.00	1101	573	169	10	31	125	88	18	1	1015
18.00-18.30	1127	430	211	6	32	105	92	11	2	889
18.30-19.00	824	415	235	4	39	135	97	10	1	936
19.00-20.00	1769	790	527	14	47	193	215	40	5	1831
20.00-21.00	1257	653	675	6	65	154	153	54	8	1768
21.00-22.00	743	545	470	6	55	147	191	51	10	1483
Total	19459	11142	6597	112	1589	3286	3604	1381	180	27891

APPENDIX 4-1 (5)

TRAFFIC COUNT ON KRUNGTHEP BRIDGE

JULY 6 1981 (MONDAY)

INBOUND (FROM THONBURI TO BANGKOK)

HOUR	MOTOR-CYCLE	PRIVATE CAR	TAXI	Bus			Truck			TOTAL EXCEPT M/C
				LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	
6.00-6.30	86	133	55	16	11	33	36	65	4	353
6.30-7.00	178	358	60	25	19	57	72	74	7	672
7.00-7.30	352	501	87	45	11	53	165	19	16	897
7.30-8.00	594	567	119	50	11	38	165	7	11	968
8.00-8.30	628	473	128	30	9	30	106	13	16	805
8.30-9.00	418	313	113	18	5	22	117	16	10	614
9.00-10.00	626	577	254	37	12	46	342	128	136	1532
10.00-11.00	450	520	202	20	8	57	254	290	281	1632
11.00-12.00	419	488	180	24	6	43	216	284	232	1473
12.00-13.00	381	485	182	28	11	37	184	212	201	1340
13.00-14.00	382	444	130	10	10	62	302	287	132	1377
14.00-15.00	427	607	109	4	6	51	302	350	68	1497
15.00-16.00	475	678	93	10	6	54	333	262	10	1446
16.00-16.30	216	331	97	25	7	27	102	39	6	634
16.30-17.00	271	338	121	20	8	42	135	38	8	710
17.00-17.30	269	418	65	15	8	25	120	30	3	684
17.30-18.00	198	436	48	12	8	24	39	53	2	622
18.00-18.30	230	340	102	22	7	31	250	265	6	1023
18.30-19.00	254	320	54	20	5	25	83	57	2	566
19.00-20.00	443	493	104	37	9	48	129	101	7	1018
20.00-21.00	373	456	178	11	6	42	165	87	67	1012
21.00-22.00	263	244	156	31	1	32	92	42	400	998
Total	7933	9520	2727	510	184	879	3709	2719	1625	21873

OUTBOUND

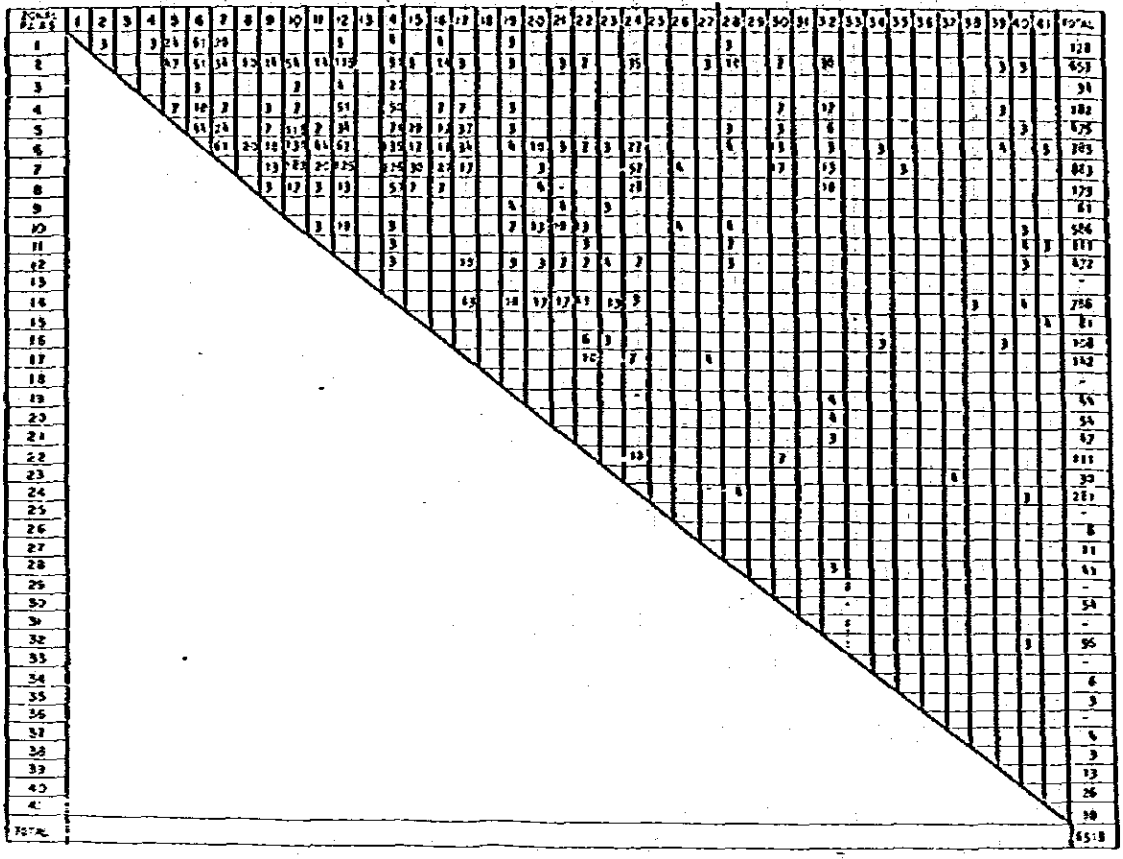
HOUR	MOTOR-CYCLE	PRIVATE CAR	TAXI	Bus			Truck			TOTAL EXCEPT M/C
				LIGHT	MEDIUM	HEAVY	LIGHT	MEDIUM	HEAVY	
6.00-6.30	38	37	41	6	10	29	20	93	1	237
6.30-7.00	92	153	60	4	20	47	53	145	3	485
7.00-7.30	201	304	92	2	39	37	48	13	3	538
7.30-8.00	273	390	87	-	34	29	66	12	3	621
8.00-8.30	256	390	135	2	27	33	69	15	7	678
8.30-9.00	207	265	85	17	3	28	99	37	5	539
9.00-10.00	447	488	163	22	12	60	279	357	25	1406
10.00-11.00	387	373	136	23	10	46	275	352	175	1390
11.00-12.00	321	323	129	3	21	36	262	390	252	1416
12.00-13.00	375	464	163	4	18	56	230	222	183	1340
13.00-14.00	355	388	154	31	10	45	270	220	136	1254
14.00-15.00	317	475	90	18	7	39	172	199	205	1205
15.00-16.00	515	720	130	21	11	60	292	463	62	1759
16.00-16.30	260	380	69	14	12	28	84	35	12	634
16.30-17.00	313	385	79	21	5	32	85	23	10	640
17.00-17.30	355	441	69	18	9	25	98	22	9	691
17.30-18.00	450	524	104	1	40	30	106	40	11	856
18.00-18.30	365	412	99	1	23	38	136	134	11	854
18.30-19.00	300	347	100	17	9	22	65	94	6	660
19.00-20.00	526	444	180	-	25	60	133	90	4	936
20.00-21.00	369	488	185	-	23	53	106	75	26	956
21.00-22.00	356	343	147	1	21	33	108	43	128	825
Total	7078	8534	2497	226	389	866	3056	3074	1278	19920

APPENDIX. 4-2(1)

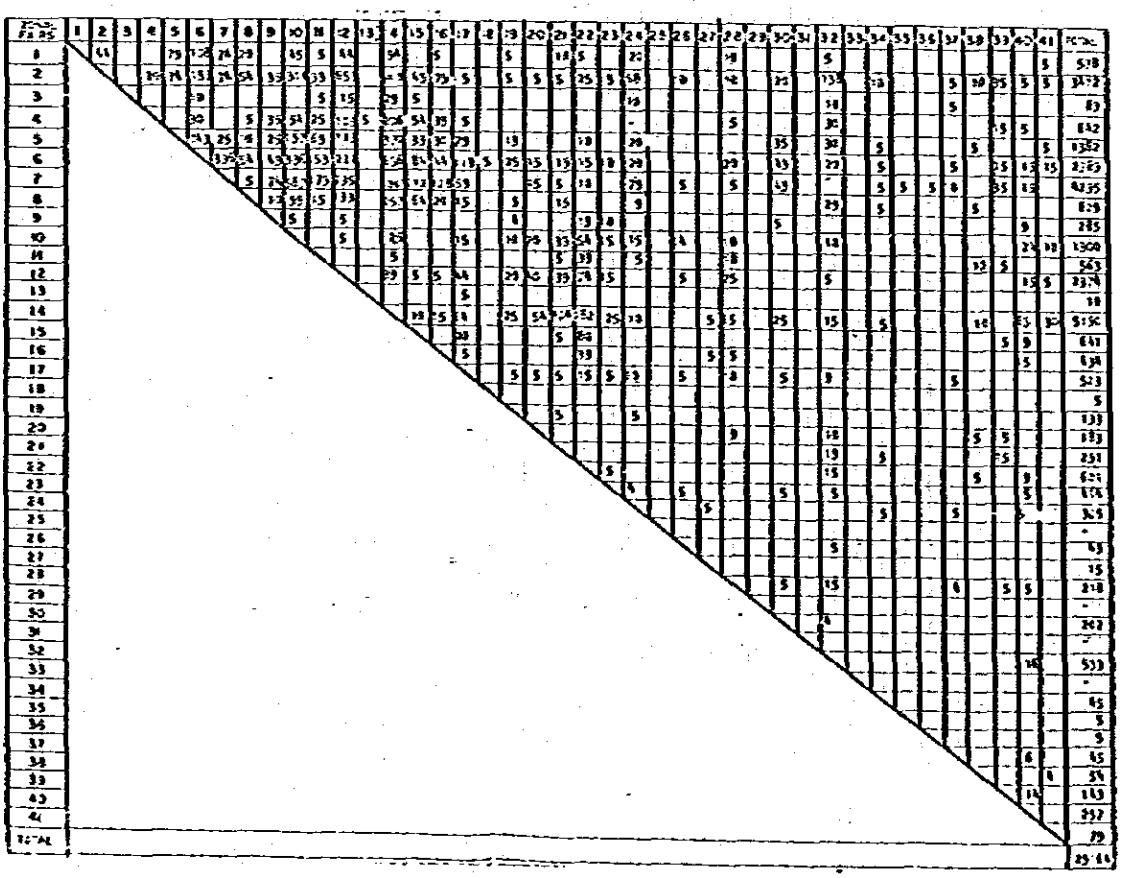
RESULT OF ROAD SIDE INTERVIEW O-D SURVEY

STATION RAMA VI BRIDGE DATE JULY 2 1981 (THURSDAY)

MOTORCYCLE



CAR

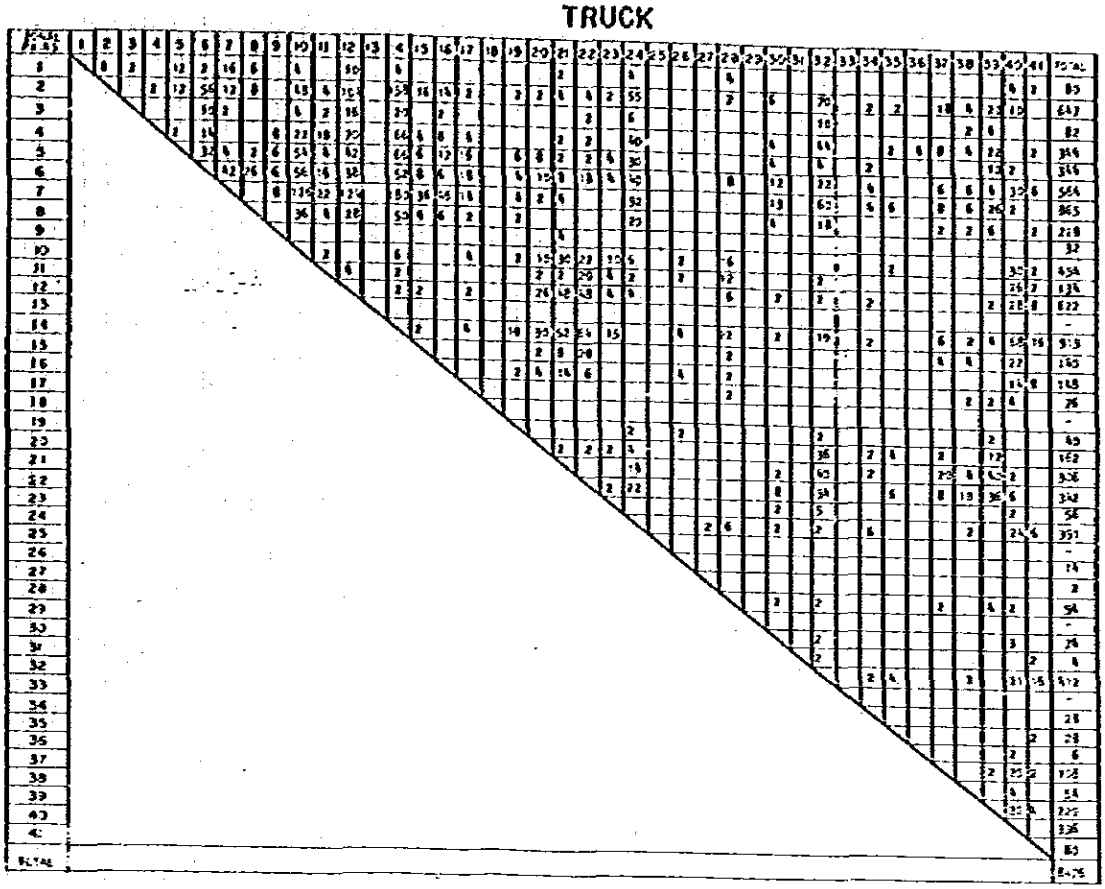


APPENDIX. 4-2 (2)

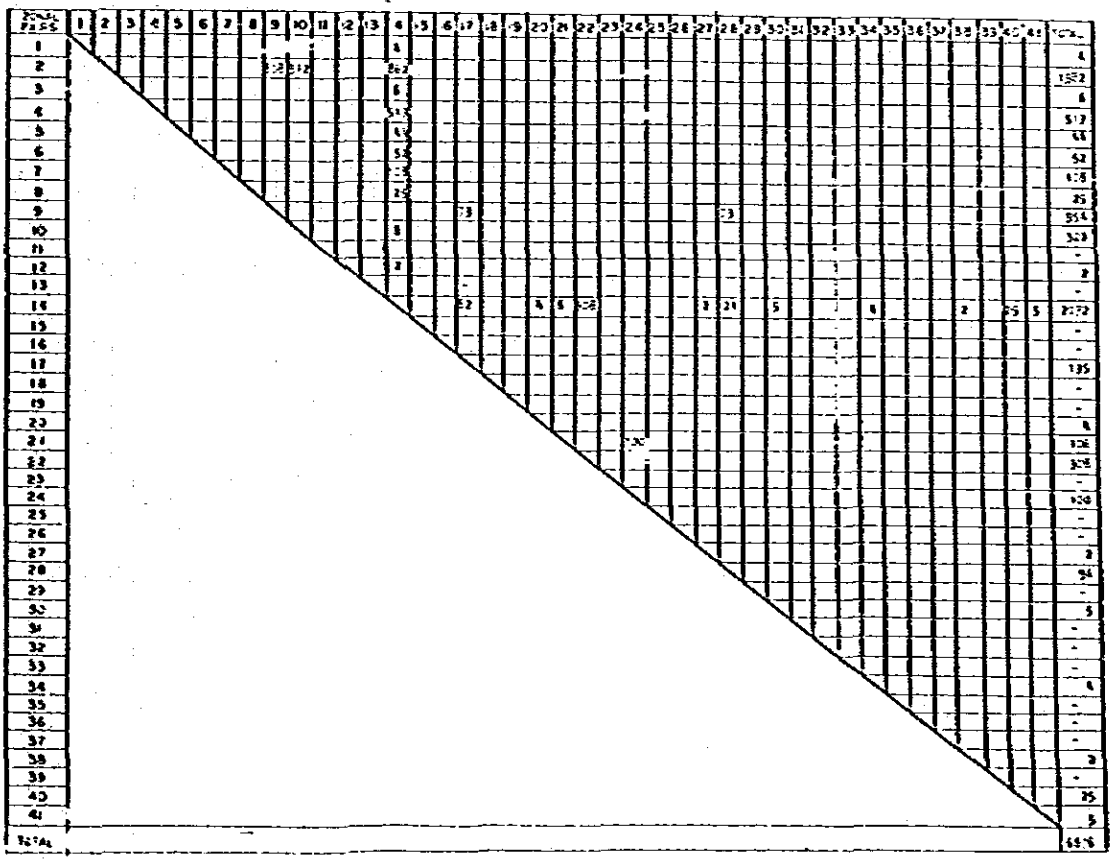
RESULT OF ROAD SIDE INTERVIEW O-D SURVEY

STATION RAMA VI BRIDGE DATE JULY 2 1981 (THURSDAY)

TRUCK



BUS

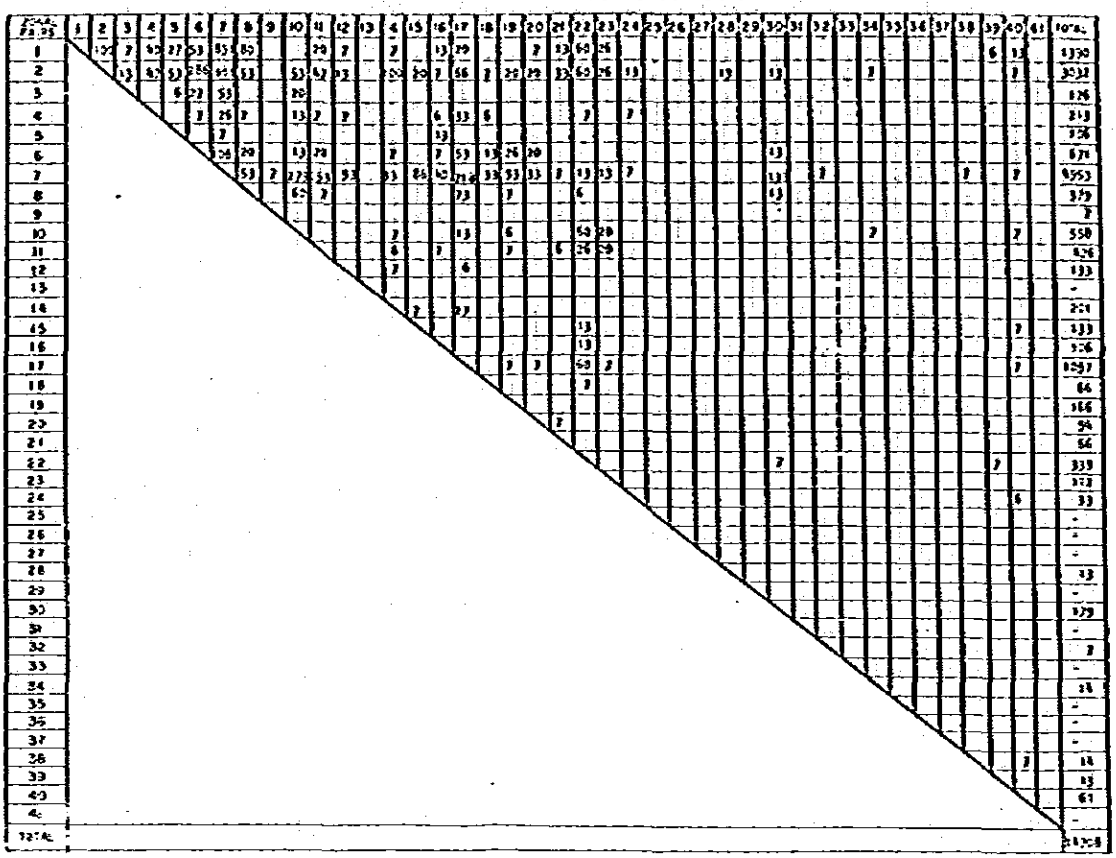


APPENDIX. 4-2(3)

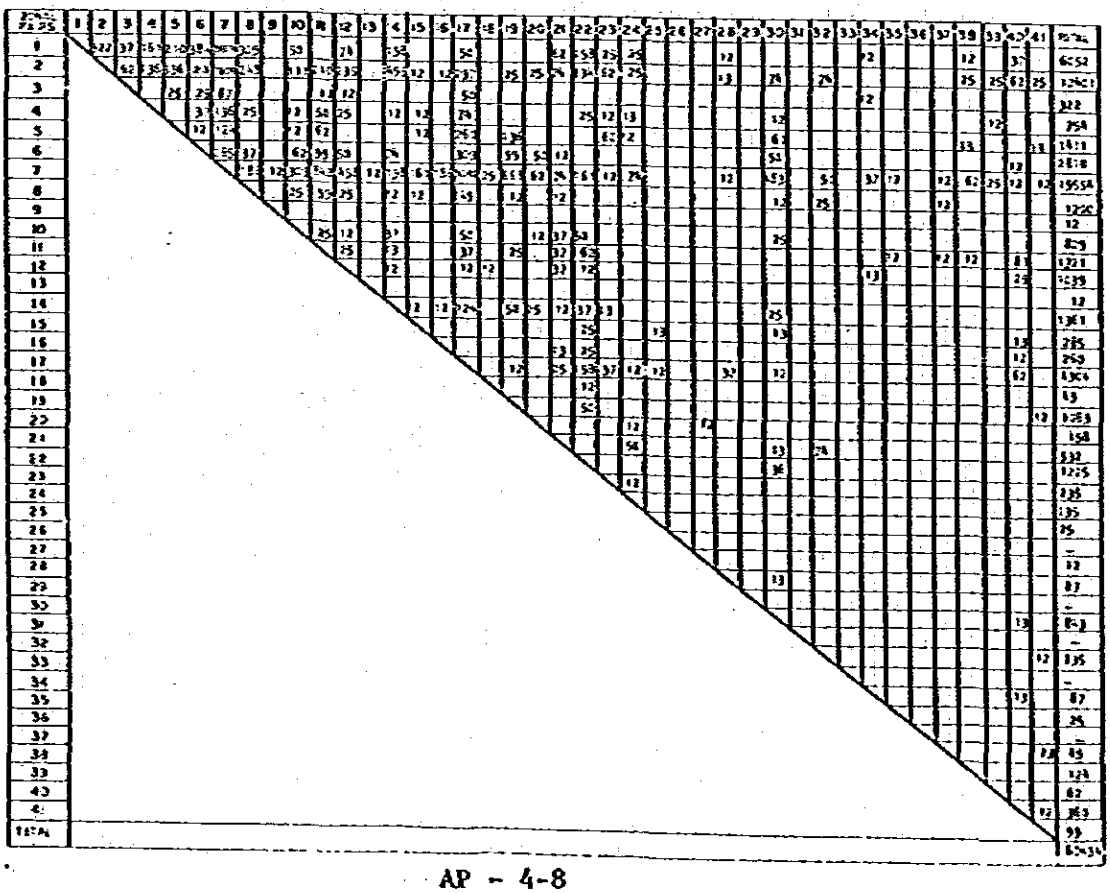
RESULT OF ROAD SIDE INTERVIEW O-D SURVEY

STATION KRUNG THON BRIDGE DATE JUNE 30 1981 (TUESDAY)

MOTORCYCLE



CAR

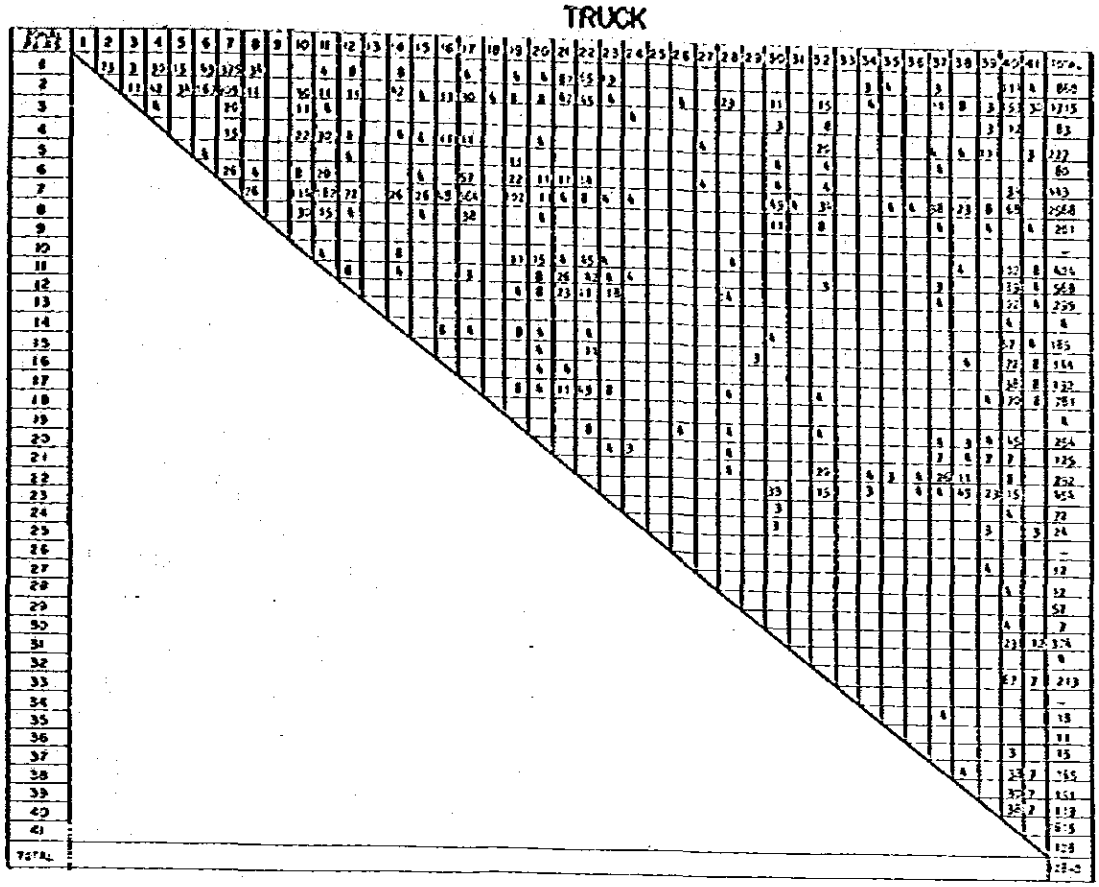


APPENDIX. 4-2 (4)

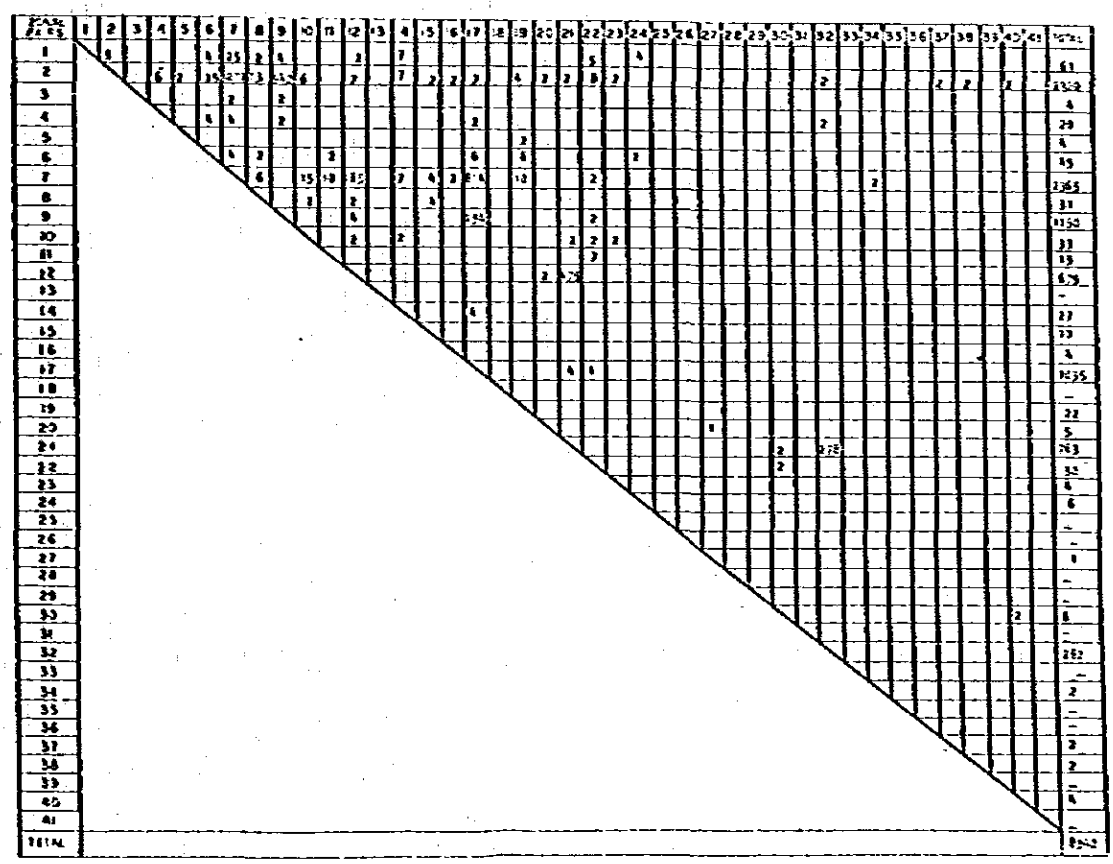
RESULT OF ROAD SIDE INTERVIEW O-D SURVEY

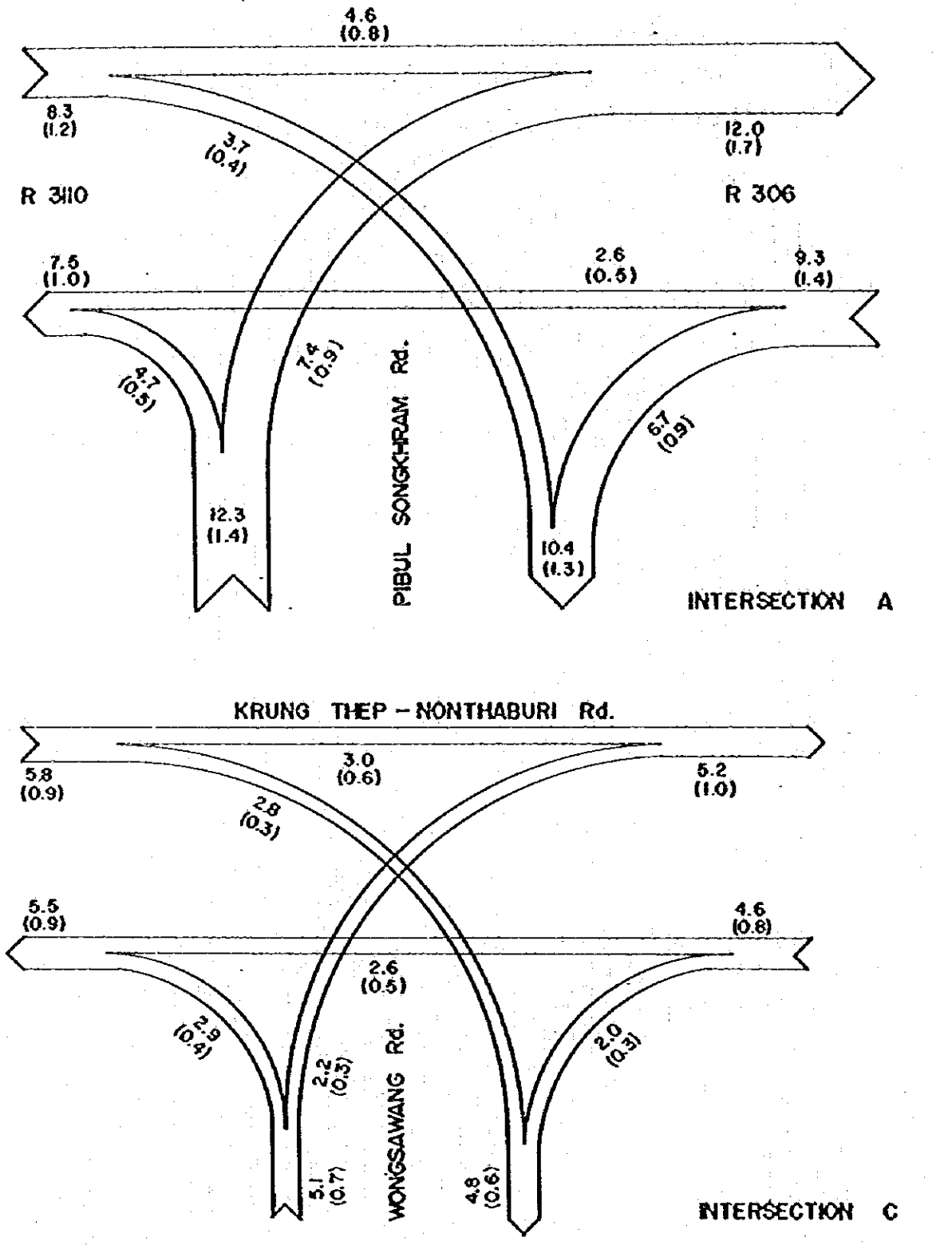
STATION KRUNG THON BRIDGE DATE JULY 30 1981 (TUESDAY)

TRUCK

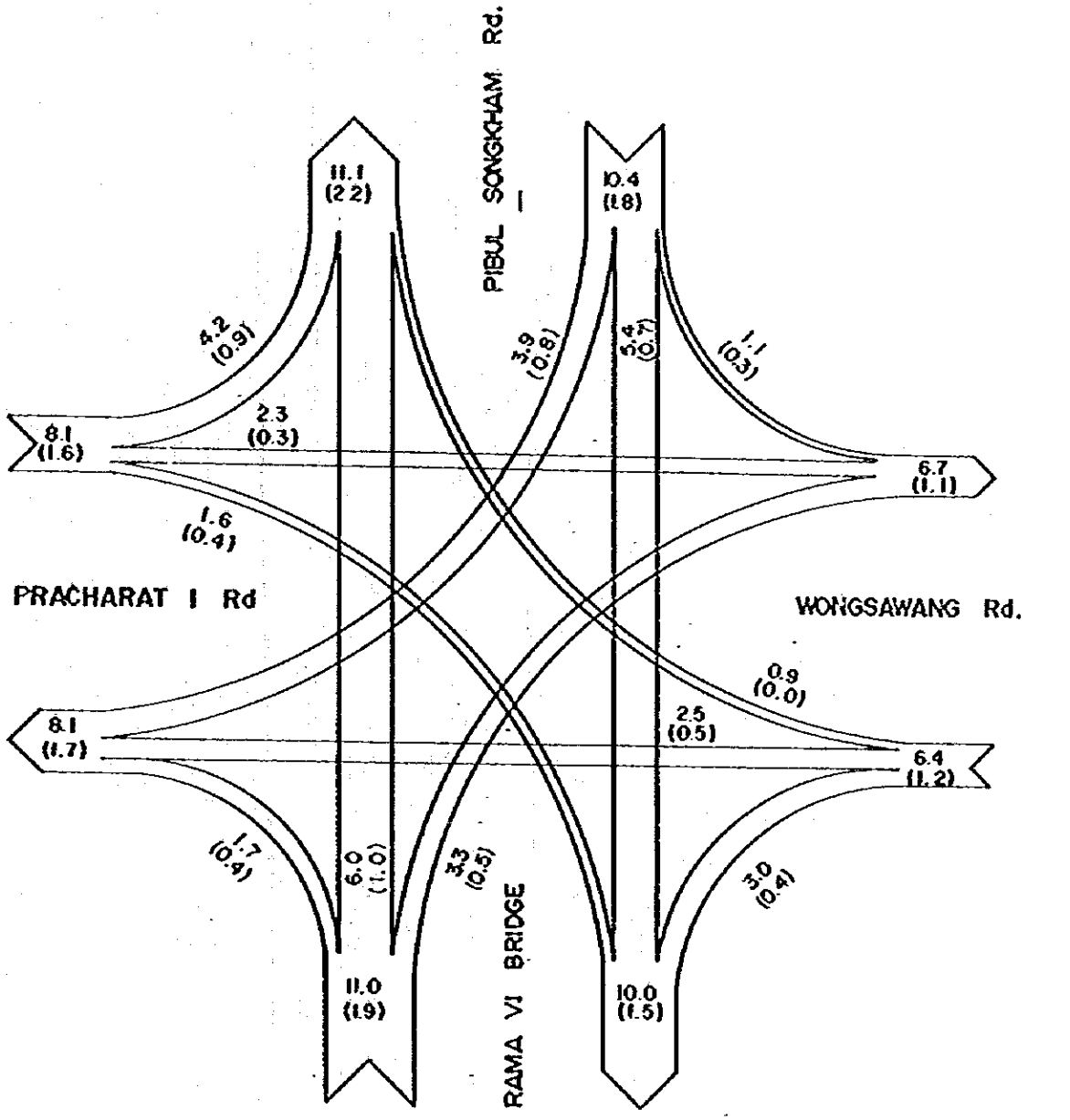


BUS





APPENDIX 4-3(1) PRESENT TRAFFIC FLOW BY DIRECTION OF INTERSECTION
THOUSAND VEHICLES / 16 hr. (6-22)
INTERSECTION NO A – C
DATE JULY 7 (Tue.) 1981



LEGEND

2.4	---- TRAFFIC VOLUMES (EXCL. MOTORCYCLE)
(0.6)	---- VOLUMES OF MOTORCYCLE

SCALE

VEHICLES

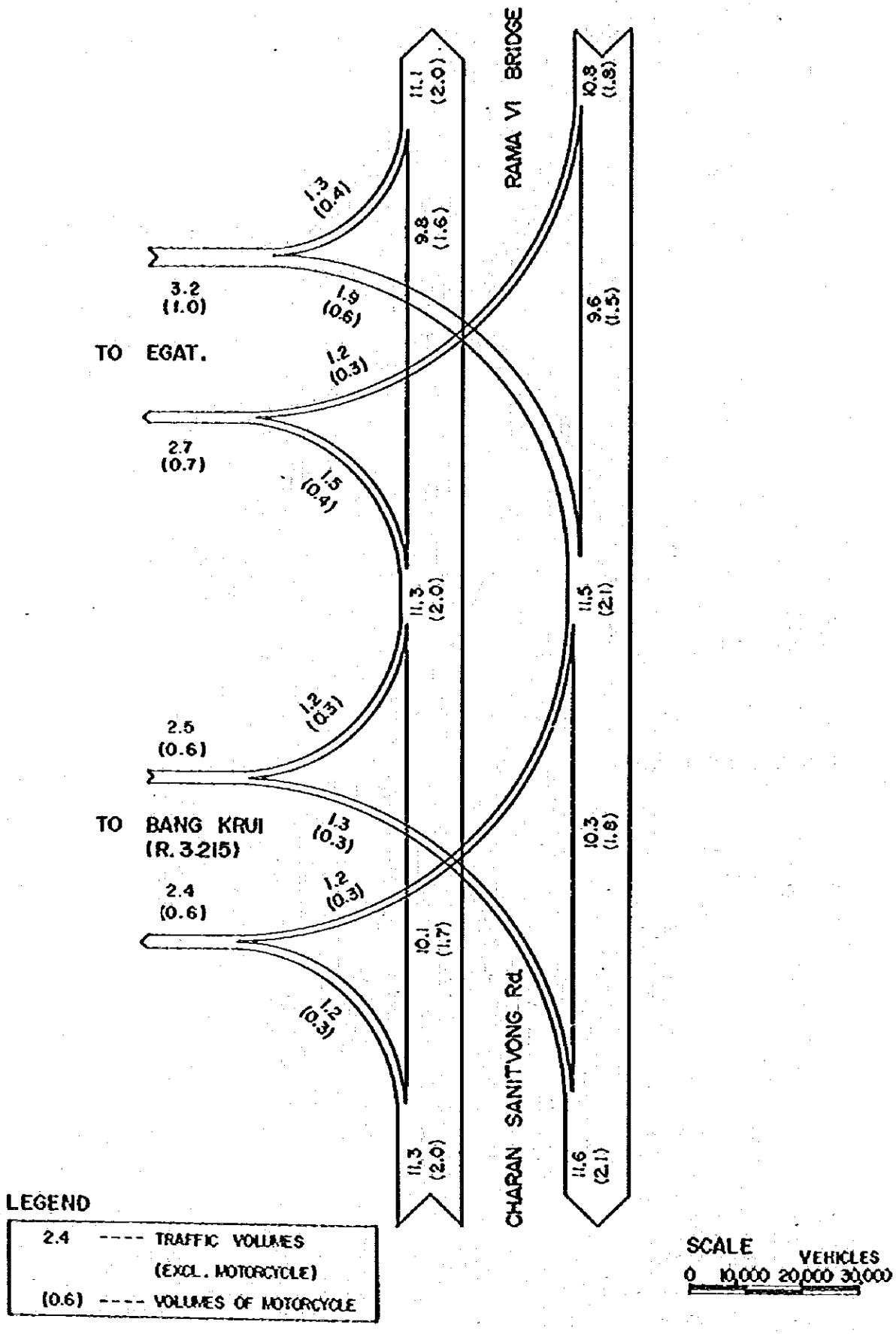
0 10,000 20,000 30,000

APPENDIX 4-3(2) PRESENT TRAFFIC FLOW BY DIRECTION OF INTERSECTION

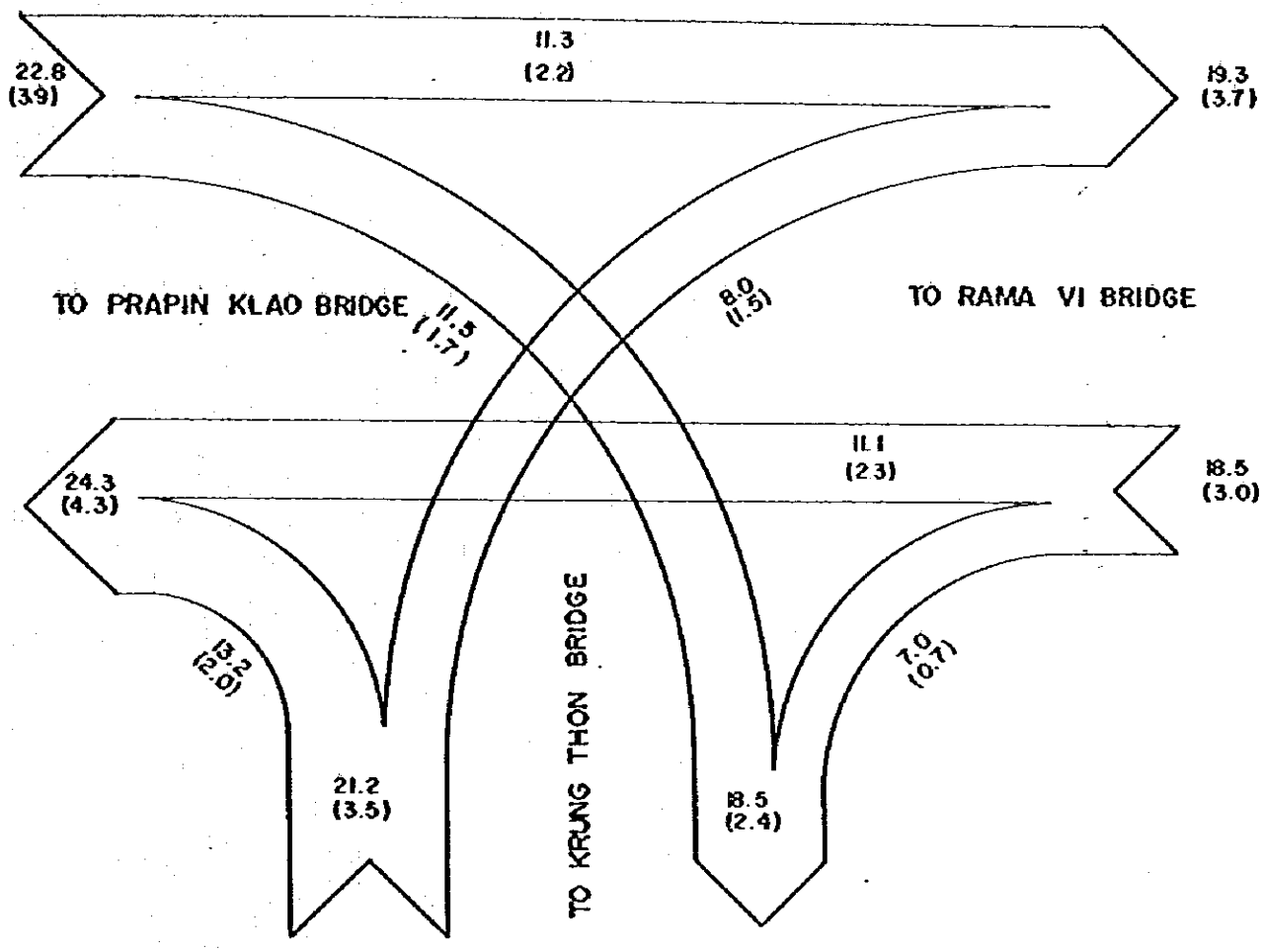
THOUSAND VEHICLES / 16 hr. (6~22)

INTERSECTION NO. 8

DATE JULY 1 (Tue.) 1981



APPENDIX 4-3(3) PRESENT TRAFFIC FLOW BY DIRECTION OF INTERSECTION
THOUSAND VEHICLES/16 hr. (6-22)
INTERSECTION NO. D
DATE JULY 7 (Tue.) 1981



LEGEND

2.4 ----	TRAFFIC VOLUMES (EXCL. MOTORCYCLE)
(0.6) ----	VOLUMES OF MOTORCYCLE

SCALE VEHICLES
0 10,000 20,000 30,000

APPENDIX 4-3(4) PRESENT TRAFFIC FLOW BY DIRECTION OF INTERSECTION
THOUSAND VEHICLES / 16 hr. (6-22)
INTERSECTION NO. E
DATE JULY 7 (Tue.) 1981

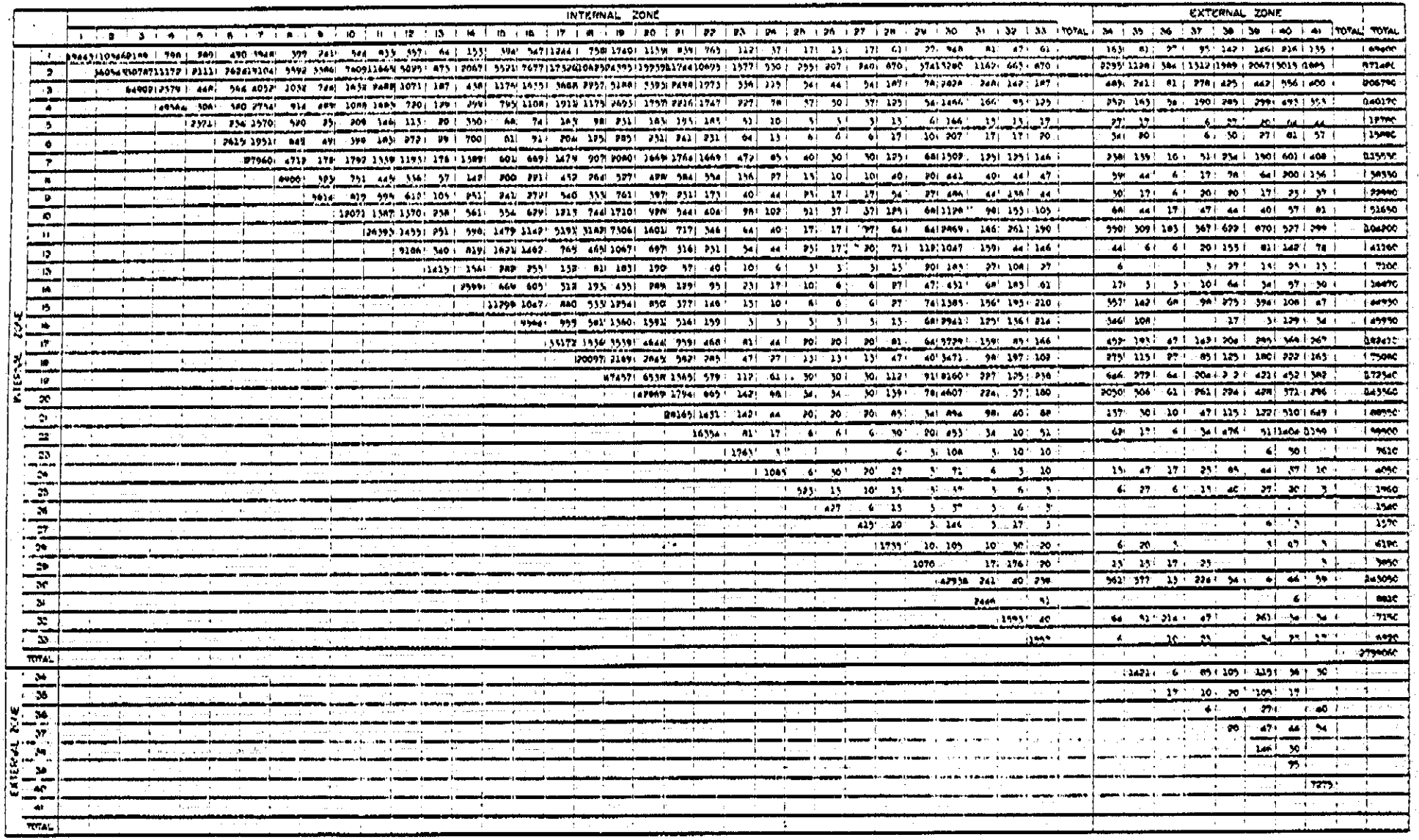
APPENDIX 5-1(1) ORIGIN - DESTINATION TABLE

MOTORCYCLE

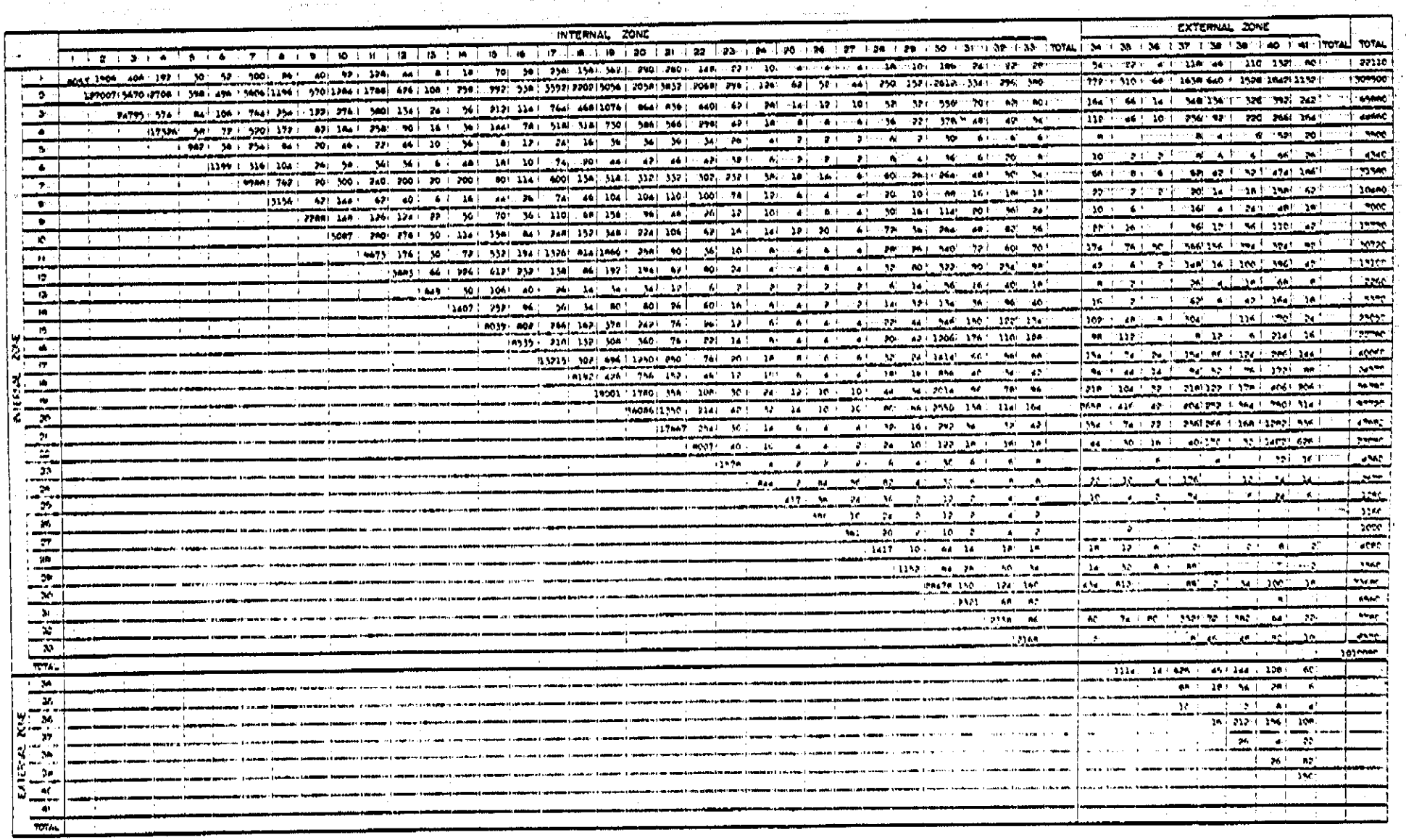
		INTERNAL ZONE																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
INTERNAL ZONE	1	37557	3972	456	566	60	74	520	174	96	212	372	130	24	40	152	210	400
	2		263594	213460	20065	816	1014	17344	3475	1322	2944	4510	1962	334	794	2134	2968	6490
	3			51399	4870	174	916	11944	786	282	632	960	416	72	172	454	632	1496
	4				88112	110	148	11064	334	192	404	450	870	50	114	308	478	946
	5					12744	90	404	300	44	94	10	44	8	63	24	98	66
	6						3375	752	850	52	110	70	54	10	132	32	34	78
	7							27719	1016	100	864	514	394	68	142	132	158	572
	8								7686	178	294	172	132	22	54	78	86	190
	9									15362	142	850	234	42	96	92	104	208
	10										21746	556	530	92	218	216	244	470
	11											25140	568	98	232	576	444	2022
	12												10794	132	316	630	368	296
	13													1545	60	108	98	50
	14														15625	258	252	190
	15															10412	404	342
	16																9772	370
	17																	89572
	18																	
	19																	
	20																	
	21																	
	22																	
	23																	
	24																	
	25																	
	26																	
	27																	
	28																	
	29																	
	30																	
	31																	
	32																	
	33																	
	TOTAL																	
EXTERNAL ZONE	34																	
	35																	
	36																	
	37																	
	38																	
	39																	
	40																	
	41																	
	TOTAL																	

		INTERNAL ZONE																	EXTERNAL ZONE									
		18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	TOTAL	34	35	36	37	38	39	40	41	TOTAL	TOTAL
INTERNAL ZONE	1	292	474	440	424	334	44	14	8	6	6	24	10	344	32	18	24											45730
	2	4100	9428	4162	8907	4686	410	206	100	80	96	336	144	8134	450	256	336											640160
	3	874	2006	1312	1496	998	130	44	30	16	22	72	30	1094	96	56	72											136270
	4	592	2043	888	454	674	88	30	14	12	14	48	22	740	64	56	48											97570
	5	58	40	72	74	72	20	4	2	2	2	6	2	64	6	6	6											8600
	6	48	110	88	94	88	16	4	2	2	2	6	4	80	6	6	8											10440
	7	390	406	644	382	646	142	36	16	12	12	48	76	566	15	15	15											75930
	8	116	268	214	296	214	40	10	8	4	4	16	8	194	16	18	18											25190
	9	128	894	154	90	44	4	4	2	1	1	22	10	148	14	30	18											35110
	10	288	462	340	210	156	39	10	5	4	4	48	26	456	40	46	40											33930
	11	1240	2844	624	278	134	24	5	2	1	2	26	26	1118	64	80	74											44700
	12	180	414	270	132	90	25	4	2	1	2	28	44	408	62	102	56											27050
	13	32	72	46	29	16	1					4	8	70	10	18	10											4670
	14	74	170	112	50	36	2	2	1			12	18	146	24	40	26											31090
	15	210	482	330	344	56	1	1				8	28	556	60	72	42											29990
	16	226	520	414	200	62		4				8	28	1136	48	76	46											29580
	17	592	1344	12796	486	206	32	16	8	8	8	30	24	2224	62	54	64											80470
	18	14092	836	11100	298	186	90	10	4	6	4	20	16	1344	36	32	40											45550
	19		41563	17520	8861	292	42	24	12	12	12	44	36	8130	88	76	92											213590
	20			56303	9081	330	52	26	12	12	16	52	26	1754	84	46	66											93790
	21				20015	556	54	14	8	8	8	32	12	438	34	22	54											57590
	22					14573	32	6	4	2	2	12	8	200	12	16	20											54940
	23						11452					6	2	38		4	4											4360
	24							1001	4	8	6	8	2	24	2	2	2											2530
	25								402	6	4	6		12		2	2											1250
	26									289	3	2		8		2												810
	27										561	8	2	16	2	2	2											1020
	28											11317	2	68	2	6	4											3670
	29												788	30	6	8	6											2190
	30													56452	90	64	84											92030
	31														1878	12	18											5020
	32															11830	12											4220
	33																1337											4040
	TOTAL																											1808420
EXTERNAL ZONE	34																											
	35																											
	36																											
	37																											
	38																											
	39																											
	40																											
	41																											
	TOTAL																											

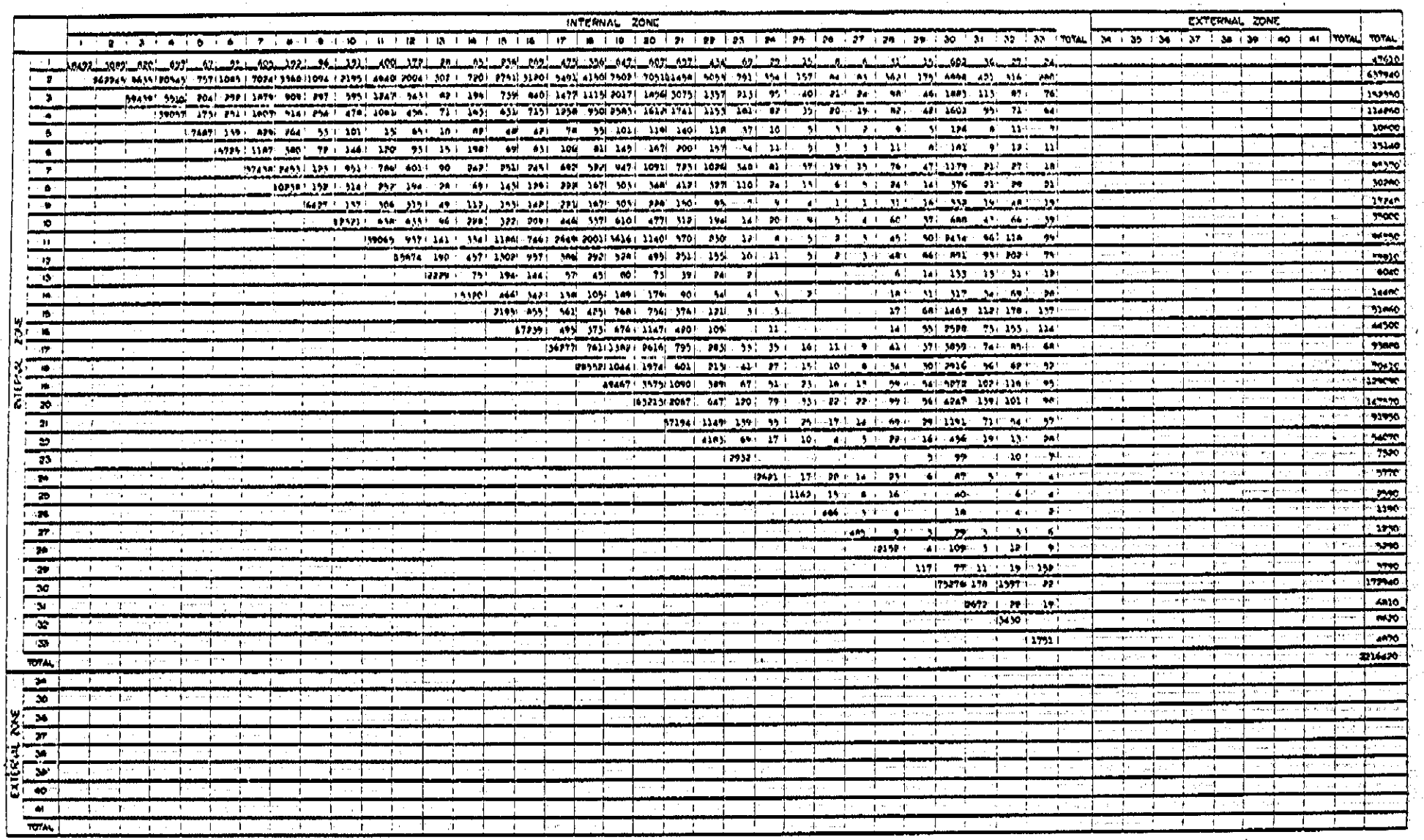
APPENDIX 5 – 1 (2) ORIGIN – DESTINATION TABLE 1981 CAR



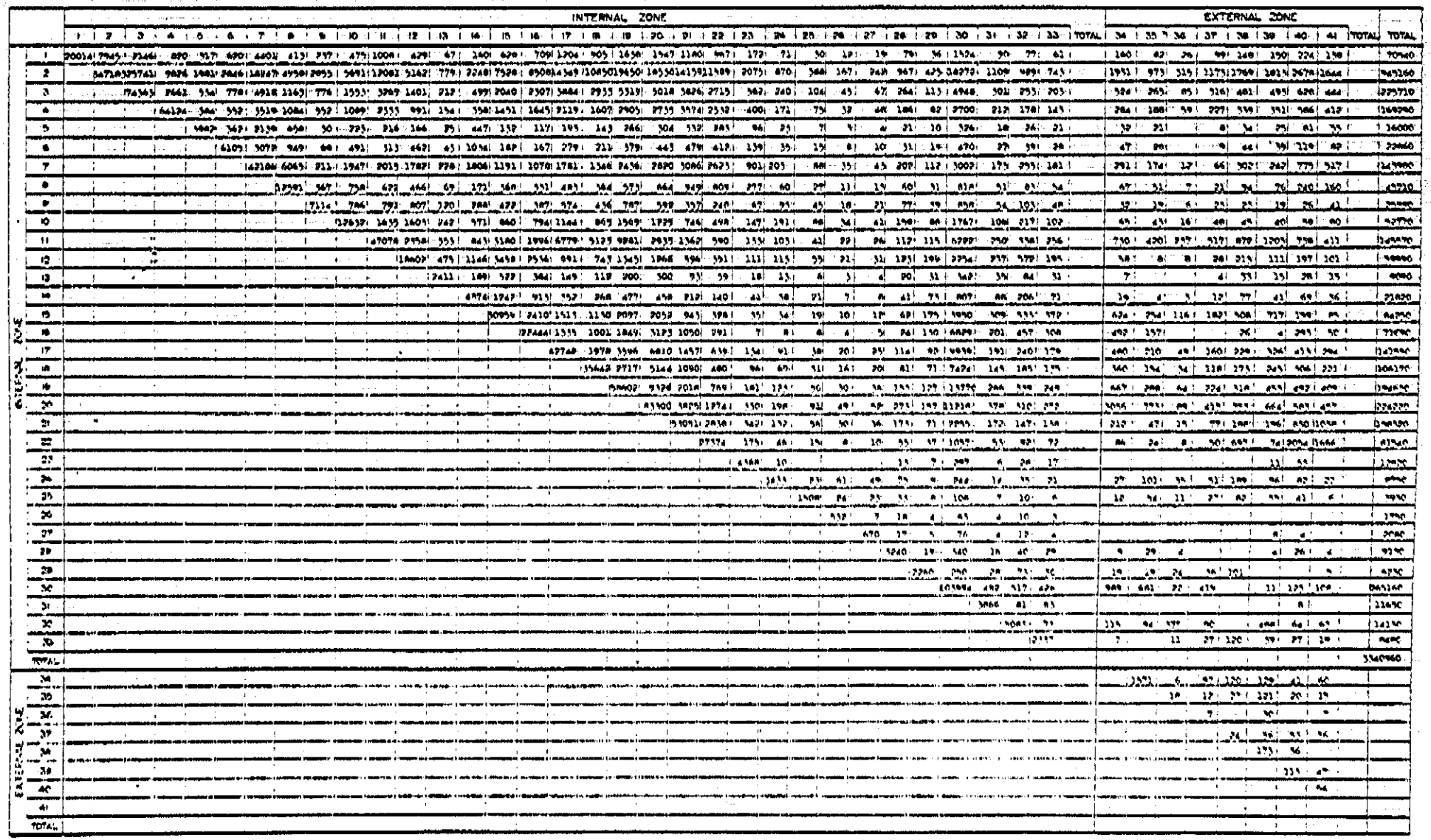
APPENDIX 5-1(3) ORIGIN - DESTINATION TABLE 1981 TRUCK



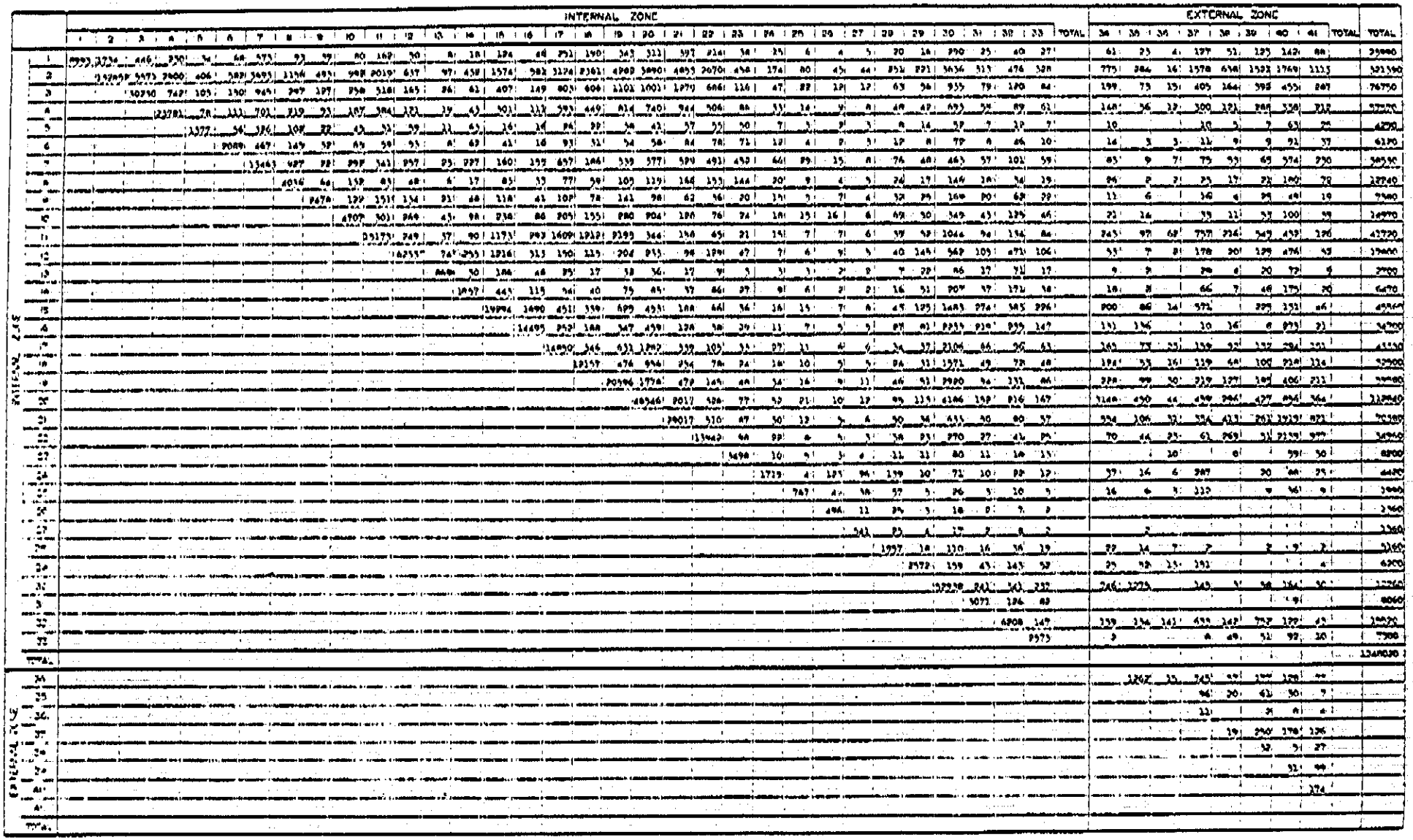
APPENDIX 5 - 2(1) ORIGIN - DESTINATION TABLE 1985 MOTORCYCLE



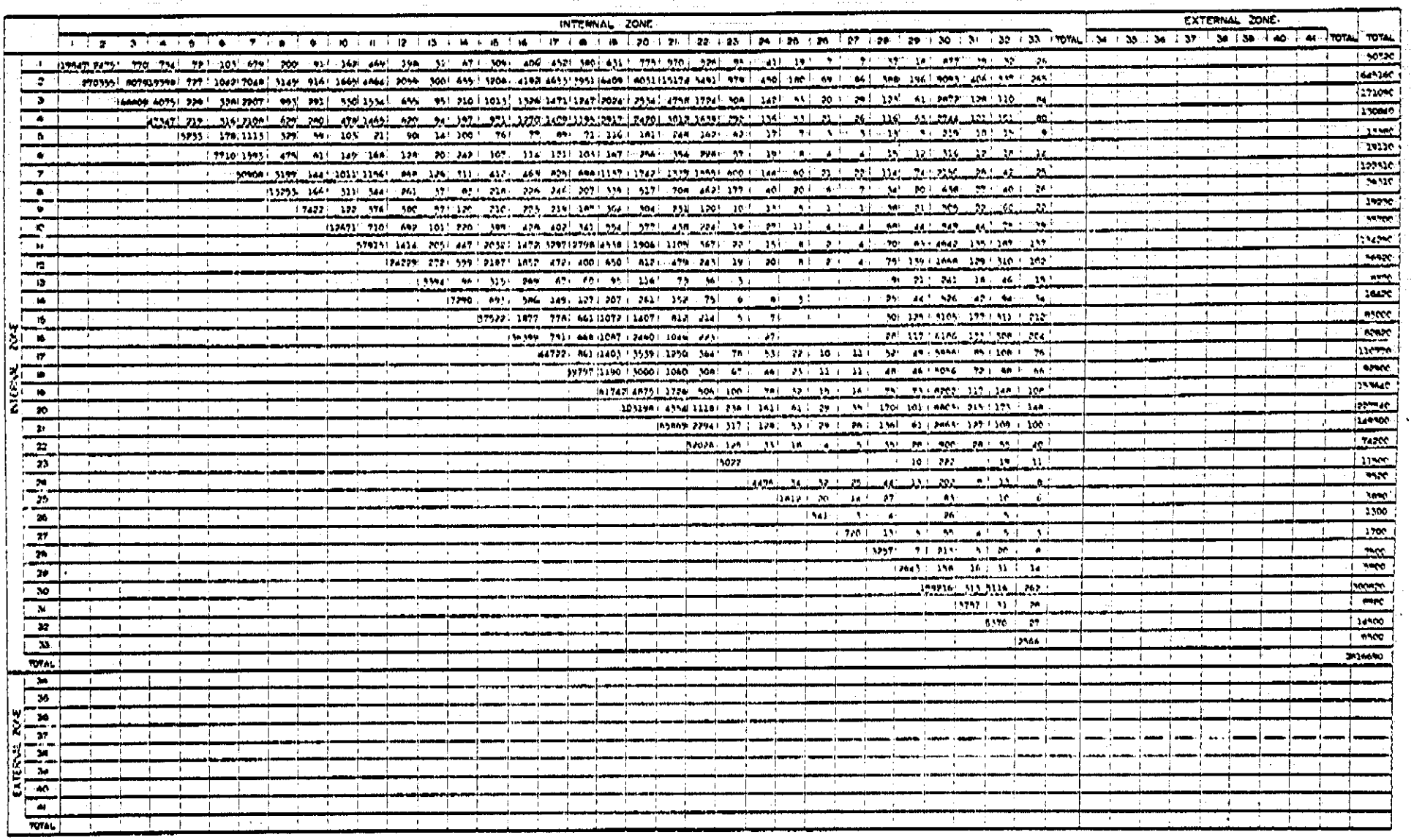
APPENDIX 5-2(2) ORIGIN - DESTINATION TABLE 1985 CAR



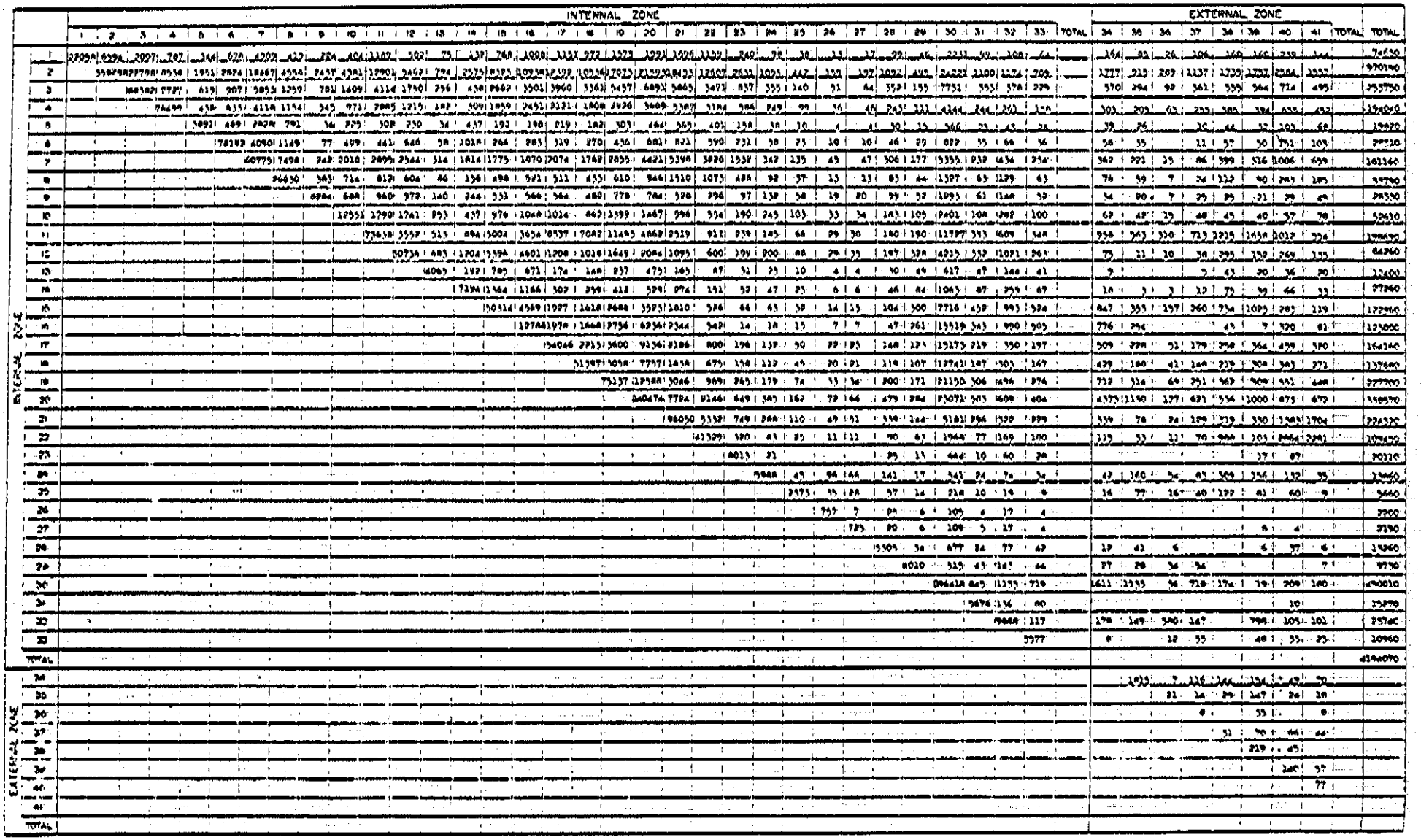
APPENDIX 5 – 2 (3) ORIGIN – DESTINATION TABLE 1985 TRUCK



APPENDIX 5 – 3 (1) ORIGIN – DESTINATION TABLE 1990 MOTORCYCLE



APPENDIX 5 - 3 (2) ORIGIN — DESTINATION TABLE 1990 CAR



APPENDIX 5 - 3 (3) ORIGIN - DESTINATION TABLE 1990 TRUCK