10.5.4 Evaluation of Interchange Type

1) General Description

A Diamond type interchange is adopted in general where the project road has parallel roads in both sides. The location of On/Off ramp is selected to keep enough distance to adjacent intersection. Where entrance and egress traffic at an interchange has a directional prominence toward a crossing road or no parallel road exists, practical types of interchange are studied in particular. The evaluation of interchange type are discussed mainly for the following interchanges;

(1) Mangga Besar Interchange
(2) Kebon Sirih Interchange
(3) Kebon Kacang Interchange
(4) Senayan Interchange
(5) South JORR Junction
(6) West JORR Interchange
(7) Latumeten Interchange
(8) Gunung Sahari Interchange
(9) East JORR Interchange

2) Evaluation Criteria

The comparison and evaluation of alternatives will be made based on the following criteria:

(1) Land Availability
(2) Function of Interchanges
(3) Construction Cost
(4) Traffic Safety and Users' Benefits
(5) Future Traffic Demand

These criteria will be analysed comprehensively. Initially, the desirable type of interchange might be considered in terms of design concept derived from function, traffic volume, traffic safety and users benefits, etc. However, land availability and construction cost, sometimes, might warrant the second best alternative. In principle, Junction take a higher priority to the criteria of function and future traffic demand while interchanges must also give higher consideration to land availability and construction cost.

3) Mangga Besar Interchange

Mangga Besar IC is located in the vicinity of existing at-grade intersection between Jl. Mangga Besar and Jl. Gajah Mada/Hayam Wuruk. The Kali Ciliwung river exists in between Jl. Gajah Mada and Jl. Hayam Wuruk. Accordingly, the existing 3-leg intersection is located above the river. Jl. Mangga Besar will extend westward and 4-leg intersection will be formed.

The landuse along Jl. Mangga Besar is well developed as predominant commerce and business. Many high-rise buildings are found. On the other hand, the west side of Jl. Gajah Mada/Hayam Wuruk, where Mangga Besar Extension is planned, is designated as urban betterment with the first priority in the masterplan of Jakarta and low income residential area is widely spread.

The salient features of this interchange are summarized as follows;

(1) 4-leg 3-way interchange is formed. Considerable traffic demand is forecasted in all directions.

(2) The N-S Axis runs above Jl. Gajah Mada/Hayam Wuruk by viaduct. The E-W Axis overpasses the N-S Axis at the existing at-grade intersection.

(3) The east side of Jl. Gajah Mada/Hayam Wuruk is too developed to acquire additionally large land, while the west side needs urban betterment by means of land readjustment.

(4) Two entrance ramps from the E-W Axis require toll gates.

Table 10.5.2 summarizes the comparison and evaluation of practical alternatives for Mangga Besar IC. The selected type of interchange is presented in Fig. 10.5.6.

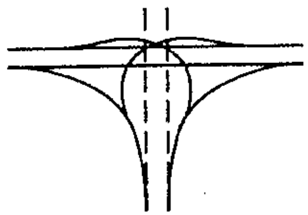
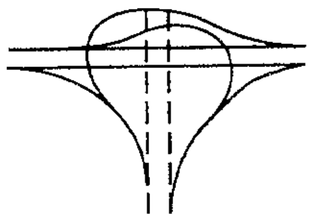
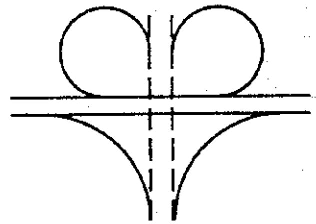
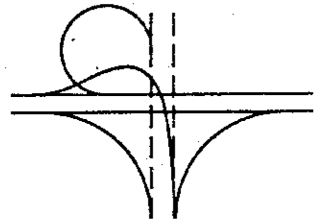
As for Mangga Besar Interchange, the following points are taken into account during design;

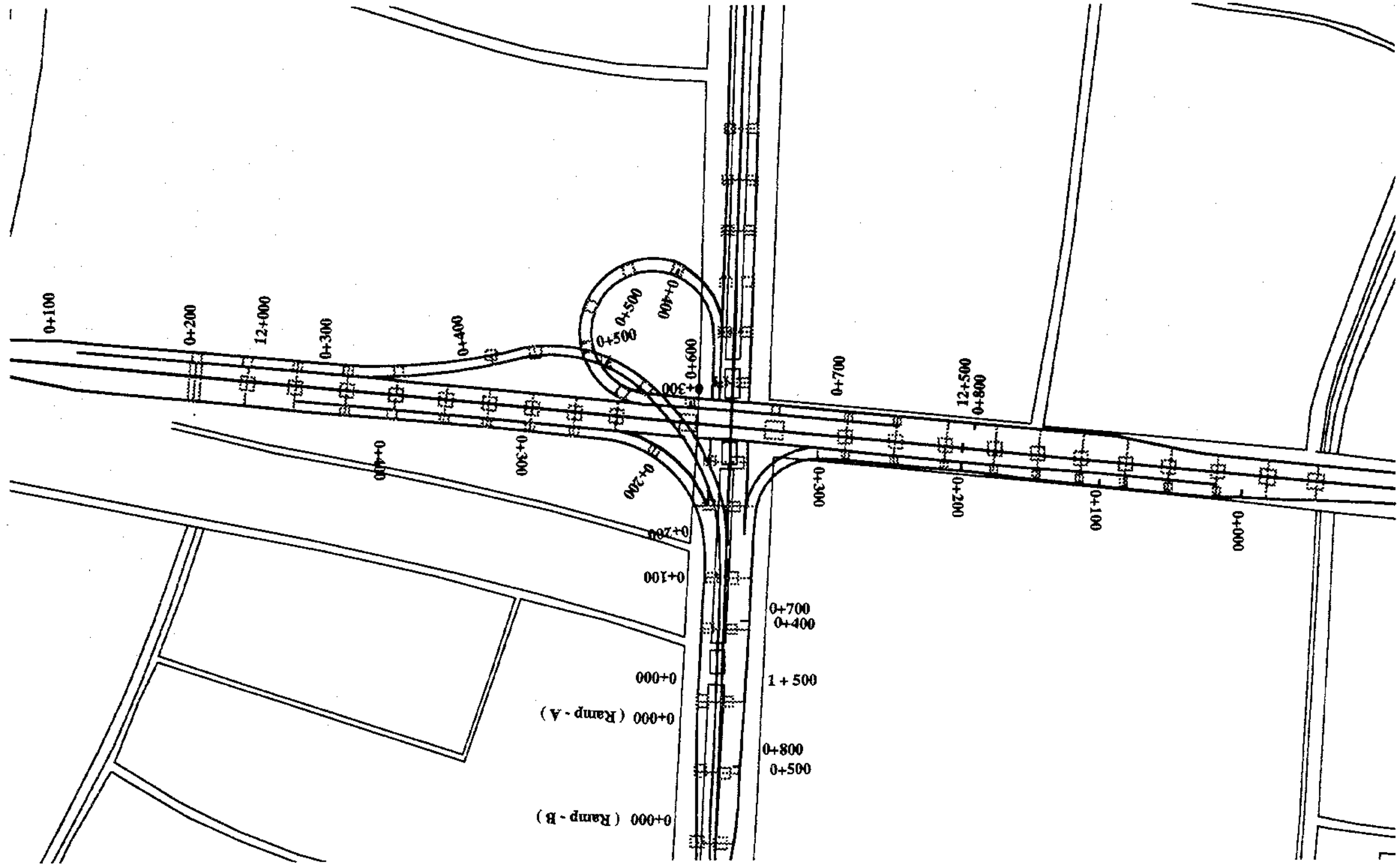
1) The North-South Axis has double deck racket type piers and the south bound is located in the upper deck because of interchange configuration.

2) Ramp-C merges the south bound N-S Axis from the right side because no additional land is required on Jl. Hayam Wuruk.

3) Toll gates are located on Ramp-C and Ramp-D. Ramp-C toll gates are placed at the ground but Ramp-D toll gates are located on the viaduct. The vertical alignment of Ramp-D is designed considering the location of toll gates.

Table 10.5.2 Comparison and Evaluation of Alternatives at Mangga Besar IC

ALTERNATIVES	ALTERNATIVE - I	ALTERNATIVE - II	ALTERNATIVE - III	ALTERNATIVE - IV
				
Salient Features	- Semi-directional Y type with four-level structures - Shorter deviation of rampway from the N-S Axis	- Semi-directoral Y type with three-level structures - Ramps for right turn are apart each other sufficiently.	- Half cloverleaf type with two-level structures - Loop ramps are installed to avoid multiple structures.	- Combination with loop and semi-directional ramps with three-level structures - Loop ramp is installed to avoid multiple structures.
Land Availability	- Required land area is the smallest but it is impossible to avoid additional land acquisition on Jl. Mangga Besar and Jl. Gajah Mada/Hayam Wuruk. **Fair**	- Required land area is not small and it is impossible to avoid additional land acquisition on Jl. Mangga Besar and Jl. Gajah Mada/Hayam Wuruk. **Poor**	- Required land area is the largest and it is impossible to avoid additional land acquisition built-up area along Jl. Mangga Besar and Jl. Gajah Mada/Hayam Wuruk. **Poor**	- Required land area is rather large but it is possible to minimize additional land acquisition in built-up area along Jl. Mangga Besar and Jl. Gajah Mada/Hayam Wuruk. **Fair**
Function of Interchange	- Configuration ensures high speed and safety. **Good**	- Configuration ensures high speed and safety. **Good**	- Loop ramps impede high speed turnings due to weaving. **Poor**	- Configuration ensures high speed and safety. **Fair**
Construction Economy	- Construction cost is high due to high-level construction method. **Poor**	- Construction cost is moderate due to simple structure. **Fair**	- Construction cost is low due to simple structures. **Fair**	- Construction cost is moderate due to simple structures. **Fair**
Traffic Flow and Safety	- Smoother alignment on rampways - Detaour distance is the shortest - Traffic safety is high. **Good**	- Smoother alignment on rampways - Traffic safety is high. **Fair**	- Toll gates on the loop ramp for the N-S Axis impair smooth traffic flow and safety. **Bad**	- Smoother alignment on rampways - Traffic safety is high. **Fair**
Future Traffic Demand	- Toll gates at On ramps to the N-S Axis will have problem against unexpected increase. **Fair**	- Toll gates at On ramps to the N-S Axis will have problem against unexpected increase. **Fair**	- Toll gates at loop ramp for the N-S Axis and weaving section on the E-W Axis will have problem against unexpected increase. **Bad**	- Toll gates at On ramps to the N-S Axis will have problem against unexpected increase. **Fair**
Evaluation	- Toll gates on loop ramp in Alternative-III cause serious traffic problems. - The highest structure in Alternative-I exceeds the limit of normal design procedure considering seismic force. It requires special yet expensive structures. - Land availability in Alternative-II is hardly confirmed in the eastern side of Jl. Gajah Mada/Hayam Wuruk. - Loop ramp in Alternative-IV does not impede any serious traffic aspects. Furthermore, land availability is rather sure in the nick of time when the development of Mangga Besar Extension will be implemented by land readjustment techniques. - Therefore, Alternative-IV is proposed for Mangga Besar Interchange.			



FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.5.6 Manga Besar Interchange

4) Kebon Sirih Interchange

Kebon Sirih IC is located in the vicinity of existing at-grade intersection between Jl. Kebon Sirih and Jl. Abdul Muis. The Kali Cideng river exists in the south of Jl. Kebon Sirih. Jl. Kebon Sirih is one of east-westward major arterial streets in Jakarta.
The landuse along Jl. Kebon Sirih is well developed governmental offices and business buildings.

Another side of the Kali Cideng river, Jl. Taman Kebon Sirih exists. Accordingly, public space for the construction of On/Off ramp is deemed sufficient.

The function of Kebon Sirih IC is to provide access to Jl. M.H. Thamrin from the north. Therefore, a semi-directional ramp is provided directional traffic with good access since On/Off ramps are located on Jl. Kebon Sirih towards Jl. M.H. Thamrin.

The salient features of this interchange are summarized as follows;

1) Number of lanes of through traveled ways are changed from four (4) to six (6) at this interchange.

2) The interval between Abdul Muis IC and Kebon Sirih IC is rather short (approximately 1 km apart).

3) The throughway of the North - South Axis is planned to pass residential area in the south of Jl. Jati Baru.

4) To construct On/Off ramp on Jl. Kebon Sirih, the Kali Cideng river is to be covered by box culvert and Jl. Taman Kebon Sirih is to convert the west bound of Jl. Kebon Sirih.

Taking the above-mentioned conditions, the selected type of interchange is presented in Fig. 10.5.7.

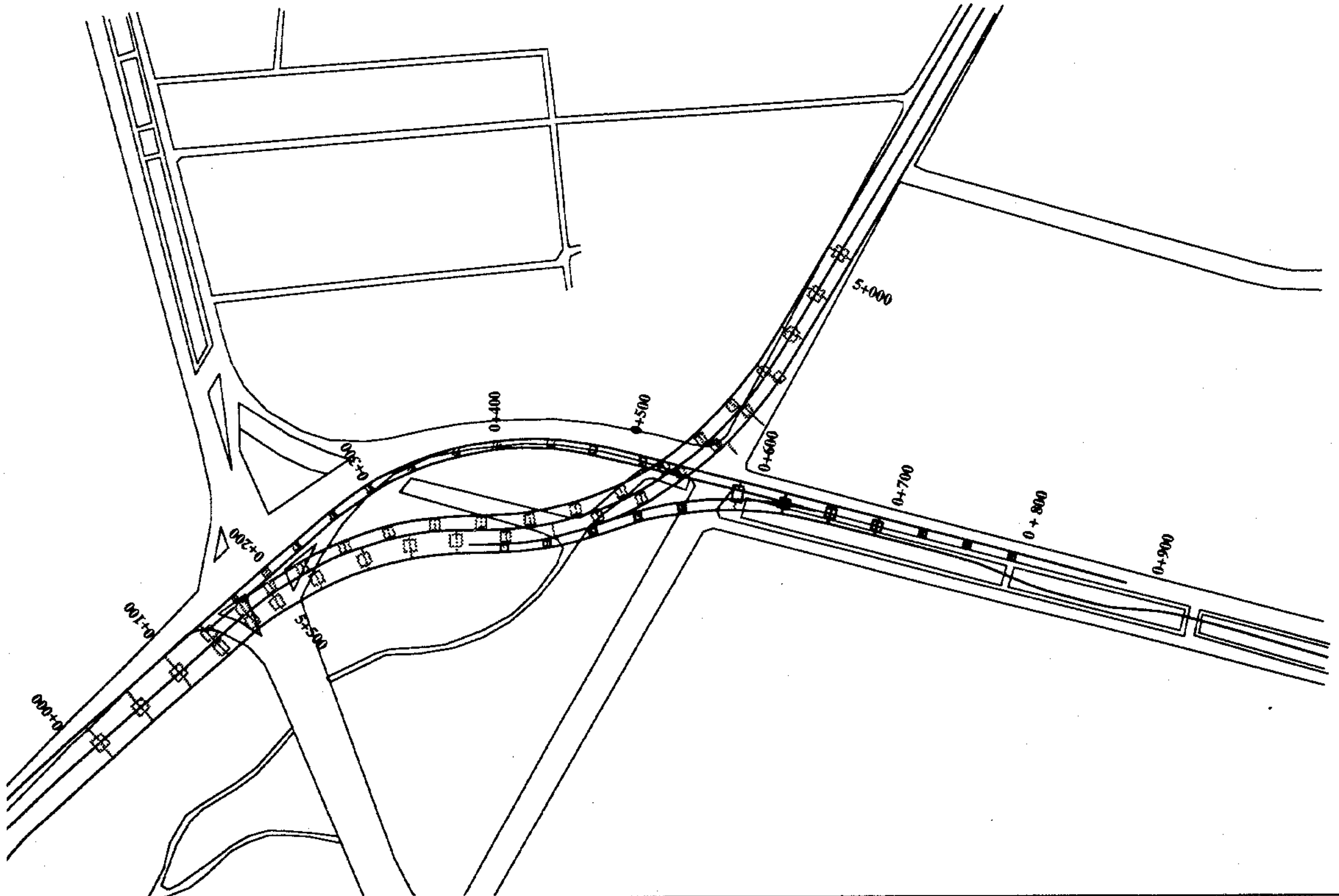
As for Kebon Sirih Interchange, the following points are taken into account during design;

1) Off ramp diverges from the intersection between Jl. Fakhrudin and Jl. Jati Baru and runs along Jl. Jati Baru to overpass the throughway.

2) To facilitate overpassing, the vertical alignment of the throughway becomes low as much as possible to keep the minimum headroom clearance of 5.1 m high.

3) The location of toll gates on On ramp is to be located far as much as possible to keep enough distance from Jl. M.H. Thamrin.

4) Diverted west bound Jl. Kebon Sirih on Jl. Taman Kebon Sirih is to return to the original location before the intersection with Jl. Abdul Muis.



FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.5.7 Kebon Sirih Interchange

5) Kebon Kacang Interchange

Kebon Kacang IC is located in Tanah Abang where the West and the Serpong railway lines exist along the Banjir Kanal. The Serpong line diverges from the West line and crosses the Banjir Kanal of which the bridge has the special structure with a floodgate.

The land use along railways is predominantly residential. Since railways and rivers disrupt the community, low cost housings in small areas encompassed by railway and river are widely spread.

The existing Jl. Kebon Kacang is two lanes two ways minor arterial street and it connects to Jl. M.H. Thamrin at H.I. (Hotel Indonesia). Roundabout in the eastern end. In the vicinity of H.I. Roundabout, there are many international hotels and business buildings. On the other hand, low cost houses are widely spread in the western section. Jl. Kebon Kacang terminates at the intersection with Jl. Mas Mansyur and no existing road except pedestrian paths is found in between the North - South Axis and Jl. Mas Mansyur. Accordingly, land acquisition along the alignment of On/Off ramp will become necessary in the whole stretch.

The function of Kebon Kacang IC is to provide access to Jl. M.H. Thamrin from the south. Therefore, rampways are to be provided directional traffic with good access since On/Off ramps are located on Jl. Kebon Kacang towards Jl. M.H. Thamrin.

The salient features of this interchange are summarized as follows;

1) The North - South Axis flies over the West railway line and the Serpong line at the interchange site.

2) The North - South Axis also flies over the existing K.S. Tubun railway flyover in the north. Accordingly, the vertical alignment rises up to three levels.

3) The distance between the North - South Axis and H.I. Roundabout is 1.4 km long. Therefore, long rampways are to become necessary.

4) To construct On/Off ramp on Jl. Kebon Kacang, the space above the waterway from the Melati reservoir along Jl. Kebon Kacang will be utilized.

Table 10.5.3 summarizes the comparison and evaluation of practical alternatives for Kebon Kacang IC.

The selected type of interchange is presented in Fig. 10.5.9.

As for Kebon Kacang Interchange, the following points are taken into account during design;

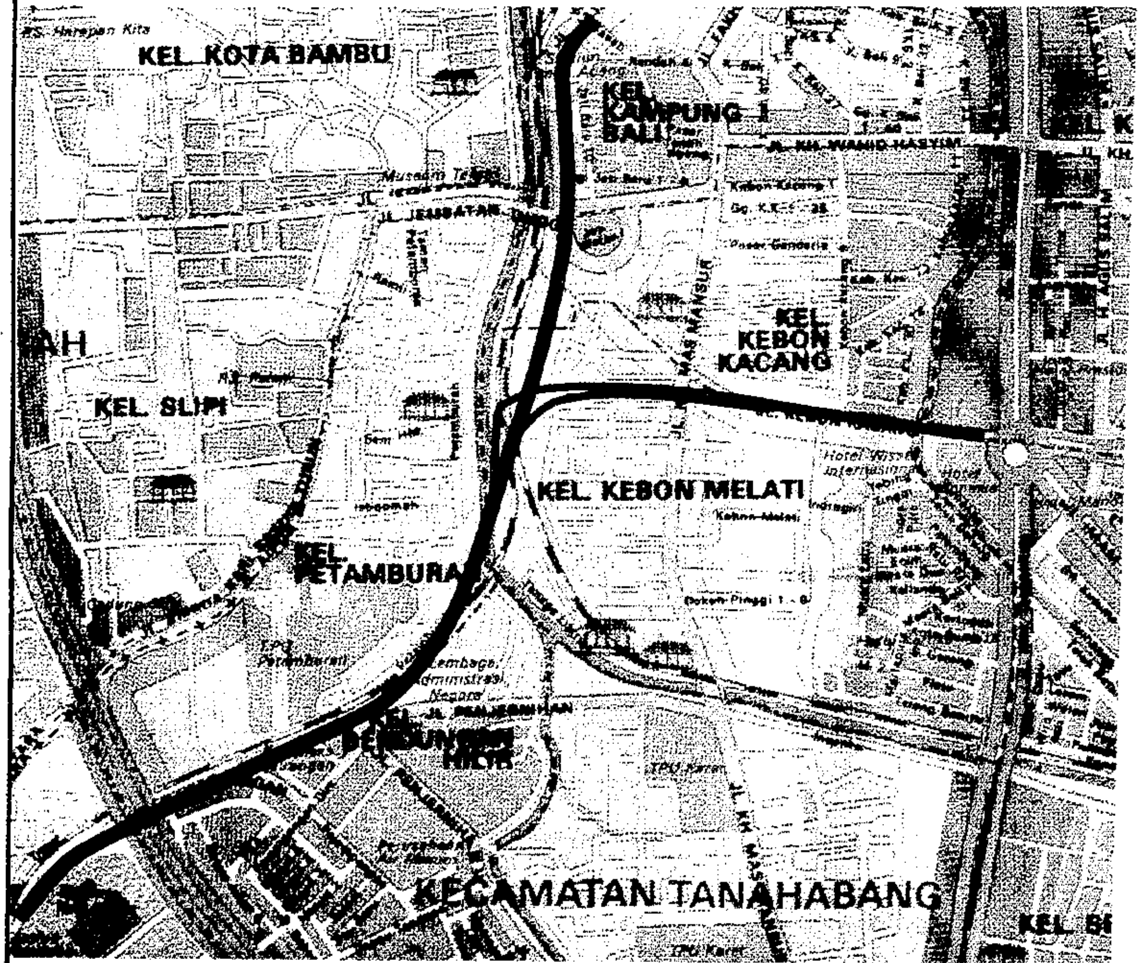
1) Off ramp diverges from the throughway to utilize the space above the Banjir Kanal and flies over the throughway towards Jl. Kebon Kacang.

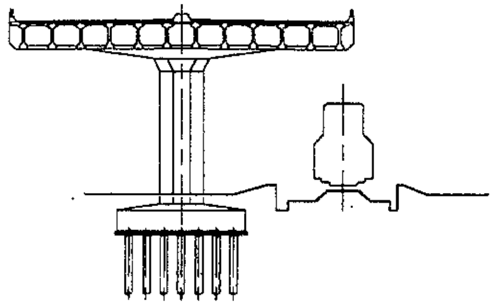
2) The location of toll gates on On ramp is to be located far as much as possible to keep enough distance from Jl. M.H. Thamrin.

3) To avoid traffic congestion caused by additional traffic load to H.I. Roundabout, an intersection improvement is to be done by a grade separation structure.

Table 10.5.3 Comparison and Evaluation of Alternatives at Kebon Kacang IC

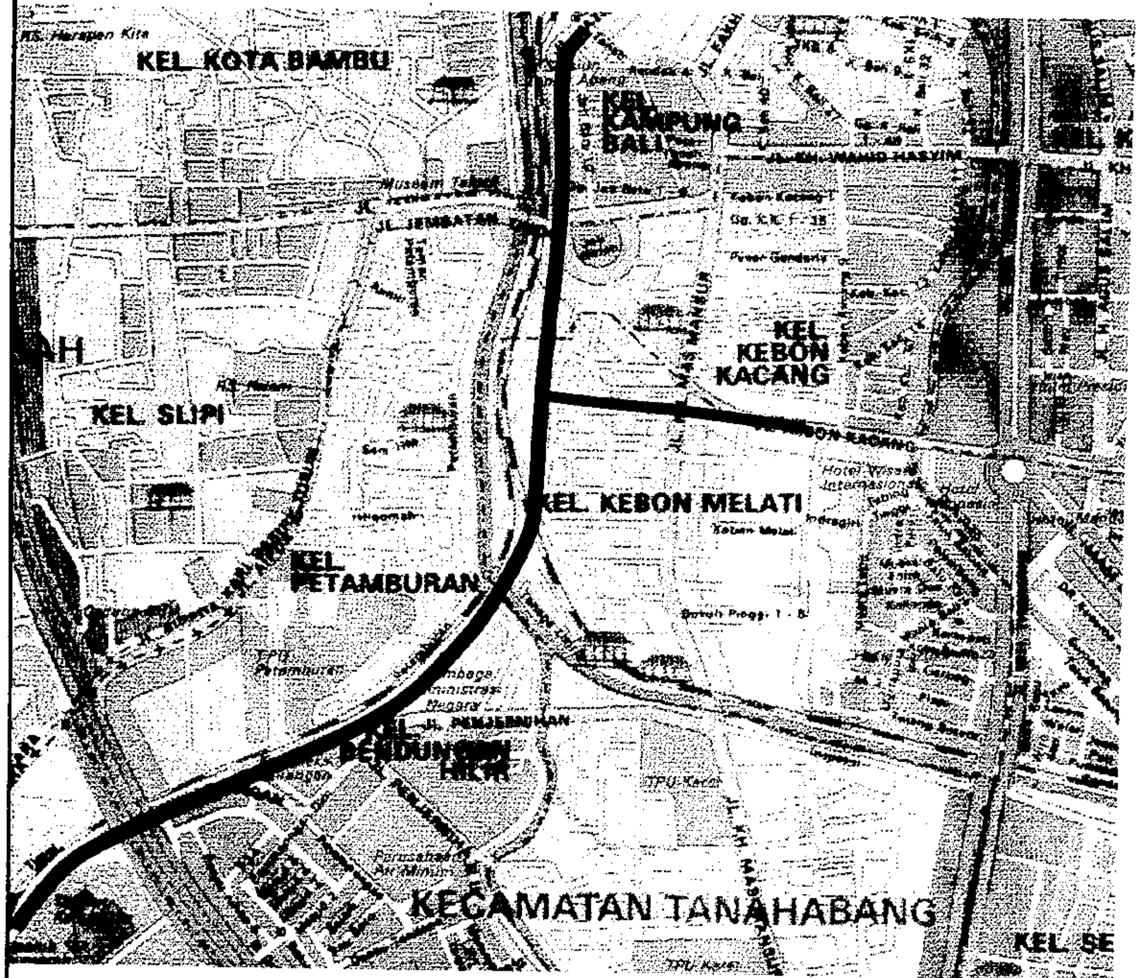
ALTERNATIVES	ALTERNATIVE - I	ALTERNATIVE - II	ALTERNATIVE - III	
	Fig. 9.5.11 (1)	Fig. 9.5.11 (2)	Fig. 9.5.11 (3)	
Salient Features	- The throughway runs parallel to the railway in the south and no frontage road is provided. - The throughway flies over the railway two times to make full use of public space.	- The throughway runs parallel to the railway in the south and at-grade frontage roads are provided along the throughway. - The frontage roads have 60 m span Banjir Kanal bridge and at-grade railway crossing with the Western line. - On/Off ramps are located on frontage road to form a diamond type interchange. - A grade separation structure is required at at-grade intersection between Jl. Kebon Kacang and Jl. Mas Mansyur.	- The throughway runs parallel to the railway in both sides and at-grade frontage roads are provided along the throughway. - Pm/Off ramps are located on frontage road to form a diamond type interchange. The north bound frontage road is to cross the Banjir Kanal and to have two railway crossings with the West and the Serpong lines to connect with Jl. Kebon Kacang and Jl. Mas Mansyur. A grade separation structure is required at at-grade intersection between Jl. Kebon Kacang and Jl. Mas Mansyur.	
Land Availability	- Required land area is the smallest but it is impossible to avoid additional land acquisition in between the North-South Axis and Jl. Mas Mansyur because of no existing road.	- Required land area is the largest and it is impossible to avoid additional land acquisition in between the North-South Axis and Jl. Mas Mansyur because of no existing road.	- Required land area is the same level as that of Alternative-II.	
Function of Interchange	- In enables to ensure high speed and capacity by the configuration using semi-directional ramp.	- The south bound frontage road and Jl. Kebon Kacang and its extension will bring a development impact. - It is possible for traffic to/from Jl. Mas Mansyur to use the North-South Axis.	- Both south and north bound frontage roads and Jl. Kebon Kacang and its extension will bring a development impact. - It is possible for traffic to/from Jl. Mas Mansyur to use the North-South Axis.	
Construction Economy	- Construction cost is high due to 1.2 km long elevated rampways.	- Construction cost is considerable because of the construction of grade separation structure and river bridges as well as large land acquisition.	- Construction cost is higher than Alternative-II because of the construction of grade separation structure and longer river bridges as well as large land acquisition.	
Traffic Flow and Safety	- Smoother alignment on rampways - Detaour distance is the shortest - Traffic safety is high.	- Traffic from Jl. M.H. Thamrin is mixed with local traffic on Jl. Kebon Kacang. - At-grade railway crossing impedes traffic safety.	- Traffic from Jl. M.H. Thamrin is mixed with local traffic on Jl. Kebon Kacang. - At-grade railway crossing impedes traffic safety.	
Future Traffic Demand	- Toll gates at On ramps on Jl. Kebon Kacang will have problem against unexpected increase.	- It is rather difficult to cope with unexpected increase due to at-grade railway crossing.	- It is more difficult to cope with unexpected increase than Alternative-II because of more at-grade railway crossings and additional the Serpong line.	
Evaluation	- Alternative-III is inferior to Alternative-II in the aspects of Construction Economy and Future Traffic. - Alternatives of I and II have individual advantages in the aspect of Function of Interchange. However, Alternative-I is superior to Alternative-II in the aspect of Traffic Flow and safety. - Land availability in Alternative-II remains uncertain, while Alternative-I has significantly smaller land acquisition area. Thus, Alternative-I has higher land avaiability. - Therefore, Alternative-I is proposed for Kebon Kacang Interchange.			

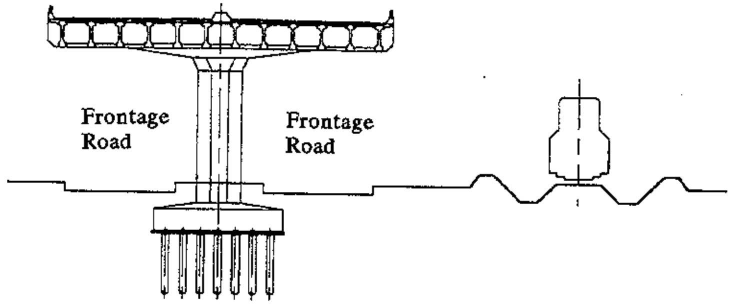




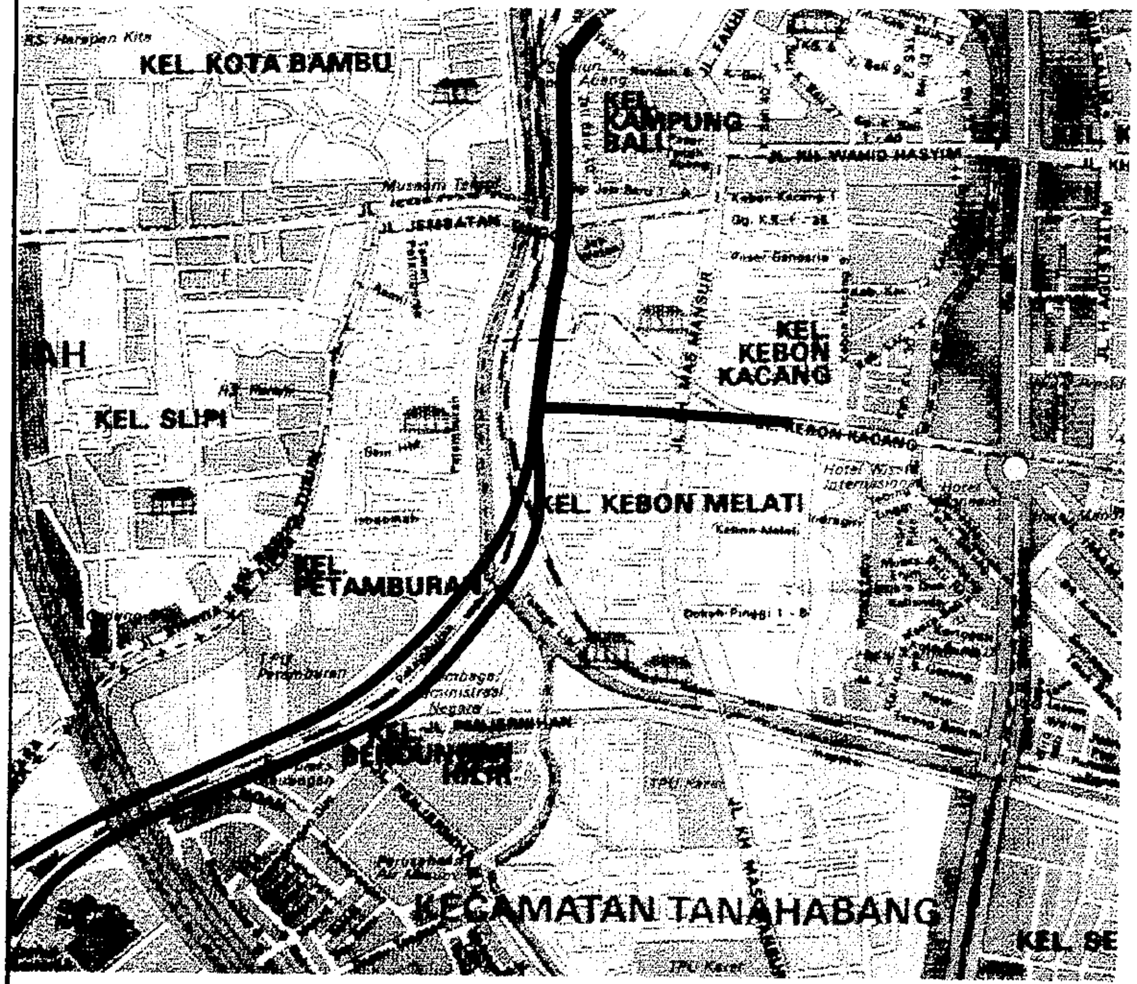
FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

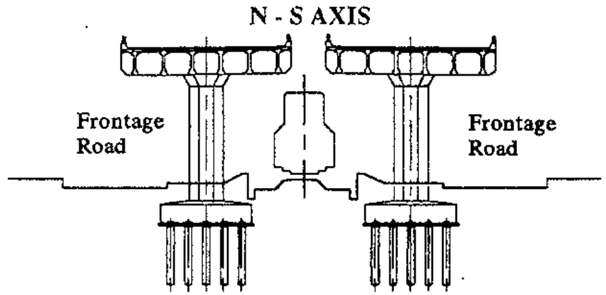
Fig. 10.5.8 (1) Alternative-I : No Frontage Road





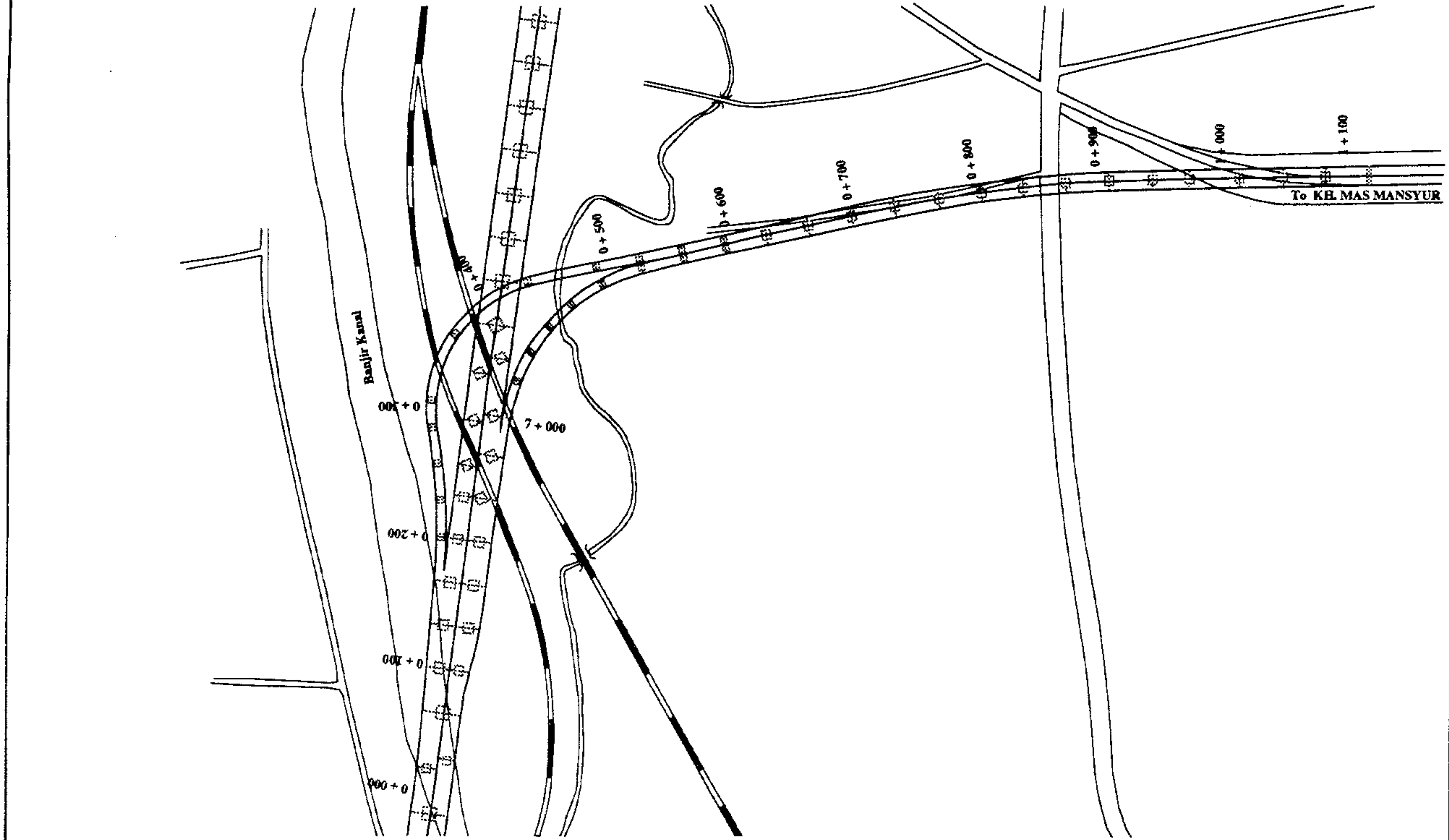
FEASIBILITY STUDY ON URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT IN JAKARTA METROPOLITAN AREA	Fig. 10.5.8 (2) Alternative-II : With Frontage Road, One Side of Railway





FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.5.8 (3) Alternative-III : With Frontage Road, Both Side of Railway



FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.5.9 Kebon Kacang Interchange

6) Senayan Interchange

Senayan IC is located in the vicinity of existing Senayan Roundabout where the Senayan Statue exists at the center. There are the northern periphery of Kebayoran sub-center. Jl. Jend. Sudirman, which comprises the north - south thoroughfare together with Jl. M.H. Thamrin, starts from this point. The North - South Axis is planned to pass behind the statue on viaduct. In the vicinity of Senayan Roundabout, there are many governmental offices and business buildings such as embassies of Papua New Guinea and China, Ministry of Foreign Affairs, Senior High School and Panin Centre. Accordingly, land acquisition along the alignment of the throughway and On/Off ramp will become necessary on the whole.

The function of Senayan IC is to provide access to Kebayoran Baru sub-center from the north. Therefore, a semi-directional ramp is provided directional traffic with good access in conjunction with a diamond type interchange on Jl. Pattimura since On/Off ramps are located on Jl. Sisngamangaraja towards Kebayoran sub-center.

The salient features of this interchange are summarized as follows;

1) The North - South Axis flies over Senayan Roundabout behind the Senayan Statue where an office of Ministry of Foreign Affairs exists.

2) On/Off ramps are located on Jl. Sisingamangaraja and on Jl. Pattimura.

3) The distance between the North - South Axis and embassies should be kept sufficiently.

4) In order to maintain an aesthetic view of the Senayan Statue, the vertical alignment of the North - South Axis should be low, referring to the similar situation of the Pancoran Statue.

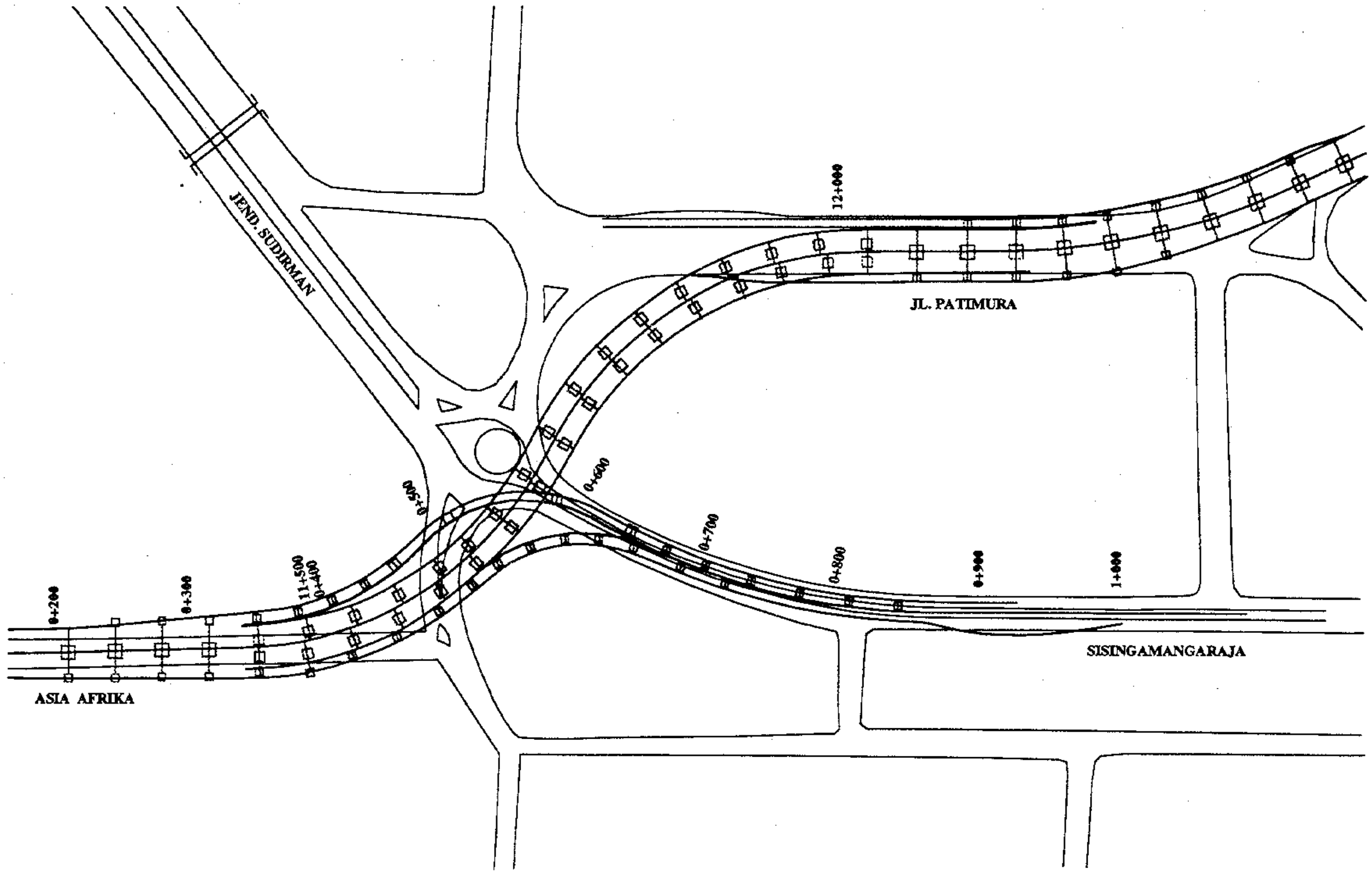
Taking the above-mentioned conditions, the selected type of interchange is presented in Fig. 10.5.10.

Fig. 10.5.11 presents the traffic maneuvering plan of access to Kebayoran sub-center.

As for Senayan Interchange, the following points are taken into account during design;

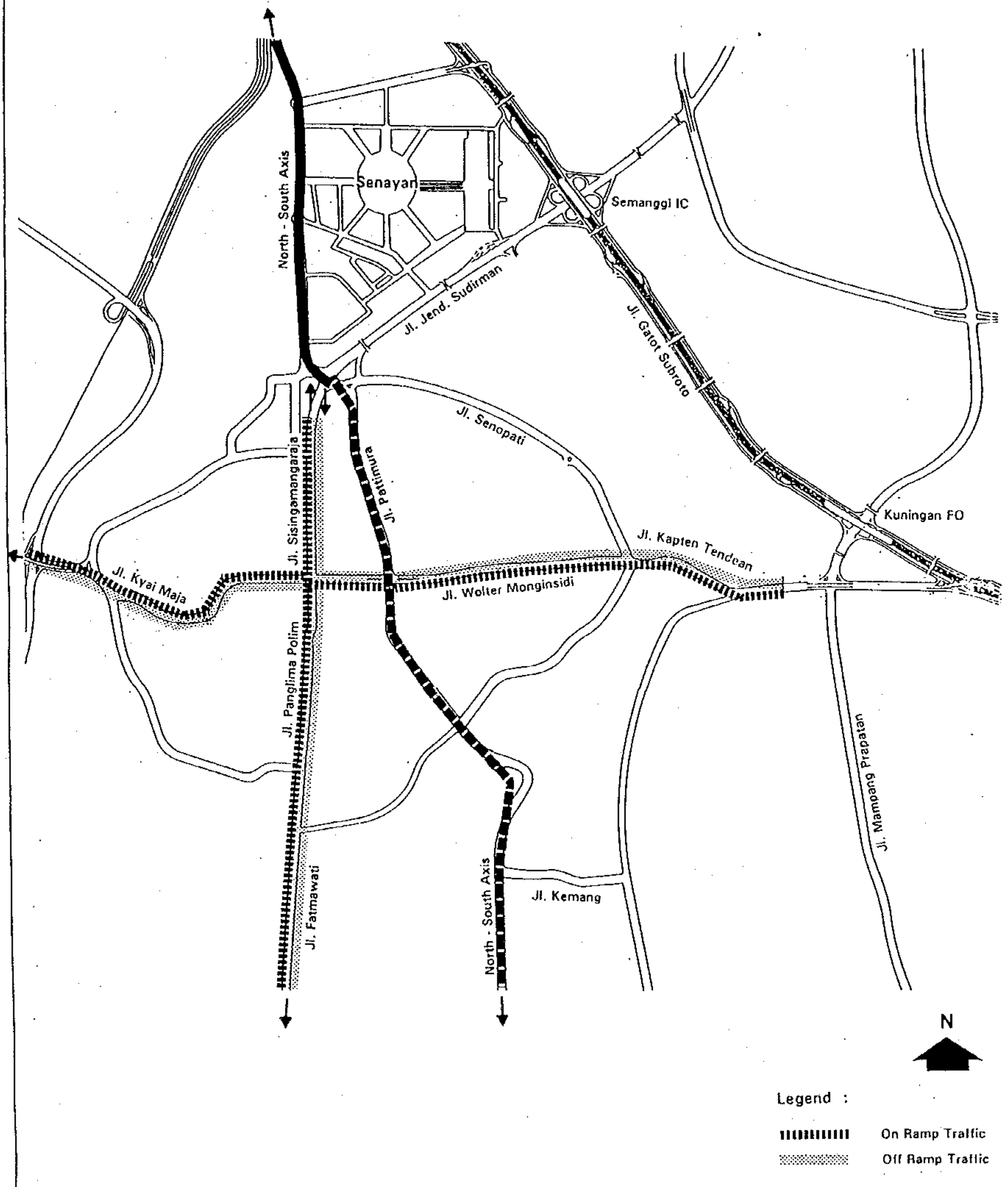
1) Off ramp on Jl. Asia Afrika diverges from the throughway prior to starting sharp curve, while On ramp on Jl. Asia Afrika merges to the throughway after finishing sharp curve.

2) To minimize additional land acquisition at On/Off ramps and aesthetic viewpoints, the vertical alignment of the throughway is to become low as much as possible.

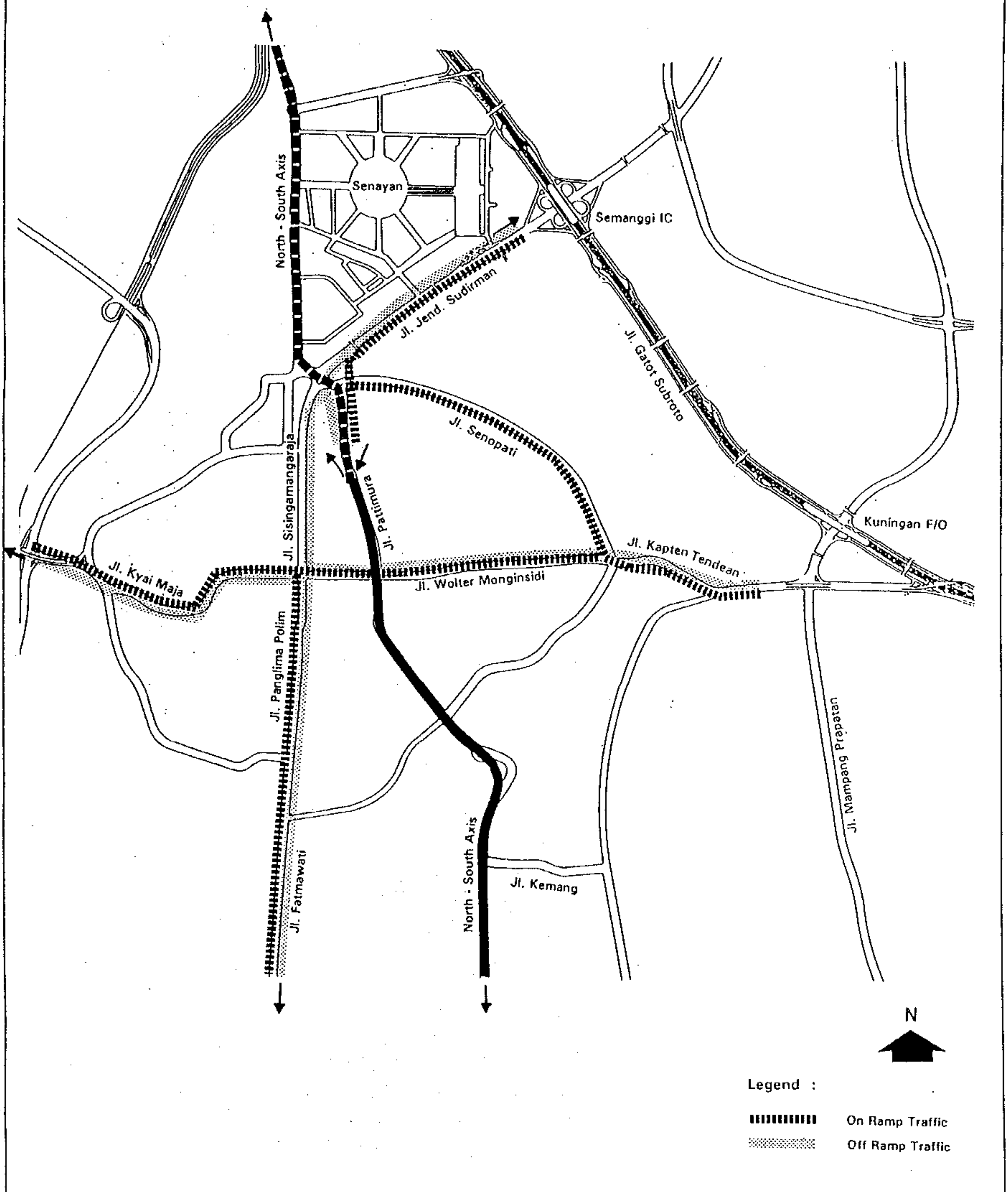


FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.5.10 Senayan Interchange



FEASIBILITY STUDY ON URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT IN JAKARTA METROPOLITAN AREA	Fig. 10.5.11 (1) Traffic Maneuvering for Northern Access at Senayan IC



FEASIBILITY STUDY ON URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT IN JAKARTA METROPOLITAN AREA	**Fig. 10.5.11 (2)** **Traffic Maneuvering for Southern Access at Senayan IC**

7) South JORR Interchange

South JORR IC is located in the vicinity of existing intersection between Jl. Pangeran Antasari and the frontage road of JORR where the Kali Krukut river flows northward and depressed area along the river exists. Jakarta Outer Ring Road (JORR) comprises toll road in the center and frontage roads in both sides. The frontage roads have been completed and opened to the public since 1986, while the toll road is under construction. Since the North - South Axis has a different toll levying system from that of JORR, a toll barrier is to be provided on the throughway in the north of South JORR IC. Furthermore, Pangeran Antasari IC is also located adjoining to the toll barrier to serve for tollway users from arterial streets in its surrounding.

Present landuse around the interchange is that residential area is widely spread in the west of Jl. Pangeran Antasari, while undeveloped areas are found in the east as shown in Fig.10.5.15. This undeveloped and depressed area is used as a playground, encompassed by hills, of which the eastern hill is 15 m high from the depressed ground. In the south of JORR, depressed low land is spread along the Kali Krukut river to retain flood water.

The distance between Ampera West IC and Fatmawati East IC is approximately 1,290 m long, in which 260 m long viaduct flies over the intersection and the river. Accordingly, South JORR IC is to be formed in between these two interchanges and to keep sufficient weaving distance.

Traffic demand in 2010 is forecasted that the eastward traffic is 45,300 PCU/day and the westward is 15,500 PCU/day, while traffic demand on the throughway of JORR is 78,000 PCU/day.

The function of South JORR IC is to provide access to regional tollways through JORR.

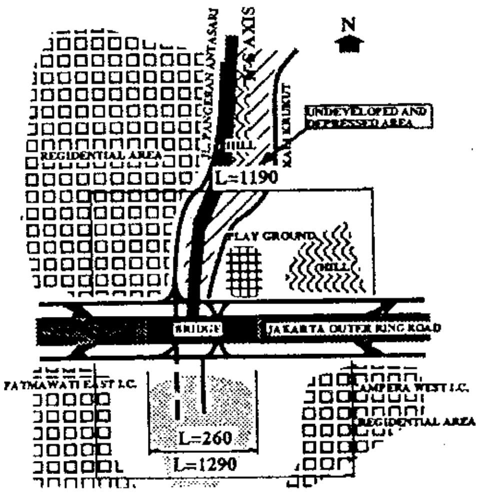


Fig.10.5.15 **Present Landuse Around the Interchange**

The salient features of this interchange are summarized as follows;

1) 3-leg, three ways tollway-to-tollway interchange is formed due to the elaboration of tollway network. Considerable traffic demand is forecasted in all directions.

2) The toll barrier is located on the throughway of the North - South Axis to collect and adjust toll fares. Accordingly, it is necessary to adopt not upper range of design speed but middle or lower range to rampway, since all vehicles should stop at a toll gate.

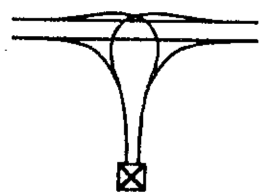
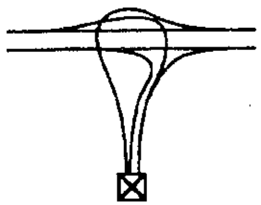
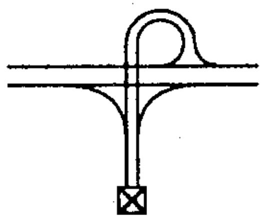
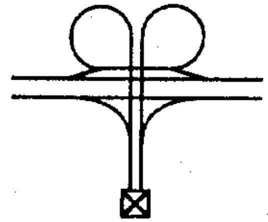
Table 10.5.4 summarizes the comparison and evaluation of practical alternatives for South JORR interchange.
The selected type of interchange is presented in Fig. 10.5.13.

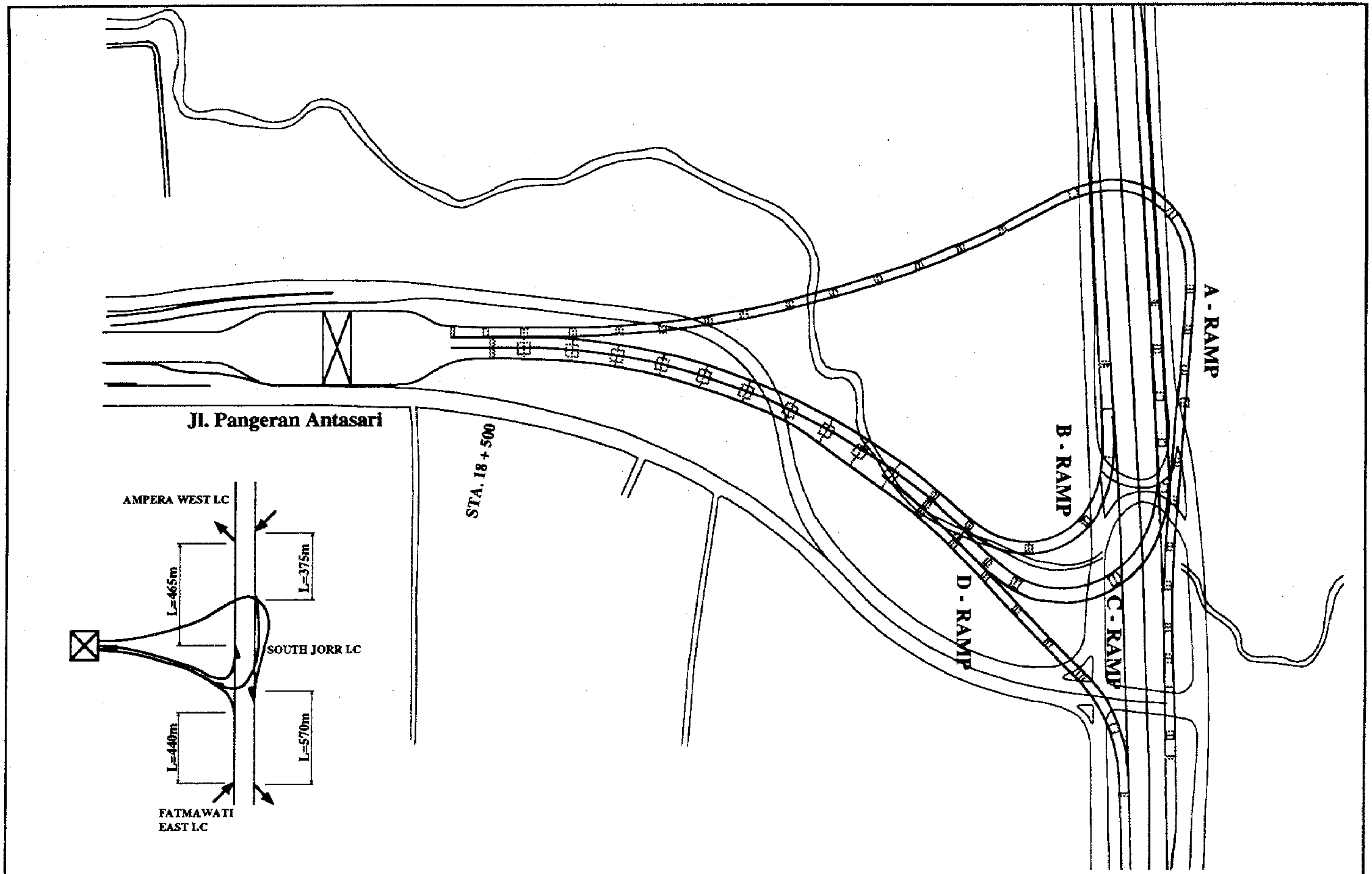
As for South JORR Interchange, the following points are taken into account during design;

1) To secure sufficient distance for weaving section between two approaching noses as shown in Fig. 10.5.13, ramps of South JORR IC will necessitate longitudinal joint or structural modification of superstructures of JORR.

2) The construction of ramps will require additional spaces to build their piers so that frontage roads should be relocated to the outer. Simultaneously, a new 4-leg at-grade intersection will be formed as the southern extension of Jl. Pangeran Antasari.

Table10.5.4 The Comparison and Valuation of Practical Alternatives for South JORR Interchange

ALTERNATIVES	ALTERNATIVE - I	ALTERNATIVE - II	ALTERNATIVE - III	ALTERNATIVE - IV
				
Salient Features	• 3-leg semi-directional type with three level structures. • The raised profile of upper ramp is so high that the gore area will be hard to be located sufficent distane from the On/Off ramp on JORR.	• 3-leg semi-directional type with two level structures • To keep required length between merging and diverging ramps and adjacent On/Off ramps on JORR and to avert high-3-level structure, ramps make detour in interchange site.	• Trumpet B-type with 2-level structures • 1) Although principal traffic warrants to select A-type trumpet severe physical constraints let type of interchange from A-type trumpet to B-type. 2) Parallel frontage road forces out of normal shape of loop ramp.	• Half clover leaf with two level structures. • 1) This alternative will be able to facilities to pass planned southern extension of Jl. Pangeran Antasari. 2) Heavy weaving movement is expected in between two loop ramps. Nevertheless, parallel frontage road requires elevated collector-distributor ramp and it causes complicated traffic maneuvering.
Land Availability	• Required land area is the smallest among alternatives, and the minimum violation of existing R.O.W. will take place. Good	• It is possible to minimize the violation of developed land outside R.O.W. since ramps make detour in undeveloped area. Good	• Required land in the north of JORR can be minimized, while that in the south is to violate developed area largely. Poor	• The largest land is required among alternatives and the violation of developed area is serious. Poor
Function of Interchange	• High mobility is kept due to the function of semi-directional ramps Fair	• The similar effects of Alternative-I are expected. Fair	• Function is in a lesser degree to apply loop ramp to principal traffic. Poor	• Loop ramps with collector-distributor ramp will cause to decrease traffic capacity both rampways and throughway of JORR. Poor
Construction Economy	• 3-level high structures and high technical requirement of works above existing traffic make construction expensive. Bad	• Construction cost will become reasonable, because construction techniques which presently are in use will be able to be adopted. Fair	• Planned southern extension of Jl. Pangeran Antasari and its at-grade intersection will make structures complicated and it will become expensive. Poor	• Construction cost would be the lowest if affected area should be reserved. Fair
Traffic Flow and Safety	• At the gore areas on JORR, considerable merging and diverging traffic will impair smooth traffic flow and safety because of rather insufficient weaning length. Poor	• It is possible to mitigate disadvantage in Alternative-I due to having longer weaving length. Fair	• The loop ramps impedes smooth traffic and safety. Poor	• Elevated collector-distributor ramp impedes smooth traffic and safety. Poor
Future Traffic Demand	• Unexpected increase of traffic will cause traffic congestion not on merging ramps to JORR but at toll plaza. Fair	• The same situation as Alternative-I will take place. Fair	• The same situation of Alternative-I is expected even though loop ramp is adopted. Fair	• Unexpected increase of traffic will cause traffic congestion in between two loop ramps. Fair
Evaluation	Step-1 : Alternative-I is significantly inferior in the aspect of construction economy. Step-2 : Alternatives-II and IV have poor land availability, especially for developed area in the South of JORR. Step-3 : Alternative-IV has disadvantage in the aspect of traffic flow and safety because required elevated collector-distributor ramp impedes smooth traffic flow and safety considerably. Step-4 : Although any type of interchange cannot avoid difficulty of construction, Alternative-II has neither serious defects nor inferiority in all aspects. Step-5 : It is concluded that Alternative-II is selected as the optimum scheme of South JORR IC.			



FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.5.13 South JORR Junction

8) West-JORR Interchange

West-JORR Interchange is located in the intersecting point with Jakarta Outer Ring Road (JORR) in between Jalan Daan Mogot and Jakarta-Merak toll road. East-West Axis is arterial road which is proposed to have six lanes for through traveled way and four lanes for frontage roads. The function of this interchange is to strengthen the arterial road network and to stimulate the development of west sub-centre. Therefore, no direct connection to toll road of JORR is provided.
The land use in the vicinity of this interchange is remained undeveloped but it will become predominant commerce, office and housing in the near future.

The salient features of this interchange are summarized as follows :

1. Role and function of this interchange are to encourage road users to/from the south and to discourage road users to/from the north because of poor road network in the south and presence of existing Jl. Daan Mogot which has similar function in the north.

2. No multiple structure for right turning is warranted.

3. Function of U-turn facilities both on E-W and On JORR are to develop in the surrounding area and indispensable of the road users for right turning traffic from E-W Axis as well as road users on frontage roads.

Table 10.5.5 summarizes the comparison and evaluation of practical alternatives for West-JORR Interchange.
The selected type of interchange is presented in Fig. 10.5.14.

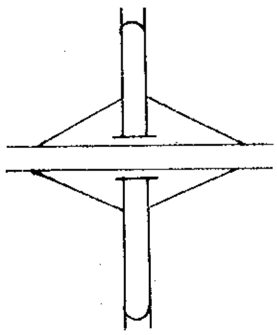
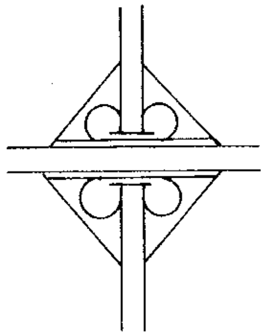
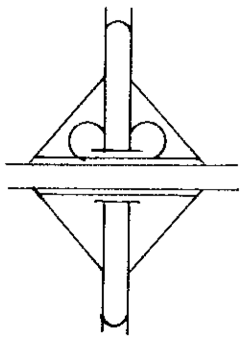
As for West-JORR Interchange, the following points are taken into account during design :

1. It is necessary for through traveled way to increase number of lanes from three to four at throughway bridge section to cope with additional through traffic from frontage roads.

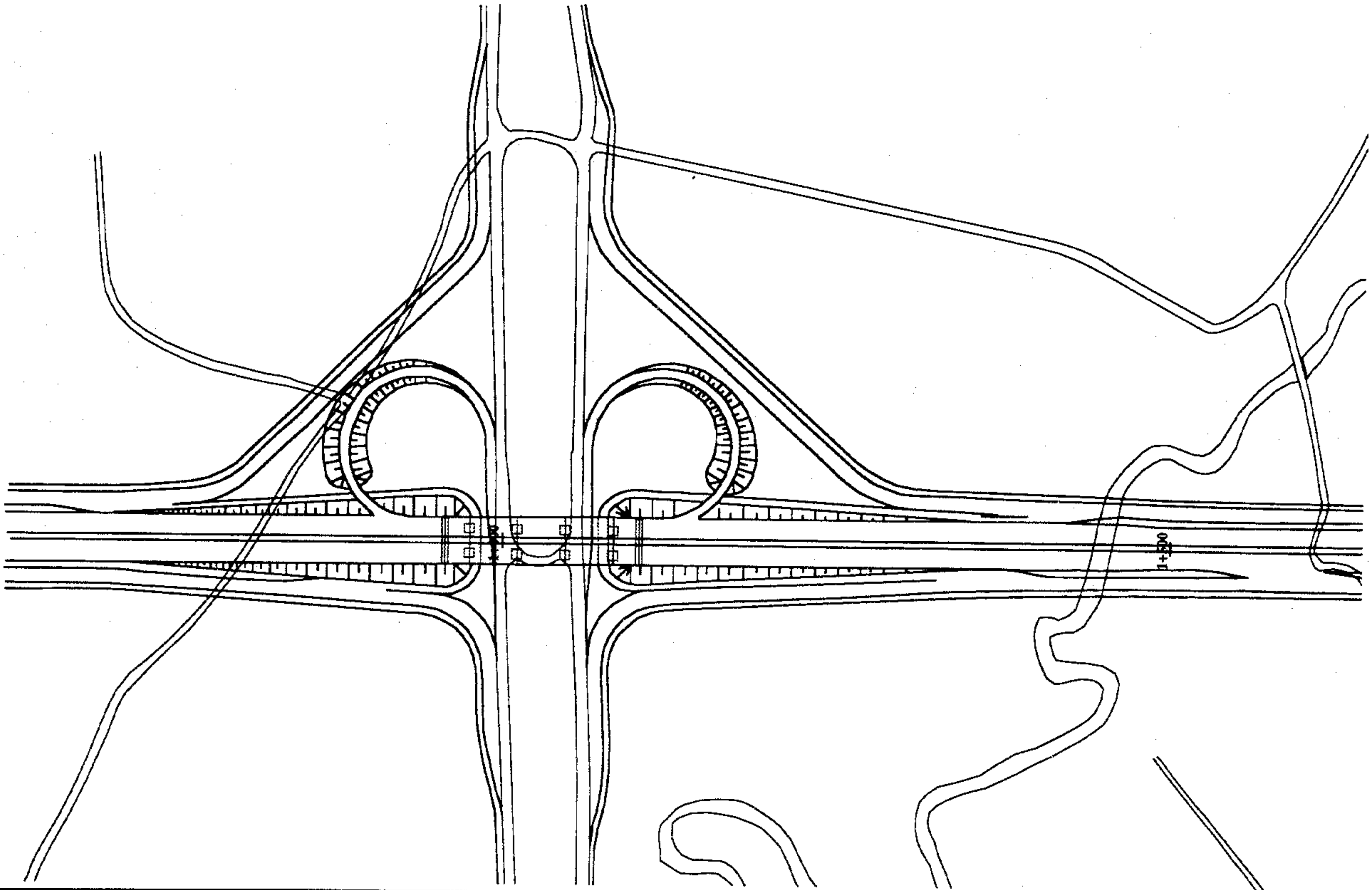
2. U turn facilities should be placed near the frontage road of JORR, so that length of bridge can be reduced.

3. The mobility of throughway should be kept. The egress from and entrances to the throughway are indispensable in the civility of intersection. The system of earlier egress than entrance will be able to secure the mobility of throughway.

Table 10.5.5 Comparison and Evaluation of Alternatives at West-JORR IC

	Alternative I	Alternative II	Alternative III
Layout of ramp configuration			
Salient features	Diamond type Minimum curve radius of ramp way is 50 m for the design speed of 40 km/h. U-turn facilities on JORR	Cloverleaf type with collector-distributor roads. Minimum curve radius of loop ramps is 50 m for the design speed of 40 km/h No U-turn facility	Half cloverleaf type with collector-distributor roads. Minimum curve radius of loop ramps is 50 m for the design speed of 40 km/h U-turn facilities on JORR
Land availability	Required land area is the smallest. Good	Required land area is the largest. Poor	Required land area in between alternative I and alternative II. Fair
Function of Interchange	Low level accessibility to reach the new west sub-centre from west bound. Poor	High level accessibility to reach all direction, but it will be able to cause imbalancing traffic volume between Jl. Daan Mogot, E-W Axis and Jakarta-Merak toll road. Poor	Medium level accessibility, but it will be able to fulfil the role and function of this interchange to stimulate the development of west sub-centre. Fair
Construction economy	Construction cost is almost same among the alterna-tives. Fair	Construction cost is almost same among the alterna-tives. Fair	Construction cost is almost same among the alterna-tives. Fair

	Alternative I	Alternative II	Alternative III
Traffic flow and safety	Right turning movement are handled by U-turn facilities on the JORR Poor	Turning movement are handled effectively through loop ramps and outer connector Long detour distance and low safety on loop ramps, but these are acceptable. Good	Turning movement are handled, by loop ramps, outer connector and U-turn facilities on JORR. Long detour distance and low safety on loop ramps, but these are acceptable to service interchange. Good
Future traffic demand	There are additional loop ramps in the future Poor	No significant difference Good	No significant difference Good
Evaluation	Traffic accessibility in alternative I is lowest level among the alternatives, because the road users from west bound of E-W have to use U-turn facillity on JORR to reach west sub-centre. Accordingly, the function of interchange to stimulate the development of west sub-centre (Walikota Jakarta Barat) will growth slowly. Loop ramps at the south part in alternative II causes the balancing traffic volume between Jalan Daan Mogot, E-W Axis and Jakarta-Merak toll road will not achieve. Half cloverleaf in alternative III can serve the road users goes to the west sub-centre and will encourage the development in west sub-centre furthermore balancing traffic volume as mentioned above will be achieved. Therefore alternative III is proposed for West-JORR Interchange, because most practical design from function of interchange aspect.		



FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.5.14 West JORR Interchange

9) Latumeten/Gunung Sahari Interchanges

Latumeten/Gunung Sahari IC are located at both western and eastern ends in the periphery of Kota. The comprehensive traffic management plan in Kota has been studied, considering its future road network since it was predicted that excessively concentrated traffic would take place at the terminus of the North - South Axis. The concept of traffic management in Kota area is delineated in Chapter 7.

It is concluded that the role and function of the East - West Axis will be enhanced considerably in conjunction with the provision of semi-directional ramps with Jl. Latumeten in the west and Jl. Gunung Sahari in the east. It will enable to disperse heavy traffic in Kota by means of circulation in periphery and to avert concentrated traffic load on Jl. Pintu Besar Selatan.

The function of Latumeten/Gunung Sahari IC is to encourage access to and egress from Kota bypassing in the periphery and to enhance the function of the East - West Axis in the CBD of Jakarta.

The salient features of these interchanges are summarized as follows;

1) The East - West Axis has the embankment section at Latumeten IC, while it has the viaduct section at Gunung Sahari IC.

2) The East - West Axis flies over the elevated Northern Extension of South - West Arc besides Jl. Latumeten.

3) Though the North - South Axis forms a diamond type interchange with Jl. Latumeten, a semi-directional ramp is to be provided additionally to encourage bypassing traffic in the periphery of Kota. Therefore, the location of diverging nose of this ramp should be located to keep sufficient distance from the egress ramp of throughway to frontage road.

4) The distance between Jl. Latumeten and the Western railway line is only 720 m. City planning roads are planned at both sides of the railway.

5) Though the North - South Axis forms a diamond type interchange with Jl. Gunung Sahari, a semi-directional ramp is to be provided additionally to encourage bypassing traffic in the periphery of Kota. Therefore, the location of merging nose of this ramp should be located to keep sufficient distance from the entrance ramp of throughway from Jl. Mangga Besar.

6) The East - West Axis flies over the elevated Central railway line which is located 900 m apart from Jl. Gunung Sahari.

Taking the above-mentioned conditions, the selected type of Latumeten and Gunung Sahari interchanges are presented in Figs. 10.5.15 and 10.5.16.

As for Latumeten Interchange, the following points are taken into account during design;

1) The semi-directional ramp is to pass beneath the elevated throughway because the East - West Axis is enough high to fly over the elevated Northern Extension.

2) Due to the vertical alignment of the throughway and the location of diverging nose of rampway, the egress ramp of throughway to frontage road is to be located in between the Western line and Jl. Moch. Mansyur.

3) The semi-directional ramp is to merge to the north bound of Jl. Latumeten innerly to keep accessibility along Jl. Latumeten and to secure the mobility of rampway.

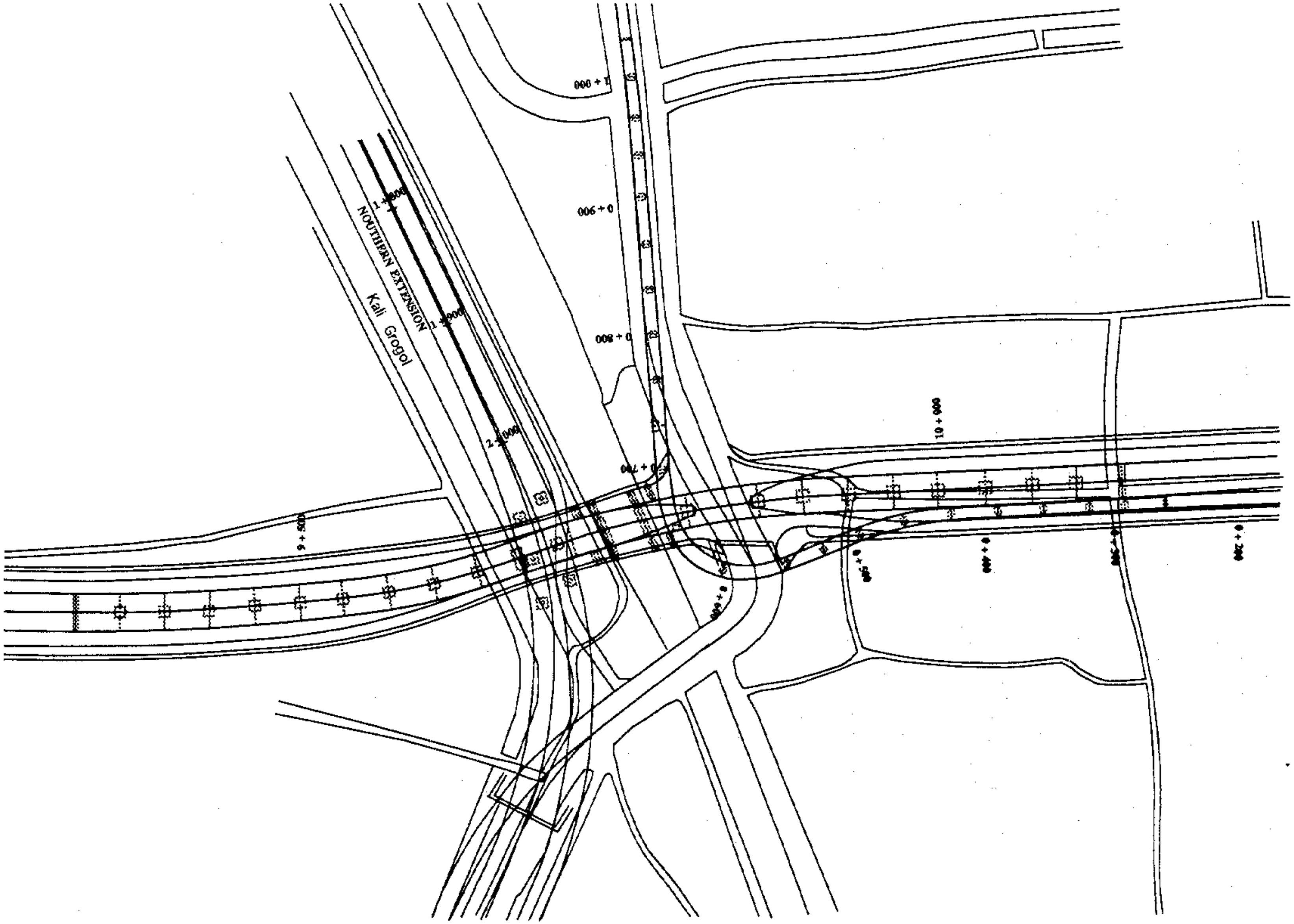
4) The at-grade intersection on Jl. Latumeten is to allow through and right turning as well as left turning from west bound frontage road because the provision of semi-directional ramp prevents access to the throughway from frontage road in about 1.5 km long stretch.

As for Gunung Sahari Interchange, the following points are taken into account during design;

1) The semi-directional ramp is to fly over the elevated throughway. To facilitate overpassing, the vertical alignment of the throughway becomes low as much as possible to keep the minimum headroom of 5.1 m high.

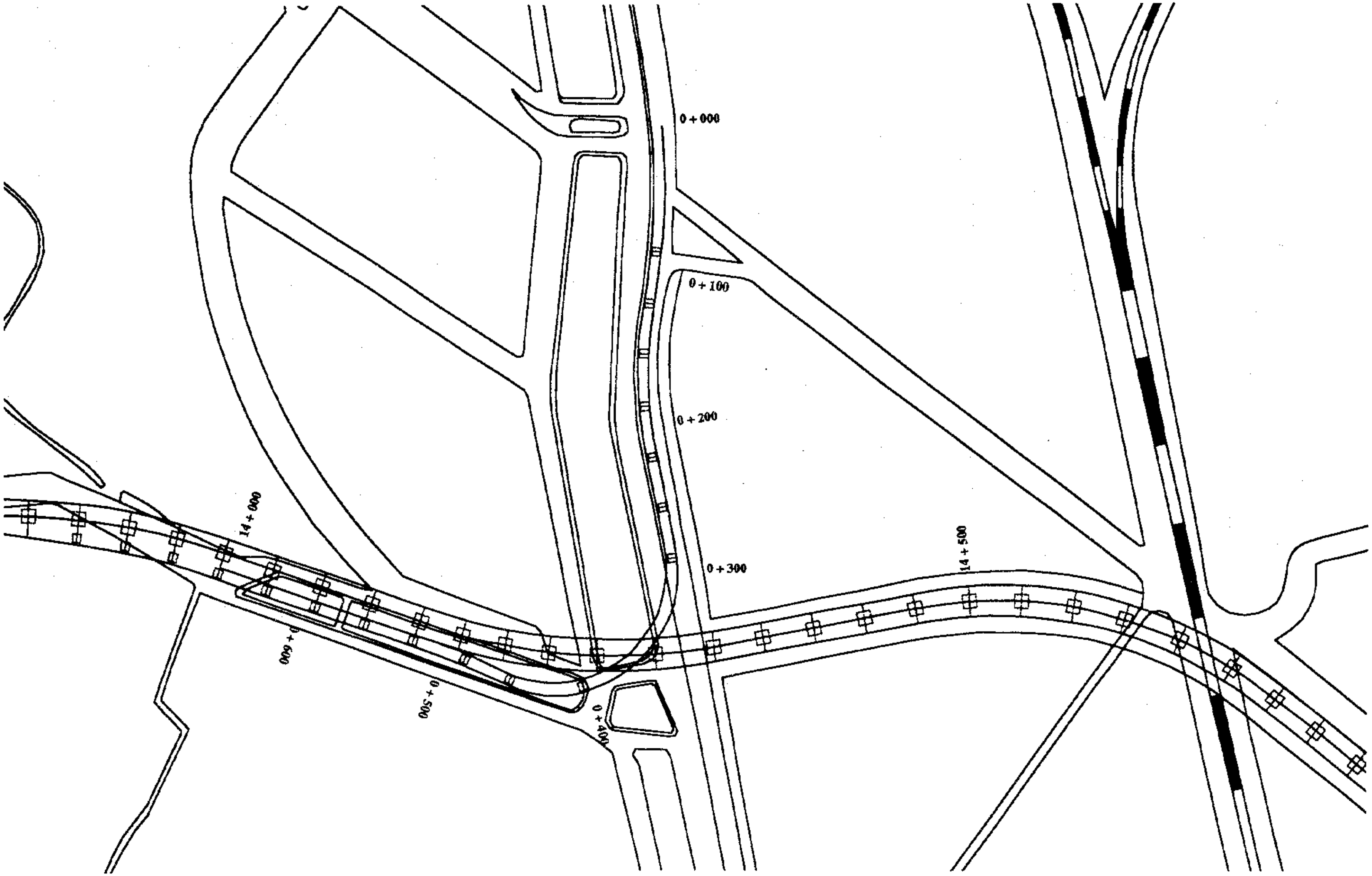
2) The location of merging nose of On ramp from Jl. Gunung Sahari is to be located at sufficient distance from the merging nose of the semi-directional ramp.

3) The semi-directional ramp is to diverge from the south bound of Jl. Gunung Sahari innerly to keep accessibility along Jl. Gunung Sahari and to secure the mobility of rampway.



FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.5.15 Latumeten Interchange



FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.5.16 Gunung Sahari Interchange

10) East-JORR Interchange

East-JORR Interchange is located in the intersecting point with Jakarta Outer Ring Road (JORR) in between Jalan Bekasi Raya and the Bekasi Railway Line. East-West Axis is arterial road and has Right Of Way 110 m including High Voltage Transmission line at the centre. The function of this interchange is to strengthen the arterial road network and to stimulate the development of east sub-centre. Therefore, no direct connection to toll road of JORR is provided.

The land use in the vicinity of this interchange is remained development but it will become predominant commerce, business, and housing in the near future.

The salient features of this interchange are summarized as follows :

1. Function of U-turn facilities both on East West Axis and on JORR are to develop in the surrounding of interchange and serve the users for right turning respectively.

2. No multiple structure for right turning is warranted.

Table 10.5.6 summarizes the comparison and evaluation of practical alternatives for the East-JORR Interchange.
The selected type of interchange is presented in Fig. 10.5.17.

As for JORR-East Interchange, the following points are taken into account during design :

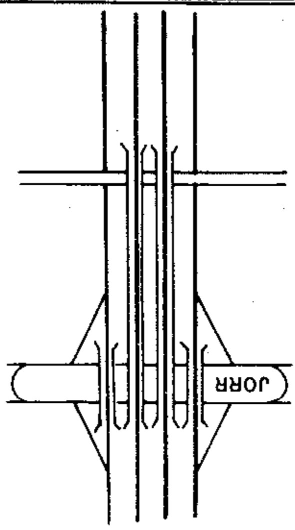
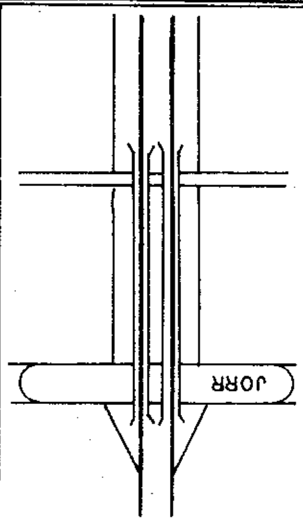
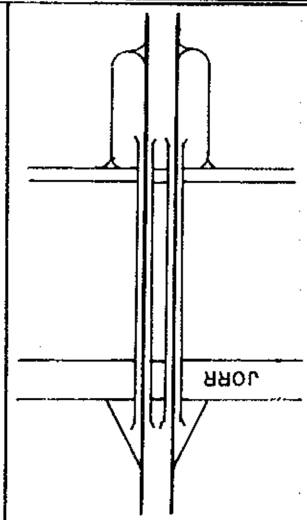
1. U-turn facilities should be placed near the frontage road of JORR, so that length of bridge can be reduced.

2. The throughway should be kept from congestion. Accordingly, the facilities to connect throughway and frontage road should be given from throughway enter to frontage road and exit from frontage road to throughway.

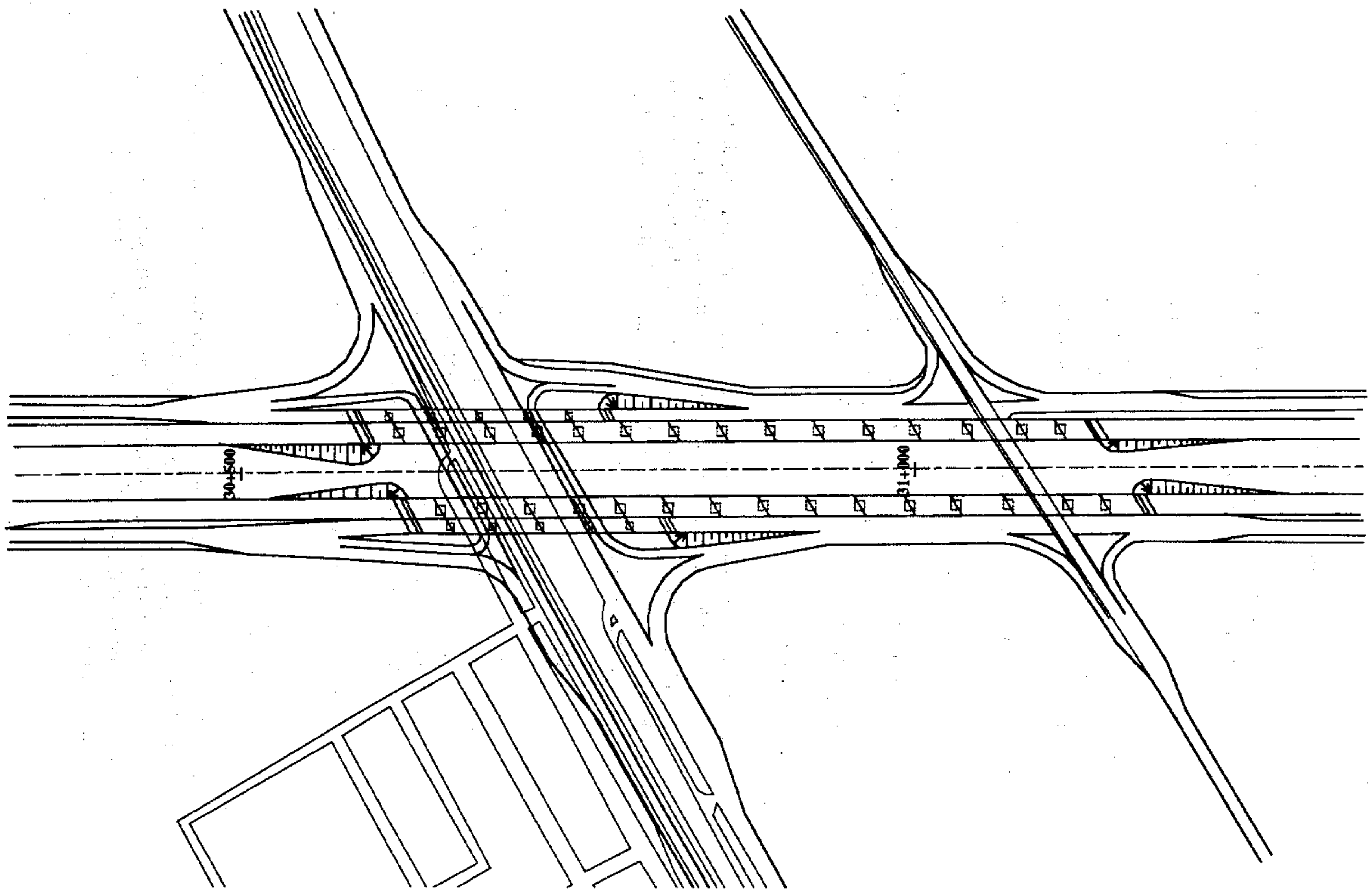
3. Diverging or Marking nose of frontage road flyover should be located far from intersection as much as possible.

4. It is necessary to make frontage roads fly over separated from throughway and overpass the JORR, but intersection between frontage road and Jalan Pulo Gebang is indispensable, so that the traffic accessibility will increase.

Table 10.5.6 Comparison and Evaluation of the Alternatives for East JORR Interchange

	Alternative 1	Alternative 2	Alternative 3
Layout of ramp configuration			
Salient features.	- Diamond type - U-Turn facilities on JORR - Minimum curve radius of ramp way is 50 m for the design speed of 40 Km/h.	- Half diamond type - U-Turn facilities on JORR - Minimum curve radius of ramp way is 50 m for the design speed of 40 Km/h.	- Half diamond and loop ramp type - Without U-Turn facilities on JORR - Minimum curve radius of loop/ramp way is 50 m for the design speed of 40 Km/h.
Function of IC.	This Interchange will able to serve the road users for all direction (Jalan Bekasi Raya , new sub centre and Jalan Pulo Gebang). Good	This Interchange will able to serve the road users for Jalan Bekasi Raya and new sub centre. Fair	This Interchange will able to serve the road users for Jalan Bekasi Raya and Jalan Pulo Gebang. Fair
Land availability.	Required land area for the interchange is smallest Good	Required land area for the interchange is largest Poor	Required land area in between alternative I and alternative II. Fair

	Alternative 1	Alternative 2	Alternative 3
Construction economy.	- Construction cost is lowest among three alternative Good	- Construction cost is highest among three alternative Poor	- Construction cost in between alternative I and alternative II Fair
Traffic flow and safety	- Shortest traffic detour - Right turning movement are handled by U-Turn facilities on the JORR Good	- Turning movement are handled by U-Turn facilities on the JORR. - Long detour distance, but these are acceptable to service interchange. Fair	- Turning movement are handled by loop ramps, without U-Turn facilities. - Longest detour distance among three alternative Poor
Future traffic demand	No significant difference Good	No significant difference Good	No significant difference Good
Evaluation	Land availability considering and High Voltage Transmission line are significant for this location. Therefore alternatives 1 which is can to serve the road users for all direction of function of interchange is proposed for East - JORR Interchange.		



FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD AYATEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.5.17 East JORR Interchange

10.6 Preliminary Design of Drainage

10.6.1 Drainage Design Standard

1) Return Period of Maximum Rainfall

The return period of maximum rainfall for design of the drainage system has been recommended as shown below :

Drainage System	Return Period
Surface water drainage	3 years
Minor rivers	50 years
Major rivers	100 years

The reasons for selecting the above return periods are as follows :

(1) Surface Water Drainage

It is assumed that water pounding for a very short time over limited areas will occur once in 3 years and that this is tolerable to achieve a less costly drainage system for the Ring Road.

(2) Minor Rivers

Selection of a shorter return period (i.e. 25 years return period) can result in bridge and culvert construction costs being reduced but it is considered that such cost reduction is minor in the total Ring Road development cost and negligible compared with the possible flood damage to future development areas.

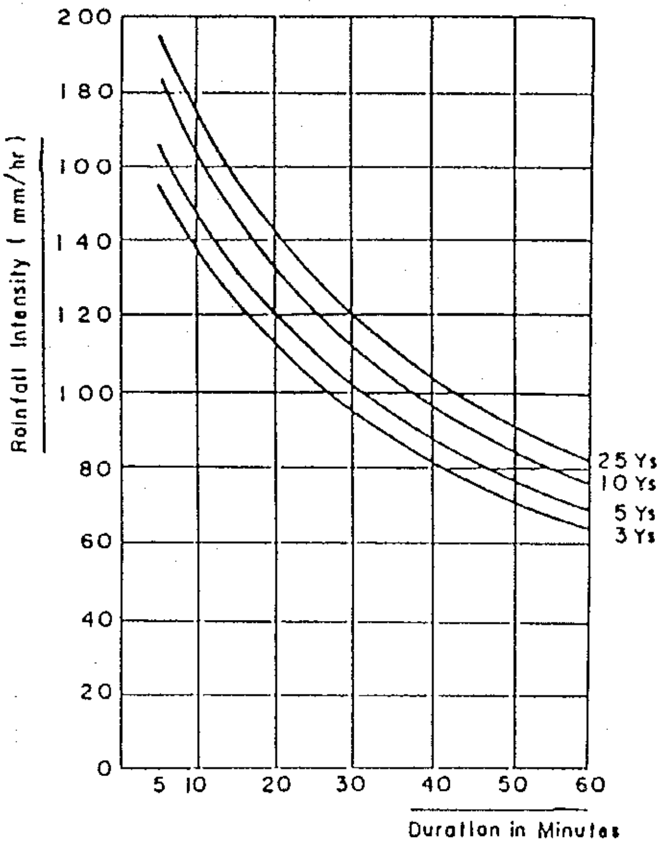
(3) Major Rivers

Since the relative river bed elevations of major rivers (i.e. Kali Ciliwung and Kali Pesanggrahan) are much lower than the general elevations of surrounding areas, the total length of bridges crossing rivers will not be determined by the width of these rivers but by the tolerable vertical alignment design of the Ring Road.

For the above reasons the Consultant's design is for a return period of 100 years.

2) Rainfall Intensity

Probable rainfall intensity - duration analysis was carried out using the rainfall data from gauge station Jakarta (No. 27).
The result of the probable rainfall intensity duration analysis is based on the Gumbel method and the Specific Coefficient method, and is summarized in Table 10.6.1 and Fig. 10.6.1.



$$It = \frac{6,023}{t+34.11} \quad (3\ \text{years})$$

$$It = \frac{6,495}{t+34.12} \quad (5\ \text{years})$$

$$It = \frac{7,177}{t+34.43} \quad (10\ \text{years})$$

$$It = \frac{7,648}{t+34.42} \quad (25\ \text{years})$$

Fig. 10.6.1 Rainfall Intensity-Duration Curve

Table 10.6.1 RAINFALL INTENSITY (mm/hr)

Duration	Return Period (Years)		
	3	50	100
M60	64	87	92
M5	154	-	-

Notes : M60 .... 60 minutes duration time
M5 .... 5 minutes duration time

Table 10.6.2 shows the resultant probable maximum daily rainfall in Kali Ciliwung by applying a discount factor of 0.8 which was estimated after careful comparison of December 1981 rainfall date and the results of past rainfall study in the basin.

Table 10.6.2 Summary of Probable Maximum Daily Rainfall for Kali Ciliwung Basin (Discounted)

Return Period	Probable Maximum Daily Rainfall (mm)
R100	182
R50	168
R25	151

3) Run-Off

(1) General

Since the provision of adequate drainage is extremely important for the maintenance of roads and for traffic safety, attention must be paid to the following aspects :

- Surface water drainage including rainwater on the pavement surface, embankment slopes and other surfaces within the limits of the ROW;
- Roadside drainage, including rainwater on the roadside and adjacent inhabited areas and from outside the limits of the ROW, which affects the roads; and
- Openings for waterways to be crossed by the road.

(2) Method Employed for Estimating River Run-Off

Estimation of run-off for each river is based on the rational formula, together with the following investigations and studies:

- Comparison with the run-off estimated by other Government agencies;
- Information regarding maximum water surface levels;
- Site investigation and flood water study (i.e. maximum discharge and water surface levels).

i) The Rational Method

The rational formula is expressed as follows :

$$Q = \frac{1}{3.6} \times f \times r \times A$$

where : Q : Run-off in cubic metres per second
f : Coefficient representing the ratio of run-off to rainfall = 0.7
r : Intensity of rainfall, in millimetres per hour for the estimated time of concentration
A : Drainage area in square kilometres

ii) Intensity of Rainfall (r)

$$r = \frac{R}{24} \left(\frac{24}{Tc}\right)^{2/3}$$

where : R : Probable maximum rainfall in the river basin (discounted by 80%) in mm/day.
Tc : Concentration time as in the formula below :

$$Tc = 1.67 \times 103 \times \frac{L^{0.7}}{S^{0.35}}, \text{ in hours}$$

where : L --- Length of river (m)
H --- Difference in height (m)
S --- Average slope of river = $\frac{H}{L}$

(3) Method Employed for Estimating Run-Off of Storm Drainage

Estimation of run-off for each storm drainage system is also made by using the rational formula as follows :

i) Rational Method

$$Q = \frac{1}{3.6} \times f \times I \times A$$

where : Q : Run-off in cubic metres per second

f : Coefficient representing the ratio of run-off to rainfall

I : Intensity of rainfall, in millimetres per hour for the estimated time of concentration

A : Drainage area in square kilometres

ii) Run-Off Coefficient

In estimating the run-off coefficient, a variety of geological and ground conditions are taken into consideration for each drainage area in view of the major differences that can exist between one area and another. The values determined are as listed below:

Type of Drainage Area	Coefficient of Run-Off "f"
Road surface (paved)	0.95
Embankment slope	0.70
Grassland	0.60
Paddy field	0.70 - 0.80
Cultivated field	0.45 - 0.60
Inhabited area	0.60
Mountainous area, bare	0.75 - 0.90
Mountainous area, vegetated	0.70 - 0.80

iii) Rainfall Intensity

Rainfall intensity is found by the rainfall intensity - duration curve shown in Figure 10.6.1.

iv) Concentration Time

Generally, concentration time is computed from the following relationship :

$$Tc = t1 + t2$$

where : Tc : Concentration time in minutes
t1 : Time for inlet conditions as follows :

Type of Area	t1 (minutes)
Completely paved area	5
Sloped development area	10 - 15
Flat inhabited area	20 - 30

t2 : Time of flow

$$t2 = \frac{L}{60V}$$

L : Distance of channel in metres to the point at which the discharge is computed.

V : Average velocity of flow in channel in metres per second.

The above calculations will be utilized to estimate the concentration times of the drainage system apart from rivers.

4) Clearance Above Design High Water Level

The clearance above design high Water Level

The clearance above design high water level for various types of drainage structures are presented below:

Drainage System	Structure Type	Clearance in Metres
Major River	Bridges	1.0
Minor River	Bridges	0.5
Drainage System	Box Culvert	0.5

5) Drainage Design

(1) General

Rainwater which falls on roadways flows laterally or obliquely under the influence of cross slope or superelevation of the carriageway and shoulders. If the ROW situation permits, a common rule for drainage when roadways are on fill is to let the flow continue off the shoulder and down the side slope to the side drain or ditch. Little erosion results if.the slopes are protected by sodding and the water flows across the roadway and down the slope as a uniform sheet.

The purpose of hydraulic design is to determine the type and size of culvert that will most economically accommodate the flow of the stream. In almost all cases, the primary control is the permissible level of the headwater pool at the upstream side of the structure. In some cases a high headwater may cause serious damage and will not be permitted. For example, higher headwater may result in inundation of valuable property in settled areas. Sometimes high velocities through the culvert may produce erosion problems at the downstream side or threaten damage to the culvert or its appurtenances. To avoid these situations therefore, the water must be disposed of quickly and safety through the structures.

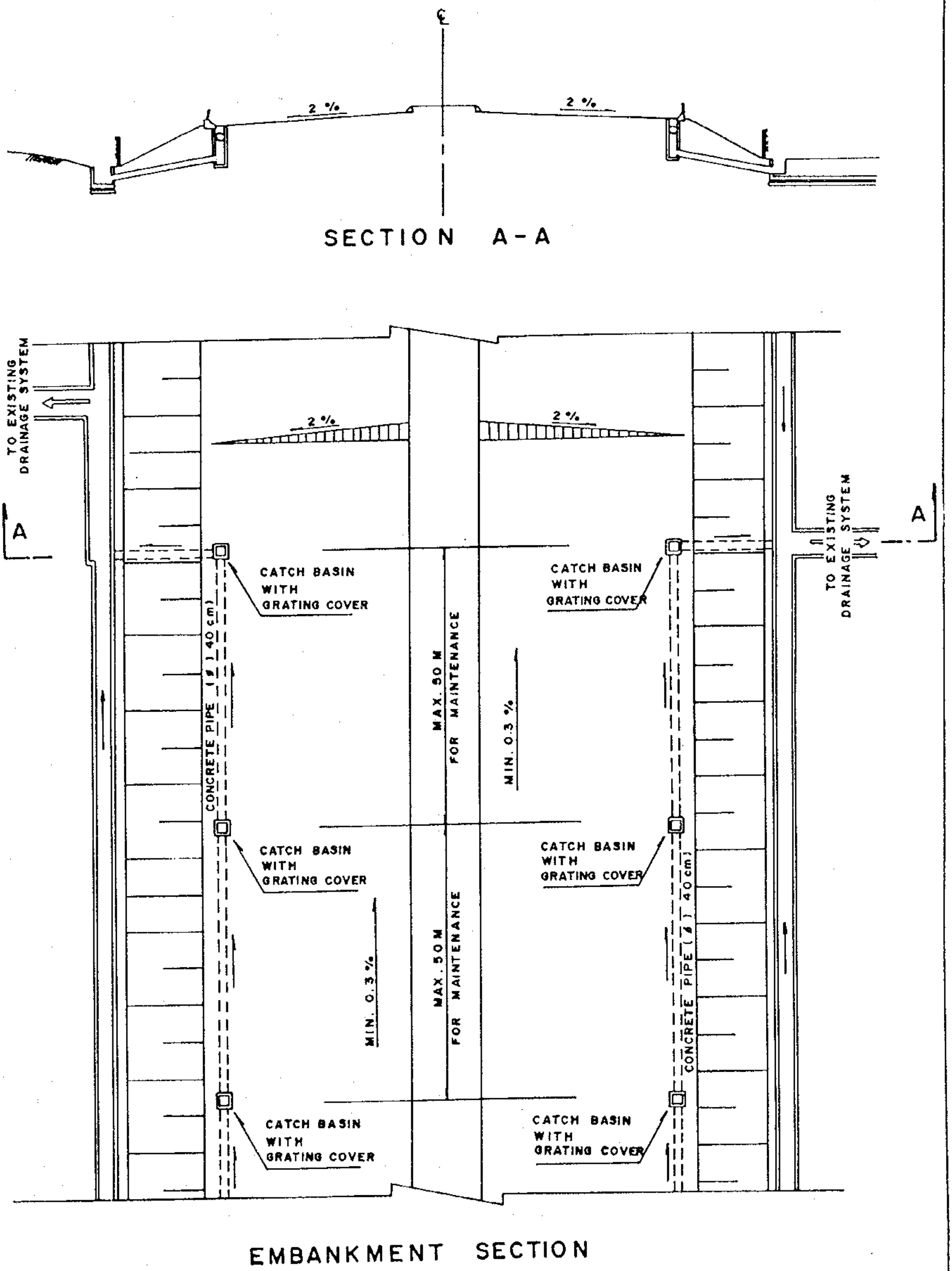
Protection is designed in order to cope with the tractive force and scour effect caused by flood. For protection of bridge structures stone masonry is used, taking the condition of the discharge volume and stream velocity into consideration.

In connection with the hydraulic structure designs and the velocity of flow through a structure, scouring and sedimentation near the structure will result if the water opening is restricted. The cover of bridge footings and wall footings is determined so as to sufficiently resit maximum possible scour.

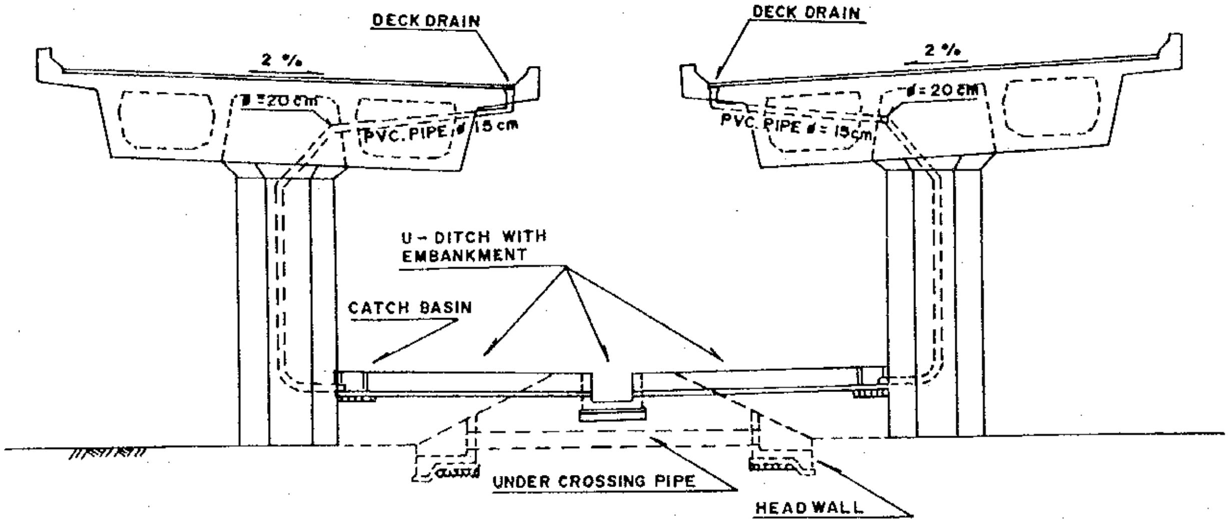
(2) Road Surface Drainage

The typical drainage system on embankments is that storm water drains flow in the wet area in the shoulder and drop into a U-ditch or pipe culvert installed in or out of the shoulder to flow to the main drainage usually installed at toe of embankment slope. Drainage installed in or out of the shoulder can connect directly to the existing waterway if it is close enough.

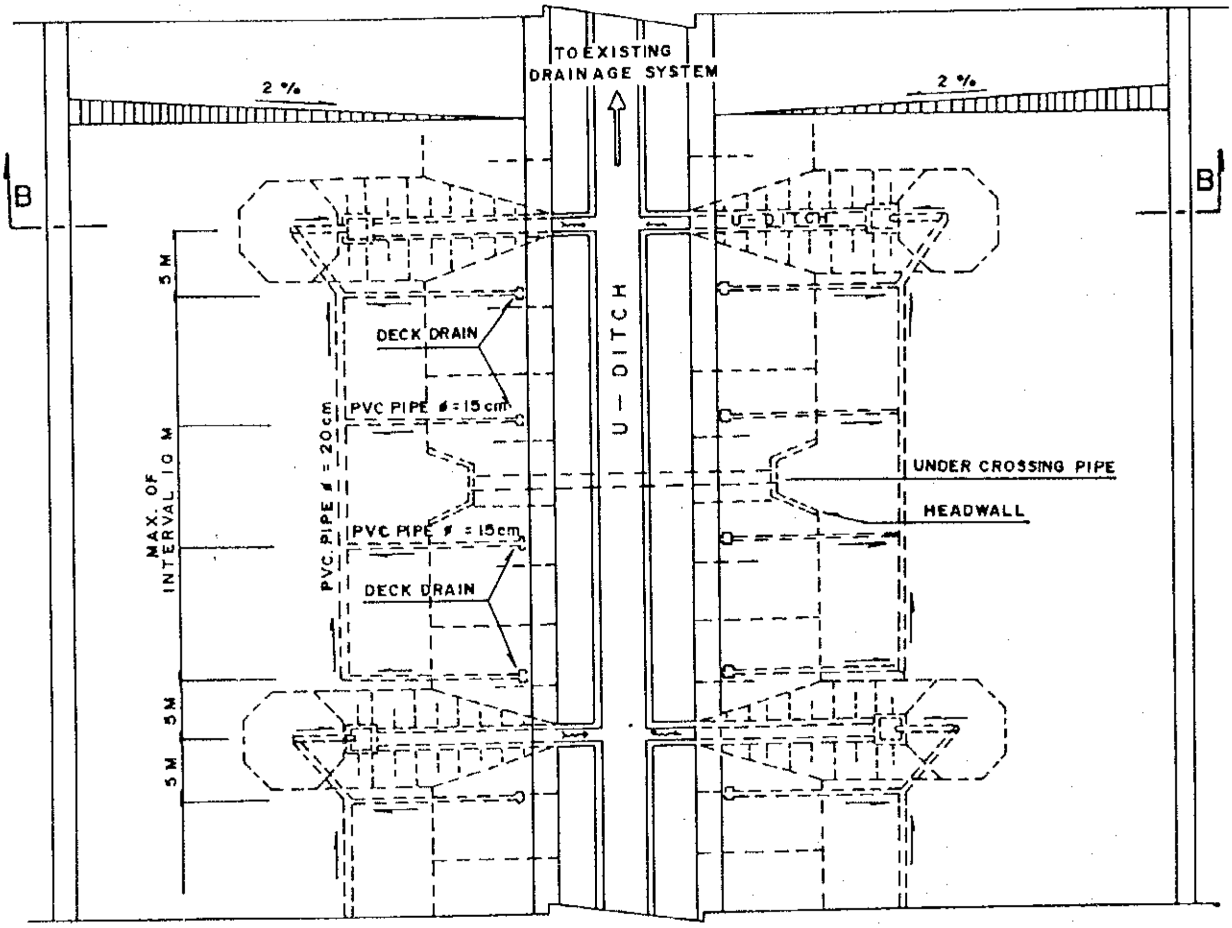
The typical drainage system on viaducts is that storm water drains flow in the wet area in the shoulder and drop into deck drain pipes to be led to the main drainage which is usually installed beneath the viaduct. This main drainage shall be placed on an embankment where it crosses a low lying area. Where the embankment divides a low lying waterway a connecting drain shall be installed through the embankment below the main drainage to equalize water level. Fig. 10.6.2 and Fig. 10.6.3 illustrate these drainage systems.



FEASIBILITY STUDY ON URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT IN JAKARTA METROPOLITAN AREA	**Fig. 10.6.2 Typical Drainage System of Embankment Section**



SECTION B — B



VIADUCT SECTION

FEASIBILITY STUDY ON URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT IN JAKARTA METROPOLITAN AREA	**Fig. 10.6.3 Typical Drainage System of Viaduct Section**

10.7 Preliminary Design of Pavement

10.7.1 General

After completion of Alternative Route Study in Phase II report, further study was made to determine the kind of pavement, i.e. the flexible or rigid pavement to adopt to this Preliminary Design. The characteristics of both flexible and rigid pavements are shown in table 10.7.1.

Table 10.7.1 Characteristic of Flexible and Rigid Pavement

	Flexible Pavement	Rigid Pavement
Target Design Perfor- mance Period	15 years extendible by stage overlay or projected rehabili- tation works.	20 years
Transformation- proof wear - proof	compared with rigid pavement, slight transformation proof and wear-proof causing rutting.	Seldom rutting and more wear-proof
Noise and vibration	Little noise and small vibration.	Joints and grooves cause vibration and noise.
Brightness of road surface	Weak reflection from road surface.	Brighter than flexible pavement in the dark.
Construction aspects	Short construction period enabling early opening to traffic.	1. Generally, the composition of construction machinery is a longer line than that of flexible pavement and causes a longer construction period than that of flexible pavement. 2. It is unusual to pave bridges and viaduct with rigid pavement. 3. The curing period and/or construction of joints may cause delays in opening to traffic.

	Flexible Pavement	Rigid Pavement
Maintenance Works	Easy maintenance work by simple maintenance methods.	Maintenance is seldom necessary except when placed on soft ground areas where sub-grade or subbase are damaged by consolidation or sliding and large scale mainte-nance becomes necessary.
Construction cost and Maintenance Cost	Initially cheaper construction cost plus frequent maintenance costs over a 20 year period may result in the same level as normal rigid pavement.	Initially higher construction cost plus usually cheaper maintenance cost. It may be liable to huge reconstruction cost as described above.

As for North-South Axis, asphalt concrete surface is proposed on RC slab due to an elevated road on viaduct in the entire stretch. On the other hand, it is proposed to adopt a flexible pavement over the entire area of arterial roads on East-West Axis. The followings are taken into consideration in making this proposal :

1) Arterial streets will need to be opened to the public at an earliest possible time to avert traffic congestion during construction.

2) A flexible pavement is more suitable considering physical conditions such as deep soft ground

Design methods of pavement are based on the "**AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURE 1986**"

The design traffic volume is shown in table 10.7.2.

Table 10.7.2 Design Traffic Volume

Major Road Section	Design Traffic Volume (pcu/days)		Traffic Growth Ratio
	Year 2000	Year 2010	$g=(V_{2010}/V_{2000})^{1/t}-1$
East West Axis :			
Section 1	78,000	90,000	0.1440
Section 2	96,000	132,000	0.0320
Section 3	97,000	125,000	0.0250
Section 4	114,000	125,000	0.0093
Section 5	106,000	94,000	-0.0120
Section 6	80,000	95,000	0.0170
Section 7	109,000	108,000	-0.0009
Section 8	90,000	100,000	0.0110
Section 9	77,000	86,000	0.0110
Section 10	78,000	88,000	0.1210
Section 11	59,000	102,000	0.0560
Average	89,500	104,100	0.016

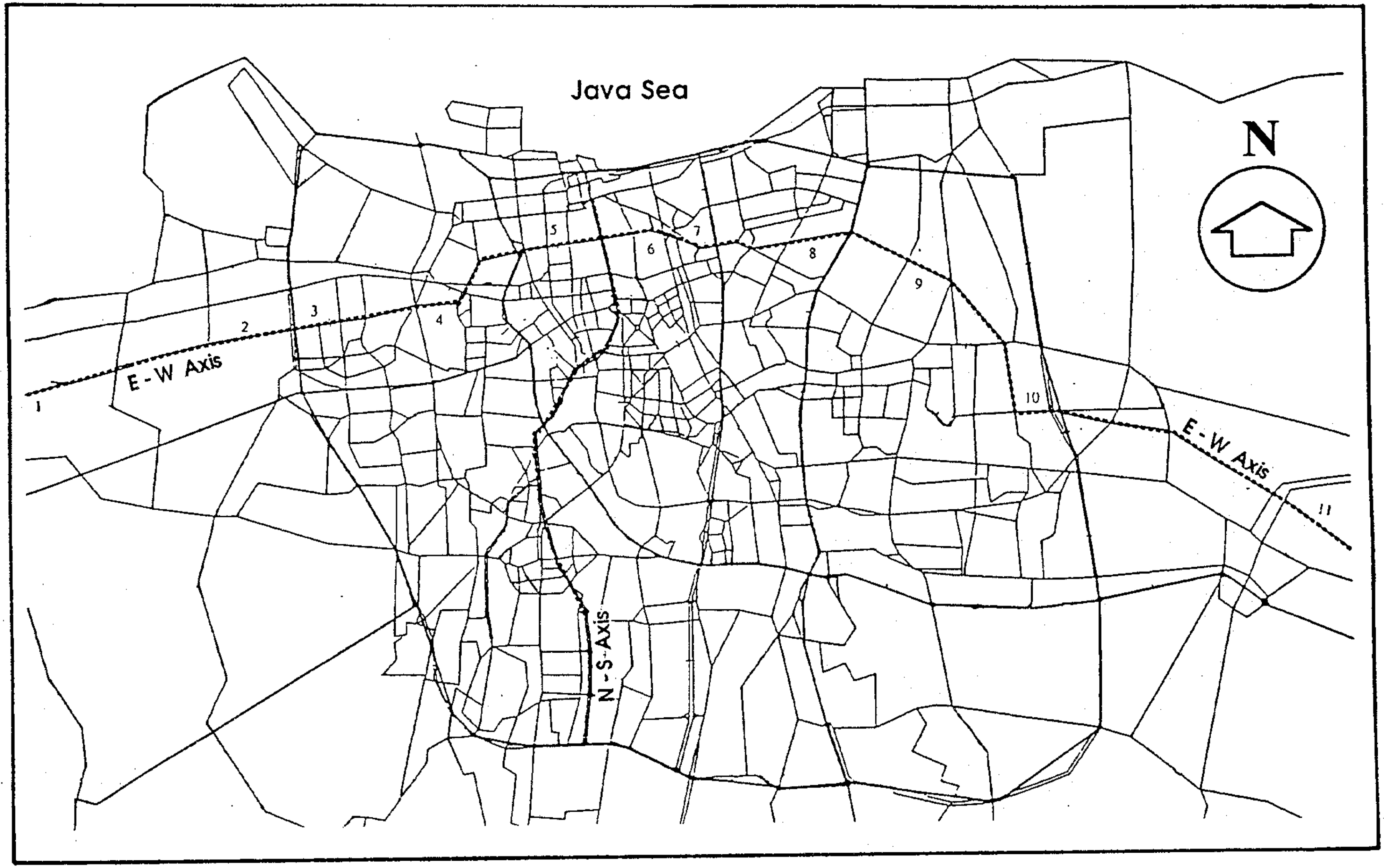


Fig. 10.7.1 Location Map of Road Section

10.7.2 Traffic Calculation

1) 18-Kip Equivalent Single Axle Loads (ESAL)

The component of estimated traffic is as follows;

24-hrs vehicle total	63,680 veh/day
24-hrs pcu total	58,523 pcu/day
Percentage of truck	18,259 pcu/day (31%)
Percentage of bus	2,834 pcu/day (5%)

Assumed heavy vehicle ratio is 36%.

Table 10.7.3 shows the cumulative 18-Kips ESAL per 1,000 pcu.

Table 10.7.3 Cumulative 18-Kips ESAL per 1,000 PCU

Assumed Heavy Vehicle Component Per 1,000 PCU		Bus 5% (30% unloaded)				Truck 31% (40% unloaded)						Total ESAL	Coeff	Total
		Medium		Large		2 - Axle		3 - Axle		Trailer				
		19		31		234		39		37				
		unloaded	loaded	unloaded	loaded	unloaded	loaded	unloaded	loaded	unloaded	loaded			
		6	13	9	22	94	140	16	23	15	22			
Axle Load Distribution	Tandem													
	26	6				94						100	0.364	36.400
	28			9								9	0.495	4.455
	36		13				140					153	1.380	211.140
	40				22							22	2.080	45.760
	44									15	22	37	3.000	111.000
	Triple													
	30							16				16	0.145	2.320
	44								23			23	0.723	116.630
	Single													
	20										22 x 2 = 44	44	1.440	63.360
		TOTAL												491.06 ESAL

W_{18} = $D_D * D_L * w_{18}$
= 0.5 * 0.6 * (6/10 * 89,500 * 491/1,000 * 365)

W_{18} = 2.887 * 10^6 * {(1+0.016)^t -1}/ 0.016

Where :

D_D = a directional distribution factor distribution, expressed as a ratio, that account for the distribution of ESAL units by direction.

D_L = a lane distribution factor, expressed as a ratio, that accounts for distribution of traffic when two lanes are available in one direction.

w_{18} = the cumulative two-directional 18-kip ESAL units predicted for a specific section of highway during the analysis period (from the planning group)
(only for six through traveled lane)

These are translated into 18-Kip equivalent Single Axle Loads as follows ;
(Refer to Fig. A10-3-1 in Appendix).

W_{18} = 2.887 x 10^6 {(1.016)^t - 1} / 0.016

Where :

t = time (years).

10.7.3 Pavement Design On East-West Axis (CBR = 5.0 %)

1) Conditions :

(1) Traffic : 2.887 x 10^6 {(1 + 0.016)^t - 1} / 0.016
(2) Reliability (2-Stage Construction) ; $0.90^{0.5}$ = 0.95
(3) Standard Normal Deviate, Z_R = -1.645
(4) Overall Standard Deviation, S_o = 0.35
(5) Effective Roadbed Resilient Modulus, M_R = 5,700 psi
(6) Design Serviceability Loss, PSI = 4.6 - 2.5 = 2.1

2) Design Total Structural Number

The Design Total Structural Number SN was determined to be 6.28, using design chart for flexible pavement presented in Fig. 10A-3-2 in Appendix.

3) Initial Performance Period

(1) Condition
PI = 50 %, Swell Probability P_s = 100 %, Swell Rate Constants
$\varnothing$ = 0.14.

(2) Potential Vertical Rise; V_R
The Potential Vertical Rise; V_R was determined as 0.83 inches (refre to Fig. 10A-3-3 in Appendix).

(3) Iteration to determine the Initial Performance Period (refer to Table 10.7.3)

a) 1st Iteration (10 years) (refer to Fig. 10A-3-4)

$$PSI_{swell} = 0.00335 \times V_R \times P_s \times (1 - e^{-\varnothing t})$$
$$= 0.2095$$

$$\text{Log}_{10} W_{18} = Z_R S_o + 9.36 \log_{10}(SN+1) - 0.2 + \frac{\log_{10}\dfrac{1.8905}{2.70}}{0.40 + \dfrac{1094}{(SN+1)^{5.19}}} + 2.32 \log_{10} M_R - 8.07$$

$= 7.583$

$W_{18} = 38.312 \times 10^6$

b) 2nd Iteration (12 years)

PSI = 0.2263
$\log_{10} W_{18}$ = 7.57
W_{18} = 37.515×10^6 ESAL

c) 3rd Iteration (12.5 years)

PSI = 0.2298
$\log_{10} W_{18}$ = 7.57
W_{18} = 37.349×10^6 ESAL

The, Initial Performance Period was determined to be 12 years.

Table 10.7.3 Reduction in Performance Period (Service Life) Arising Swelling Consideration

Iteration No.	Trial Performance Period (years)	Serviceability Loss Due to Swelling ΔPSIsw	Corresponding serviceability Loss Due to Traffic ΔPSItr	Allowable Cumulative Traffic (18-Kip ESAL)	Corresponding Performance Period (years)
1	10	0.2095	1.8905	38.312 $\times 10^6$	12.13
2	12	0.2263	1.8737	37.515 $\times 10^6$	11.90
3	12.5	0.2298	1.8702	37.349 $\times 10^6$	11.85

4) Determination of Structural Layer Thickness for Initial Pavement

(1) Conditions

- Asphalt Concrete
  E_{ac} = 400,000 psi a_1 = 0.42 m_1 = 1.0

- ATB
  E_{atb} = 200,000 psi a_2 = 0.3 m_2 = 1.0

- Mechanical Stabilized Base Course
  E_{bs} = 30,000 psi a_3 = 0.14 m_3 = 1.15
  (CBR = 100%)

- Granular Sub Base (CBR > 30%)
  E_{sb} = 15,000 psi a_4 = 0.11 m_4 = 1.20

(2) Asphalt Concrete Layer Thickness D_1

W_{18} = $2.887 \times 10^6 \{(1.016)^{12} - 1\} / 0.016$
W_{18} = 37.8613×10^6 ESAL
M_R = 200,000
ΔPSI_{TR} = 1.8737

Using Figure 10.7.6 with above input parameters, the structural Number of SN_1 was determined to be 1.78

$D_1 = SN_1 / a_1$
$= 1.78 / 0.42$
$= 4.2$ inch
≈ 10 cm
$SN_1 = 10 \times 0.42 / 2.54$
$= 1.65$ inch

(3) ATB Layer Thickness D_2

$W_{18} = 37.8613 \times 10^6$ ESAL
$M_R = 30{,}000$
$\Delta PSI_{TR} = 1.8737$

Similarly, SN_2 was determined to be 3.64 (using Figure 10.7.1).

$D_2 = (3.64 - 1.65) / (0.3 \times 1)$
$= 6.63$ inch
≈ 15 cm
$SN_2 = 15 \times 0.3 / 2.54$
$= 1.77$ inch

(4) Mechanical Stabilized Base Course Layer Thickness D_3

$W_{18} = 37.8613 \times 10^6$ ESAL
$M_R = 15{,}000$ psi
$\Delta PSI = 1.8737$

Similarly, SN_3 was determined to be 4.64 (using Figure 10.7.8).

$D_3 = \{4.64 - (1.65 + 1.78)\} / 0.14 \times 1.15$
$= 7.51$ inch
$= 19.07$ cm
≈ 20 cm
$SN_3 = 20 \times 0.14 \times 1.15 / 2.54$
$= 1.27$ inch

(5) Granular Sub-Base Course Layer Thickness D_4

Similarly, SN_4 was determined to be 6.28 (using Figure 10.7.3).

$D_4 = \{6.28 - (1.65 + 1.78 + 1.27)\} / 0.11 \times 1.2$
$= 11.97$ inch
≈ 30 cm

(6) Development of Overlay Design

(a) Conditions

Traffic between 12 years to 20 years : $(67.4194 - 37.8613)10^6 = 29.5581*10^6$ ESAL
Reliability 95 % = 0.95
Standard Normal Deviate, $Z_R = -1.645$
Overall Standard Deviation, $S_o = 0.35$
Roadbed Resilient Modulus, $M_R = 5{,}700$ psi
Serviceability loss due to Traffic, $PSI_{TR} = 2.1 - (0.261 - 0.226) = 2.065$

(b) Equation

$$SN_{OL} = SN_Y - (F_{RL} \times SN_{xeff})$$

Where :

SN_{OL}	=	Structural number of the required asphalt concrete overlay
SN_Y	=	Structural number required for a new pavement to carry the estimated future traffic for the prevailing roadbed soil support conditions.
F_{RL}	=	Remaining life factor, and
SN_{xeff}	=	Effective structural number of the existing pavement at the time the overlay is placed.

(c) Determination of SN_Y

SN_Y is determined to be 5.92, using design chart presented in Fig. 10A-3-8.

(d) Determination of R_{LX} (Estimated remaining life of the the original pavement at the time of overlay)

Using Fig. 10A-3-9, R_{LX} is determined to be 47% with input parameters $SN_O = 6.0$ (6.28) and terminal Serviceability Loss of 2.5.

(e) Determination of R_{LY} (Estimated remaining life of the overlay when it reaches its design terminal serviceability of 2.5)

The estimated future 18-Kip ESAL traffic to ultimate failure (i.e., when the serviceability drops to 2.0 and remaining life is zero) is 48.031×10^6 ESAL.

$$R_{LY} = \frac{48.031 \times 10^6 - 29.5581 \times 10^6}{29.5581 \times 10^6} = 38.46\ \%$$

(f) Determination of F_{RL}

Using Fig. 10A-3-10, F_{RL} is determined to be 0.72 with input parameter $R_{LY} = 38.46\%$ and $R_{LX} = 47\%$.

(g) Determination of the Effective Structural Number

$SN_{xeff} = C_X \times SN_O$

C_X is determined using Fig. 10A-3-11 with input parameter R_{LX} = 47% to be 0.88.

Thus,

$SN_{xeff} = 0.88 \times 6.28$
$= 5.526$

Inserting the value of SN_Y, F_{RL} and SN_{xeff} to equation 3) herein above,

$SN_{OL} = SN_Y - (F_{RL} \times SN_{xeff})$
$= 5.92 - (0.72 \times 5.526)$
= 1,9413 inch

$D_{OL} = SN_{OL}/a_1$
$= 1.9413 / 0.42$
= 4.622 inch
≈ 12 cm

(7) Conclusion

1) Initial Pavement

Surface Course	=	4 cm	Dense Grade Asphalt Concrete
Binder Course	=	6 cm	Coarse Grade Asphalt Concrete
ATB	=	15 cm	A T B
Mechanical Stabilized Base Course	=	20 cm	Mechanical Stabilized Base Course (CBR 100%) Stability ≥ 350 kg
Granular Sub Base Course	=	30 cm	Granular Sub Base CBR ≥ 30%

2) 2nd Stage (Overlay) after 12 years

Surface Course	=	5 cm	Dense Grade Asphalt Concrete
Binder Course	=	7 cm	Coarse Grade Asphalt Concrete

10.8 Preliminary Design of Bridge and Other Structures

10.8.1 Superstructure

1) General

The selection of superstructure type is to be made considering construction economy, ease of construction, maintenance and aesthetic view.
The designed spans of bridges in project roads vary from 25 m to 90 m in length. The practical types of bridges in this range are as follows;

(1) PC Hollow Slab
(2) PC Composite Simple I Girder
(3) PC Simple T Girder
(4) PC Composite Simple U Girder
(5) PC Simple Box Girder
(6) PC Continuous Box Girder (All Staging)
(7) PC Continuous Box Girder (Cantilever)
(8) Steel Composite Simple Girder
(9) Steel Simple Box Girder
(10) Steel Continuous Box Girder

Table 10.8.1 presents the applicability of each type of bridges by span. Table 10.8.2 gives the suitability of each type of bridges such as girder height-span ratio, election method and sharpest curvature.

2) Throughway

It is impractical to adopt the most common election methods such as all staging and staging using steel support where the construction of superstructure is planned to take place on existing roads and traffic should be maintained during construction. Therefore, such types of bridges as PC Hollow Slab, PC Simple Box Girder and PC Continuous Box Girder (All Staging) are assumed not applicable on existing roads. On the other hand, since PC Composite Simple I Girder, PC Simple T Girder and PC Composite Simple U Girder are elected by truck crane or using election girder and its slab is constructed in-place utilizing these girders as staging, they have significant advantages on existing roads not to impede traffic flow. In this case, I girder is superior to others at the aspect that lighter girder requires smaller crane or election girder. Accordingly, PC Composite Simple I Girders have been constructed in many actual practices in Jakarta.

It is concluded that PC Composite Simple I Girder is adopted to the standard bridge, ranging the span from 25 m to 45 m. However, where aesthetic view becomes major issues such as Kota, Senayan and Kebayoran Baru, PC Composite Simple U Girder is designed. Where the span exceeds 45m long or Steel Piers are required, Steel Composite Simple Girder, Steel

Table 10.8.1 Applicability of Bridges by Span

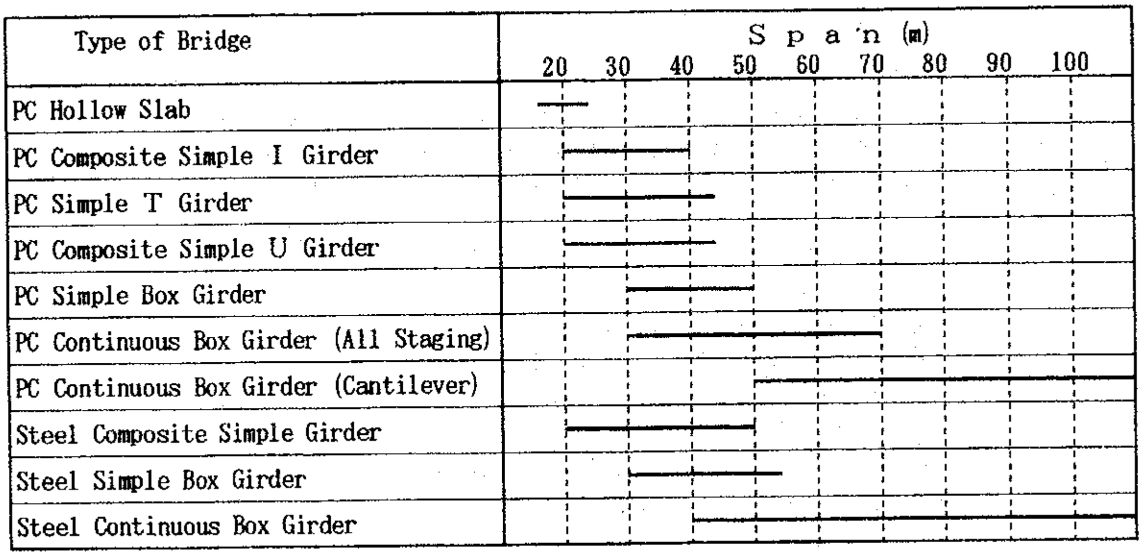


Table 10.8.2 Suitability of Bridges such as Girder Height-Span Ratio, Election Method and Sharpest Curvature

Type of Bridges	Girder Height-Span Ratio	Election Method	Sharpest Curvature			
			200m	150m	100m	50m
PC Hollow Slab	1／22	All Staging	○	○	○	○
PC Composite Simple I Girder	1／18	Truck Crane, Election Girder	○	△	×	×
PC Simple T Girder	1／18	Truck Crane, Election Girder	△	×	×	×
PC Composite Simple U Girder	1／18	Truck Crane, Election Girder	○	△	×	×
PC Simple Box Girder	1／20	All Staging	○	○	△	×
PC Simple Box Girder	1／20	Segmental Precast Election	△	×	×	×
PC Continuous Box Girder	1／18	Segmental Precast Election	△	×	×	×
PC Continuous Box Girder (All Staging)	1／18	All Staging	○	○	○	○
PC Continuous Box Girder (Cantilever)	1／18	Cantilever Election	△	×	×	×
Steel Composite Simple Girder	1／18	Truck Crane	○	△	×	×
Steel Simple Box Girder	1／22	Truck Crane	○	○	△	×
Steel Continuous Box Girder	1／23	Truck Crane	○	○	○	○

Simple Box Girder and Steel Continuous Box Girder are selected according to construction requirements stemmed from site condition.

Table 10.8.3 is summarized the justifications to select each type of bridge by section.

Table 10.8.3 Summary of Justification for Bridge Type Selection

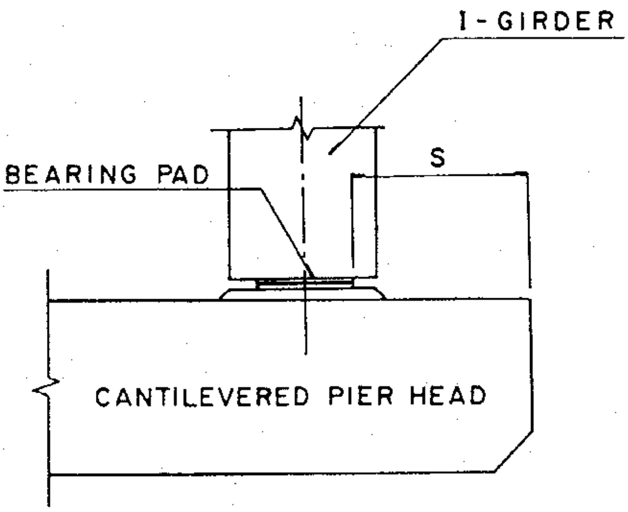
Type of Bridge	Adopted Section	Justification
PC Composite Simple I Girder	Standard section, ranging the span from 25 m to 45m	- Many actual practices - Superiority in construction economy - Sure construction method
PC Composite Simple U Girder	Kota, Senayan and Kebayoran Baru as aesthetic viewpoint	- Consistency in side view as shown in Figs. 9.8.1 and 9.8.2 - Superiority in aesthetics because of no diaphragm
Steel Composite Simple Girder Steel Simple Box Girder Steel Continuous Box Girder	Span exceeding 45 m long or steel pier	- Superiority in construction method - Advantage of lower profile compared with PC Continuous Box Girder (Cantilever) which requires 2 m construction allowance.

3) Rampway

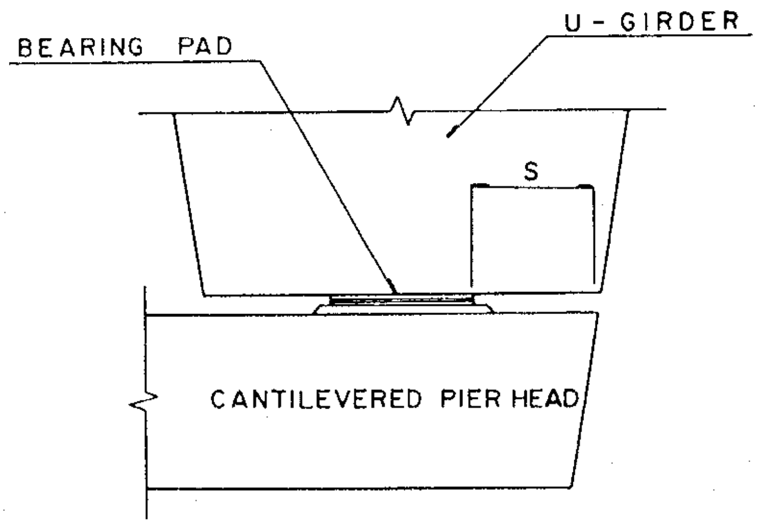
The rampway always has the salient features of longer span, ranging from 50 m to 90 m to overpass the throughway and sharper curvature to turn in small area, ranging from 200 m to 40 m. According to the applicability of bridges as shown in Figs 10.8.1 and 10.8.2, PC Continuous Box Girder (Cantilever) and Steel Continuous Box Girder are practical types.

The cost comparison in case of 70 m span between PC Continuous Box Girder (Cantilever) and Steel Continuous Box Girder reveals the fact that Steel Continuous Box Girder is 1.3 times higher than PC Continuous Box Girder (Cantilever) including the cost of substructure. However, it is concluded that PC Continuous Box Girder (Cantilever) is inferior to Steel Continuous Box Girder from the following two reasons;

(1) PC Continuous Box Girder (Cantilever) requires the construction allowance of 2 m and it lets the profile raise to turn out longer bridge section.
(2) 300 m radius is the sharpest practice in Japan in case of PC Continuous Box Girder (Cantilever)
Therefore, Steel Continuous Box Girder is adopted to the rampway of which the span exceeds 45 m and the radius becomes 200 m or

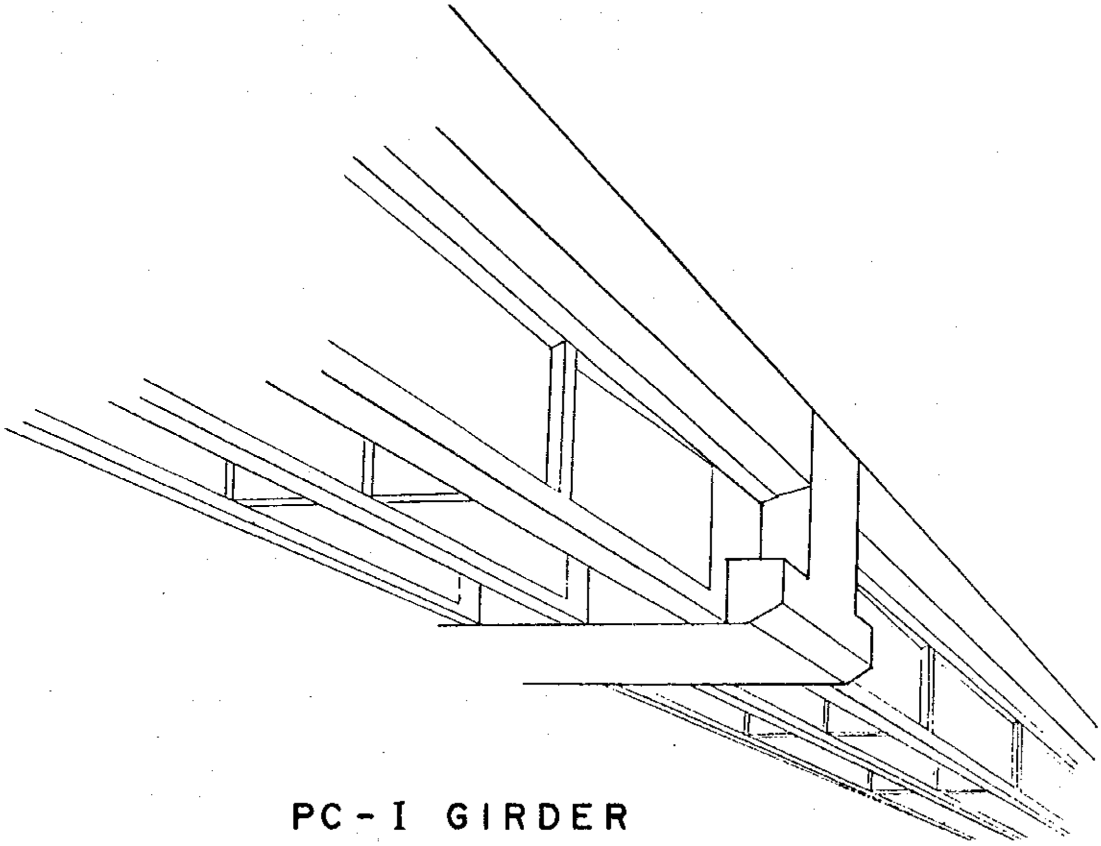


PC - I GIRDER

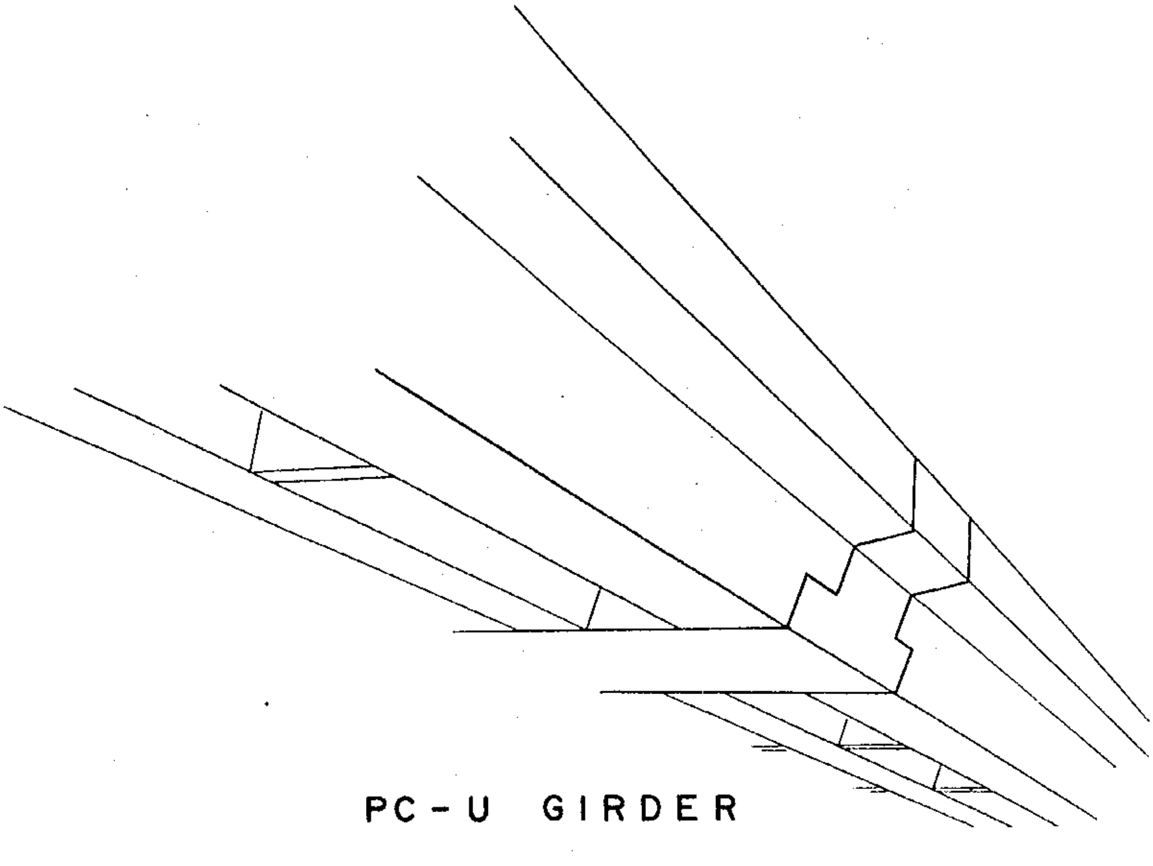


PC - U GIRDER

FEASIBILITY STUDY ON URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT IN JAKARTA METROPOLITAN AREA	**Fig. 10.8.1** **Distance of Bearing from the Edge of Substructure**



PC-I GIRDER



PC-U GIRDER

FEASIBILITY STUDY ON URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT IN JAKARTA METROPOLITAN AREA	**Fig. 10.8.2** **Perspective View PC-I Girder and PC-U Girder**

sharper. If the span is within 45 m long and the radius is bigger than 200 m, PC Composite Simple I Girder and PC Composite Simple U Girder are selected according to construction requirements stemmed from site condition.

4) Jl. Pangeran Antasari

The comparison and evaluation of bridge type selection on Jl. Pangeran Antasari is presented in Table 10.8.4.

10.8.2 Substructure

1) General

Generally piers are planned to be located at median to make full use of the space above road. T type pier has octagonal shape in desirable condition and the rectangular in marginal condition.

Pile bent piers have been constructed in the rivers in Indonesia. This type is apt to be suffered damages from scouring, and sometimes discharge area is to be reduced by entangled floating matters. Therefore, Wall type pier is recommended for the construction of pier in the river. Total thickness of wall piers should be determined less than 7% of designed discharge area to mitigate adverse effects by raised head as shown in Fig. 10.8.3.

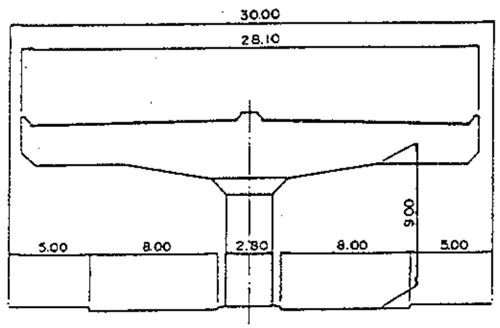
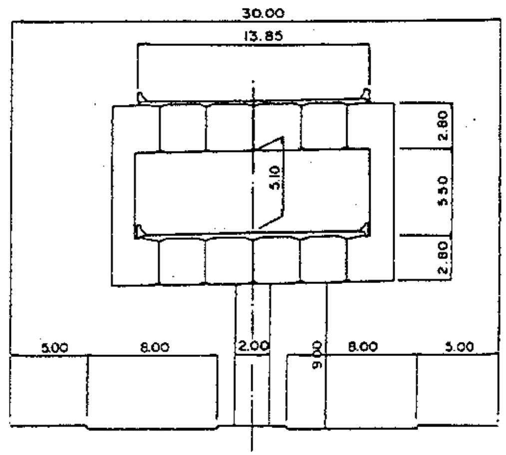
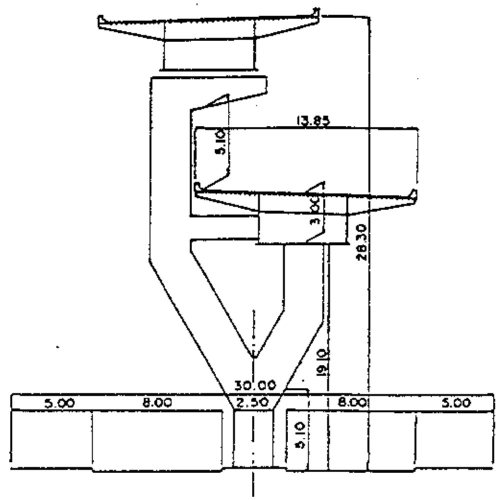
2) Mangga Besar IC

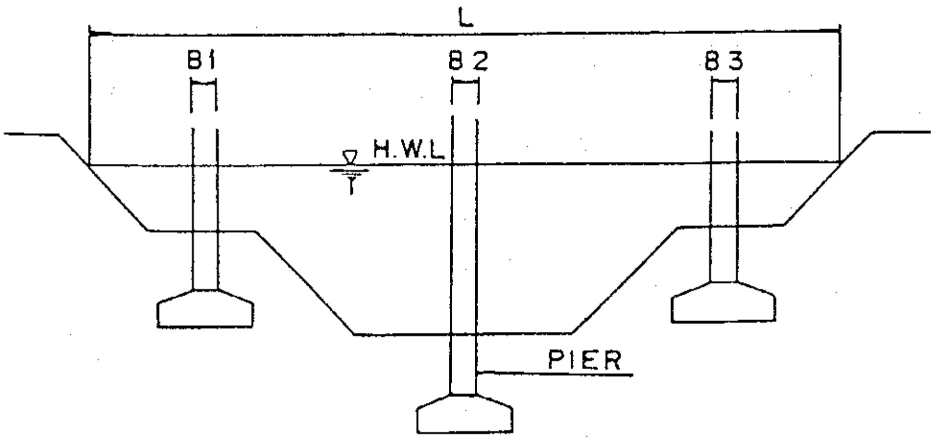
Since severe physical constraints make interval of bridge piers long and arrangement of superstructures are complicated as shown in Figs. 10.8.4 and 10.8.5, only steel fabricated piers become practical in lieu of RC or PC piers. As for superstructure, Steel composite simple girder is selected to make steel piers economical by lessening dead load.

3) Along the Kali Ciliwung

The pier location along the Kali Ciliwung is selected at the sidewalk in the eastern bank to make full use of the space above the river and road. In this stretch, the North - South Axis has double deck with racket type pier due to the severe physical constraints. The superstructure is selected PC composite simple U girder from aesthetic viewpoint. Even though it is double deck high level structure, it is still practical for substructure to be constructed by reinforced concrete as shown in Fig. 10.8.6.

Table 10.8.4 Study on Type of Structure on Jl. Pangeran Antasari

Cross Section			
Type of Structure	PC SINGLE DECK	STEEL DOUBLE DECK —RACKET	STEEL DOUBLE DECK —Y·
Salient Features	1) 28 m wide superstructure will cover the space above frontage road in 30 m wide ROW in the whole stretch as putting on the lid. 2) It is pointed out that it is probable to bring about adverse environmental effects by confined exhaust gas under viaduct. 3) It is inevitable to disturb traffic for a long time because of longer construction period and wider staging space. 4) It will require additional land bigger than that of other alternatives. 5) This alternative has advantage in the aspect of construction cost.	1) 14 m wide superstructure which will occupy only half of ROW may not prevent diffusion of exhaust gas from the space beneath viaduct. 2) Since all structures except foundation will be fabricated in a factory, it is possible to minimize traffic disturbance during construction. 3) This alternative enables to offer additional land at On/Off ramps as small as possible. 4) Dirct construction cost is rather expensive compared with that of PC Single deck but it is possible to reduce construction period significantly.	1) This alternative can offer better structure at aesthetic viewpoint so as to made higher elevation as well as longer span. 2) It is possible to avert adverse environmental impact as well as Steel Double Deck-racket. 3) Since all structures except foundation will be fabricated in a factory, it is possible to minimize traffic disturbance during construction. 4) It is the most expensive structure among alternatives.
Evaluation	It is inferior to other alternatives in the aspects of traffic management during construction and environmental impact although it is superior in construction cost.	It will be the most preferable if the financial viability of the project is confirmed.	It is sure that this alternative has disadvantage in the aspect of construction cost.



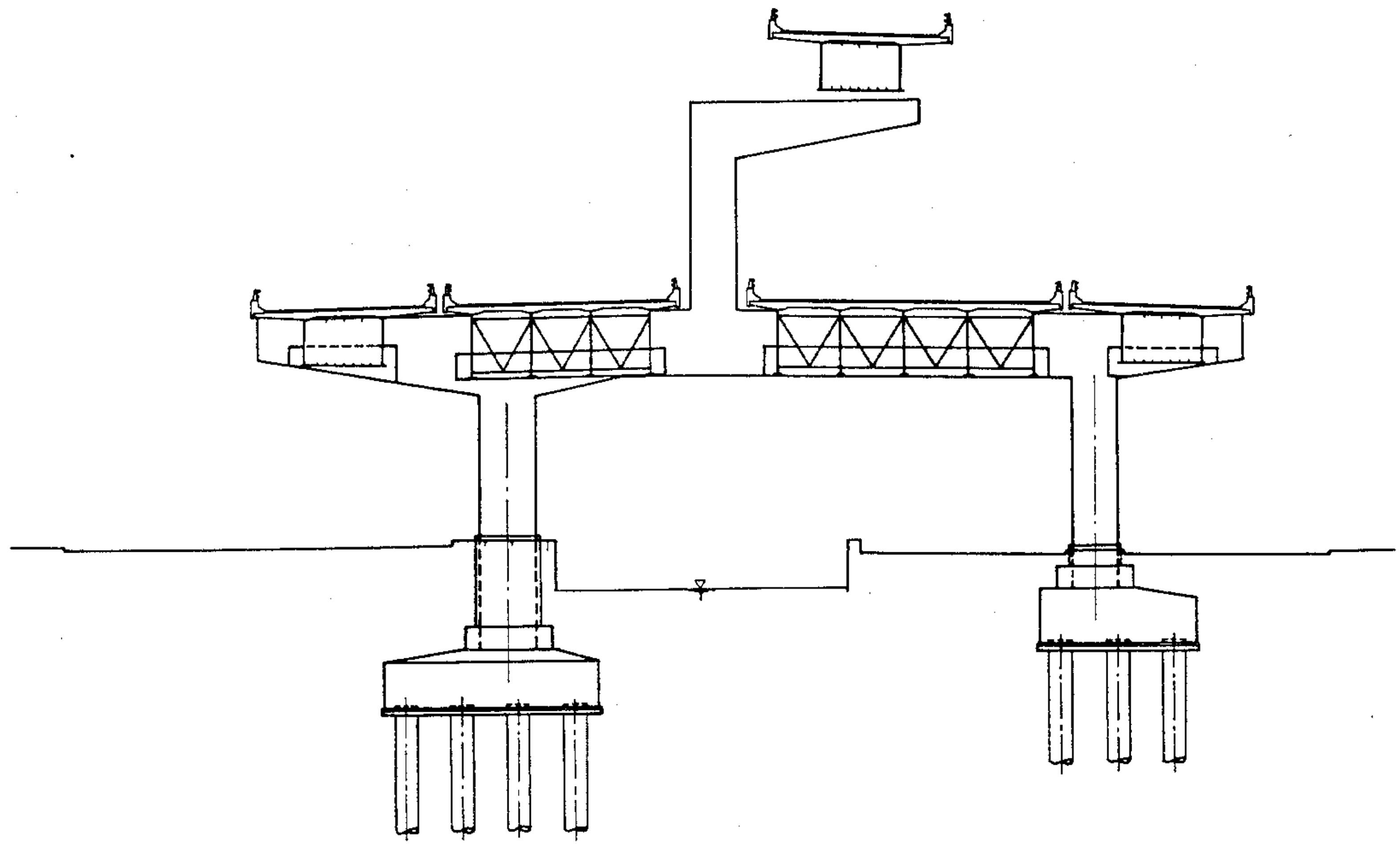
$$N = \frac{\Sigma Bi}{L \cdot 100} \leqq 7.0\,\%$$

N : Obstruction Ratio of flow Area

L : Design High Water Level Width

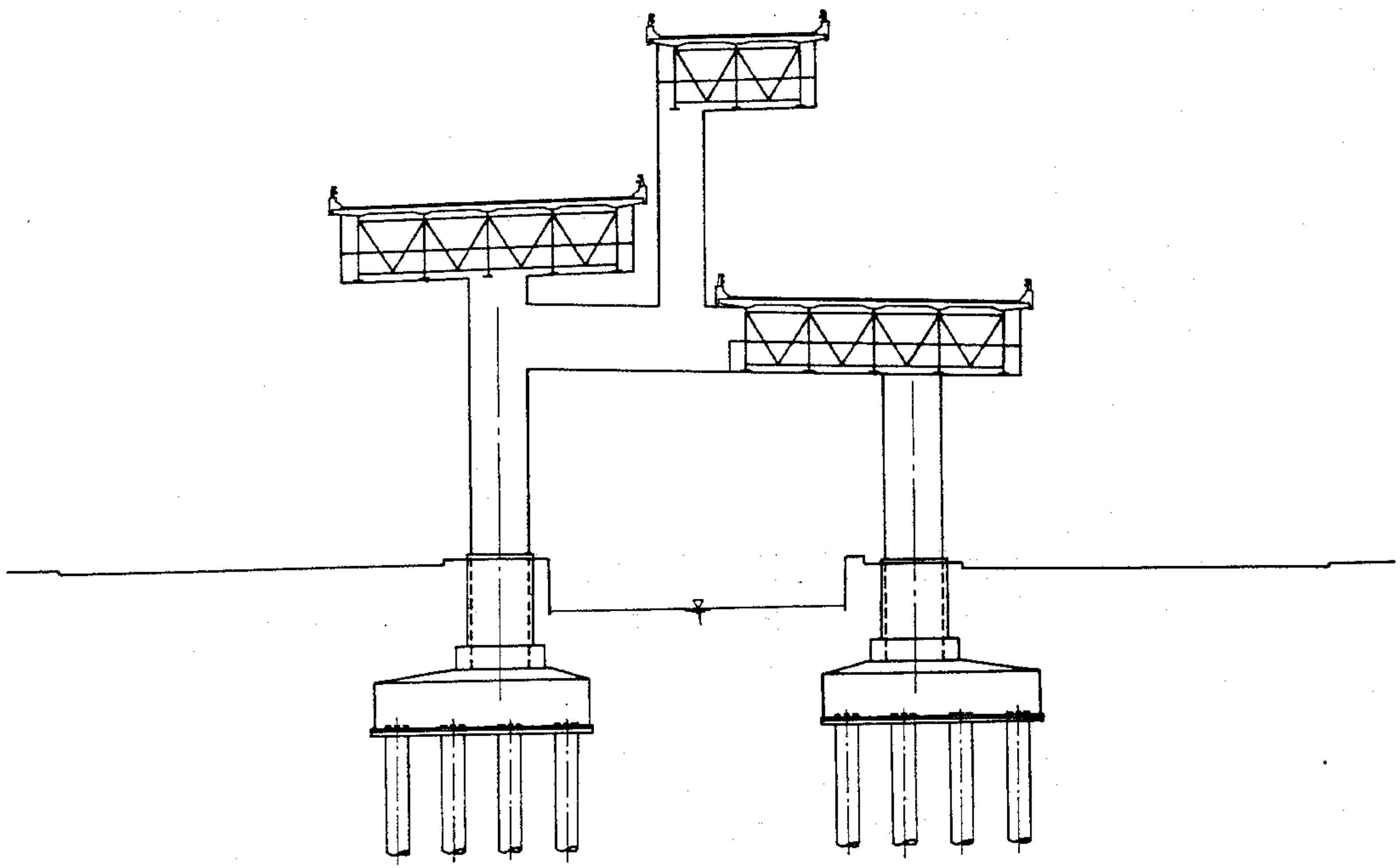
Bi : Pier Thickmess

Fig. 10.8.3 Loss of Discharge Area



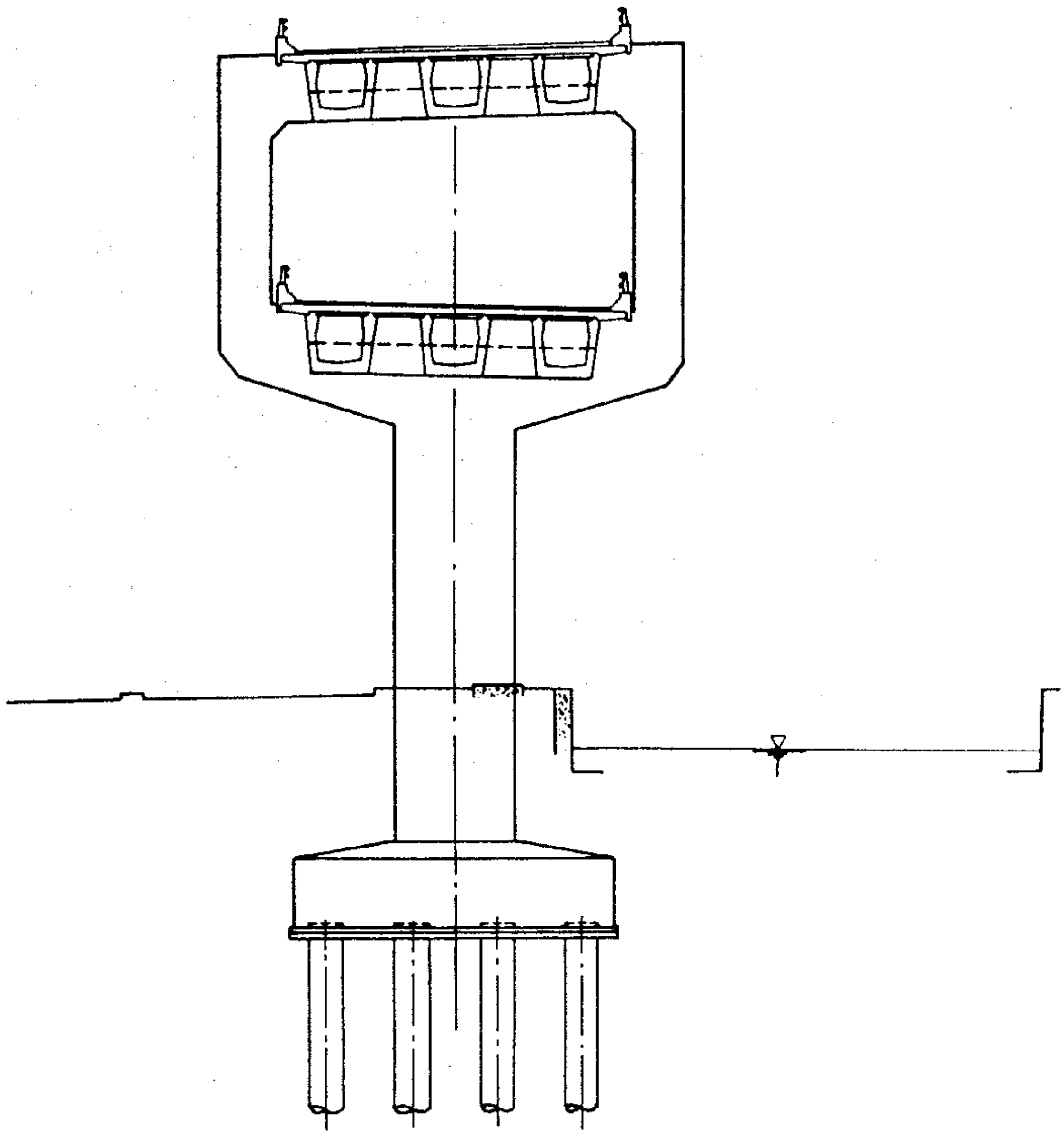
FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.8.4 Pier (1) on The Mangga Besar IC



FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.8.5 Pier (2) on The Mangga Besar IC



FEASIBILITY STUDY ON URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT IN JAKARTA METROPOLITAN AREA	**Fig. 10.8.6 Pier (3) on The Kali Ciliwung**

10.8.3 Type of Foundation

The selection of foundation type is to be made considering depth of foundation, construction condition, factor relating surroundings, soile condition, and characteristic of construction. The general relationship between foundation type and depth of foundation is shown in Table 10.8.5.

Since practical construction methods of pile foundation are selected among driving pile, pile installation by inner excavation and cast-in-place concrete pile with reversed circulation drilling or benote excavator, a driving method is the cheapest among alternatives and has advantages of bearing capacity and high steady, while it is disadvantage of public nuisance such as noise, vibration and emission.

The conventional type of diesel pile hammer has the noise level of 90 dB(A) at 30 m apart from hammer and it is beyond the allowable noise level of 75dB(A) in Tokyo.

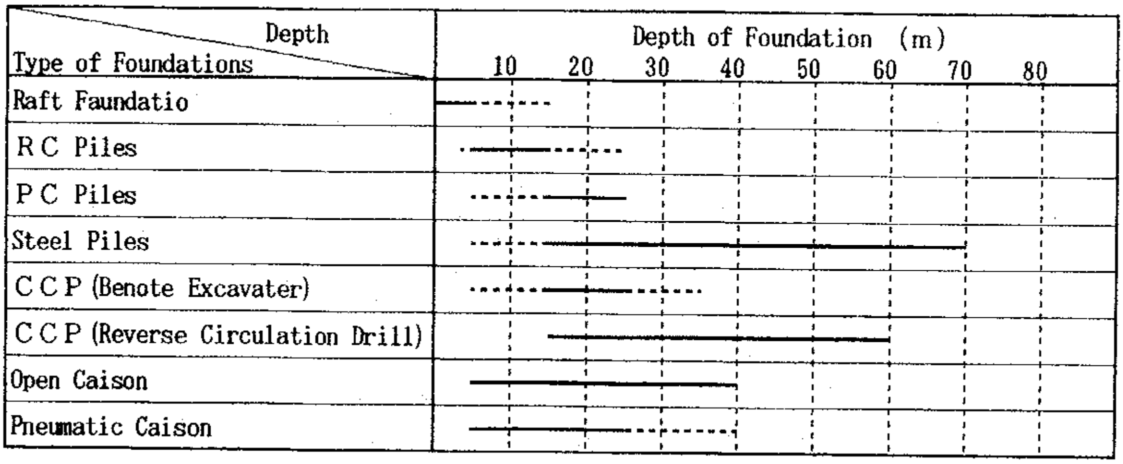
However, noise-proof diesel pile hammer can mitigate the noise level until 70-73dB(A). Therefore, Driving PC Piles was adopted for in comparatively few inhabited area of eastern part, southern part and western part.

Bore PC Piles was adopted for in densely private houses or buildings area (Jl. Hayam Wuruk, Kebayoran Baru, Senayan).
Benote Piles was adopted for in near Mangga Besar I.C. where the depth of the bearing stratum is about 40 m.

Foundation type and depth of foundation are shown in Table 10.8.7.

The summary of structures is given in Table 10A-1 in Appendix.

Table 10.8.5 Application of Foundation by Depth



Notes —— Many actual practices
---- Actual practices

The result of analysis of each piles which driving pile, PC pile installation by inner excavation (hereinafter called "Bore PC pile"), and cast-in-place concrete pile (Benote Pile) is given in Table 10.8.6.

Table 10.8.6 Analysis of Each Piles

Items		Unit	Driving PC Pile	Bore PC Pile	Benote Pile	Bore PC Pile	Benote Pile
Pile Length		m	15.0			35.0	
Pile Diameter		m	0.60	0.60	1.00	0.60	1.00
Cofficient Subgrade Reaction K	Normal	t/m²	1180	1180	830	1180	830
	Earthquake	t/m²	2360	2360	1660	2360	1660
Spring Constant Axial Direction Kv		t/m	36000	24400	41200	16500	52500
Pile End Section Ultimate Bearing Capacity qdA		t/Pile	263.9	212.1	235.6	212.1	235.6
Circumferential Skin Friction UΣlif		t/Pile	105.6	52.8	295.3	128.2	923.6
Allowable Bearing Capacity	Normal	t/Pile	123.2	88.3	165.7	113.4	362.0
	Earthquake	t/Pile	184.7	132.4	252.6	170.1	551.0
Allowable Pull out Capacity	Normal	t/Pile	17.6	8.8	66.9	21.4	195.2
	Earthquake	t/Pile	35.2	17.6	116.1	42.7	349.1

Table 10.8.7 List of Foundation and Pile Length

	Station	Type of Foundation	Pile Length (m)	Borig No.
N-S Axis	SAT. 1+120～STA. 1+990	Benoto Piles	35	NS-1
	SAT. 1+990～STA. 4+670	Bore PC piles	13	NS-2, 3
	SAT. 4+670～STA. 5+560	Bore PC piles	21	NS-4
	SAT. 5+560～STA. 7+120	Driving PC piles	21	NS-5
	SAT. 7+120～STA. 9+480	Driving PC piles	10	NS-6
	SAT. 9+480～STA. 11+440	Bore PC piles	7	NS-7
	SAT. 11+440～STA. 14+120	Bore PC piles	12	NS-8
	SAT. 14+120～STA. 17+470	Driving PC piles	15	NS-9
	SAT. 17+470～STA. 18+400	Driving PC piles	6	NS-10
E-W Axis	SAT. 1+000～STA. 2+500	Driving PC piles	5～7	EW-1
	SAT. 2+500～STA. 4+000	Driving PC piles	15	EW-2
	SAT. 4+000～STA. 6+000	Driving PC piles	20～2	EW-3
	SAT. 6+000～STA. 7+500	Driving PC piles	10	EW-4
	SAT. 7+500～STA. 10+400	Driving PC piles	13	EW-5
	SAT. 10+400～STA. 11+800	Bore PC piles	14	EW-5
	SAT. 11+800～STA. 12+750	Benoto Piles	35	NS-1
	SAT. 12+750～STA. 14+700	Bore PC piles	14	EW-6
	SAT. 14+700～STA. 16+000	Bore PC piles	8	EW-7
	SAT. 16+500～STA. 18+450	Driving PC piles	7	EW-8
	SAT. 18+450～STA. 20+630	Driving PC piles	11	EW-9
	SAT. 20+630～STA. 22+690	Driving PC piles	9	EW-10
	SAT. 20+630～STA. 22+690	Driving PC piles	10	EW-11
	SAT. 20+630～STA. 22+690	Driving PC piles	9～6	EW-12, 13
	SAT. 20+630～STA. 22+690	Driving PC piles	4	EW-14
	SAT. 20+630～STA. 22+690	Raft Foundation		EW-15

10.8.4 Approach Area of Abutment

The height of from the ground to the top of abutment is 4 m in the soft ground area except West JORR I.C, East JORR I.C and near Buaran I.C of East-West Axis.

Extended Structure is recommended for the earth work range from abutment on embankment height 2 m, and Piled Slub is recommended for the range of embankment height 2 m.

Extended Structure and Piled Slub was adopted in "Northern Extension of the South West Arc". Extended Structure is elected the precast RC beam length 10 m and its slab is constructed in-place and Pile Slub is directly support slab by pile at intervals of 5 m. Extended Structure and Piled Slab are shown in Fig. 10.8.7 and Fig. 10.8.8.

10.8.5 U-Turn Flyover

U-Turn Flyover designed by the truck which width of 2.5 m, length of 12.0 m and turning outer radius of 15.0 m.
U-Turn Flyover is shown in Fig. 10.8.9 and Fig. 10.8.10.

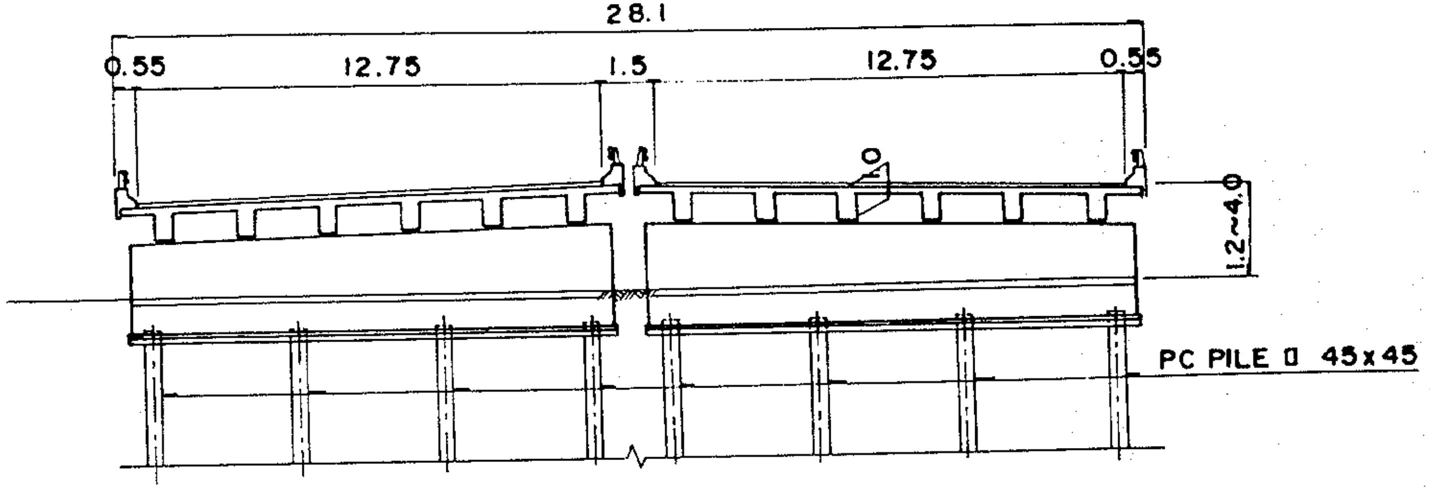
10.8.6 Special Consideration of Headroom

Considering bridge aesthetics and amenity to avoid oppressive view, minimum headroom from surface to bottom of viaduct girder is kept 9 m high which may be justified by the following breakdown at crossing pedestrian overpass :

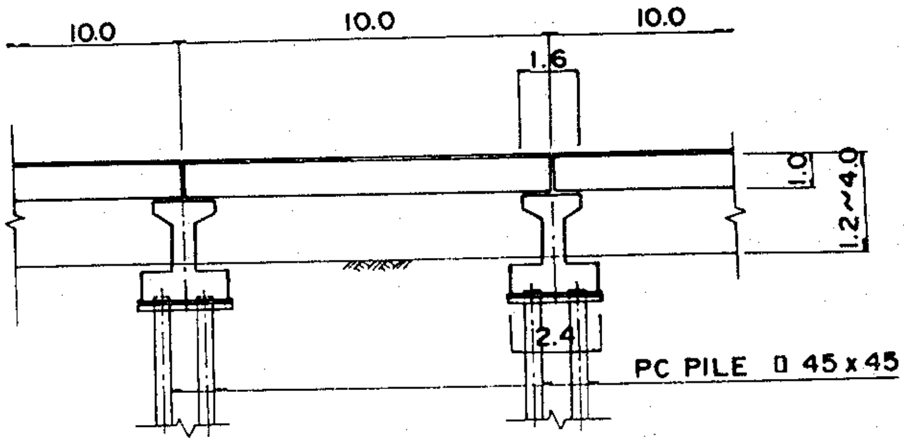
Vehicular headroom	:	5.1 m
Girder height of pedestrian bridge	:	1.4 m
Pedestrian headroom	:	2.5 m
Total	:	9.0 m

10.8.7 Minimum Lateral Distance from Pier

Minimum lateral distance between pier and horizontal vehicular clearance limit is 0.5 m in case of installation of vehicular guardrail, while absolute minimum distance of 0.25 m is adopted because design of pier structure has already incorporated crush load of 100 ton in longitudinal direction and 50 ton in transverse direction to secure safety factor of 1.5.



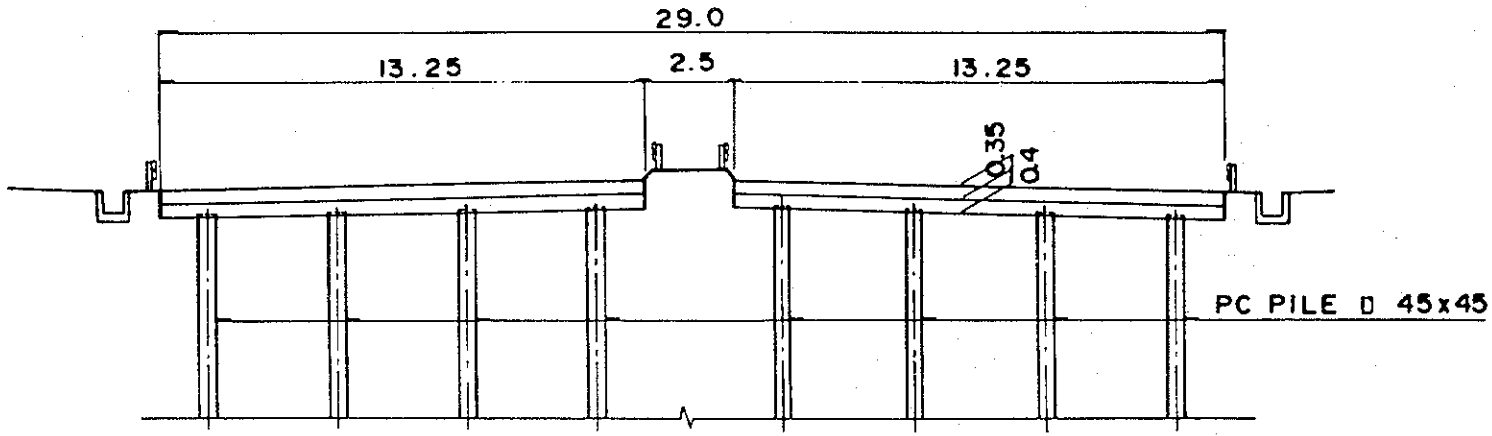
SECTION S=1:200



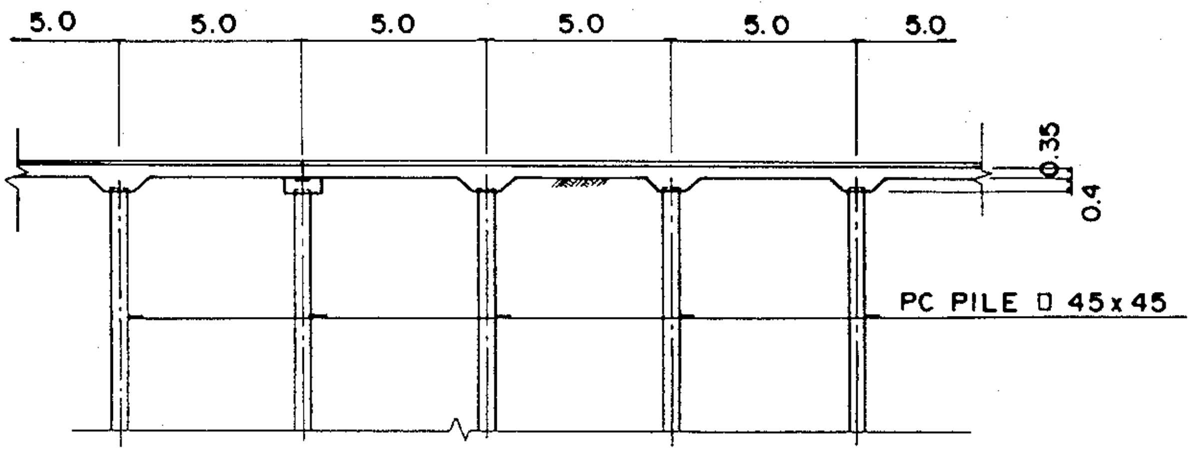
ELEVATION S=1:200

FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.8.7 Extended Structure



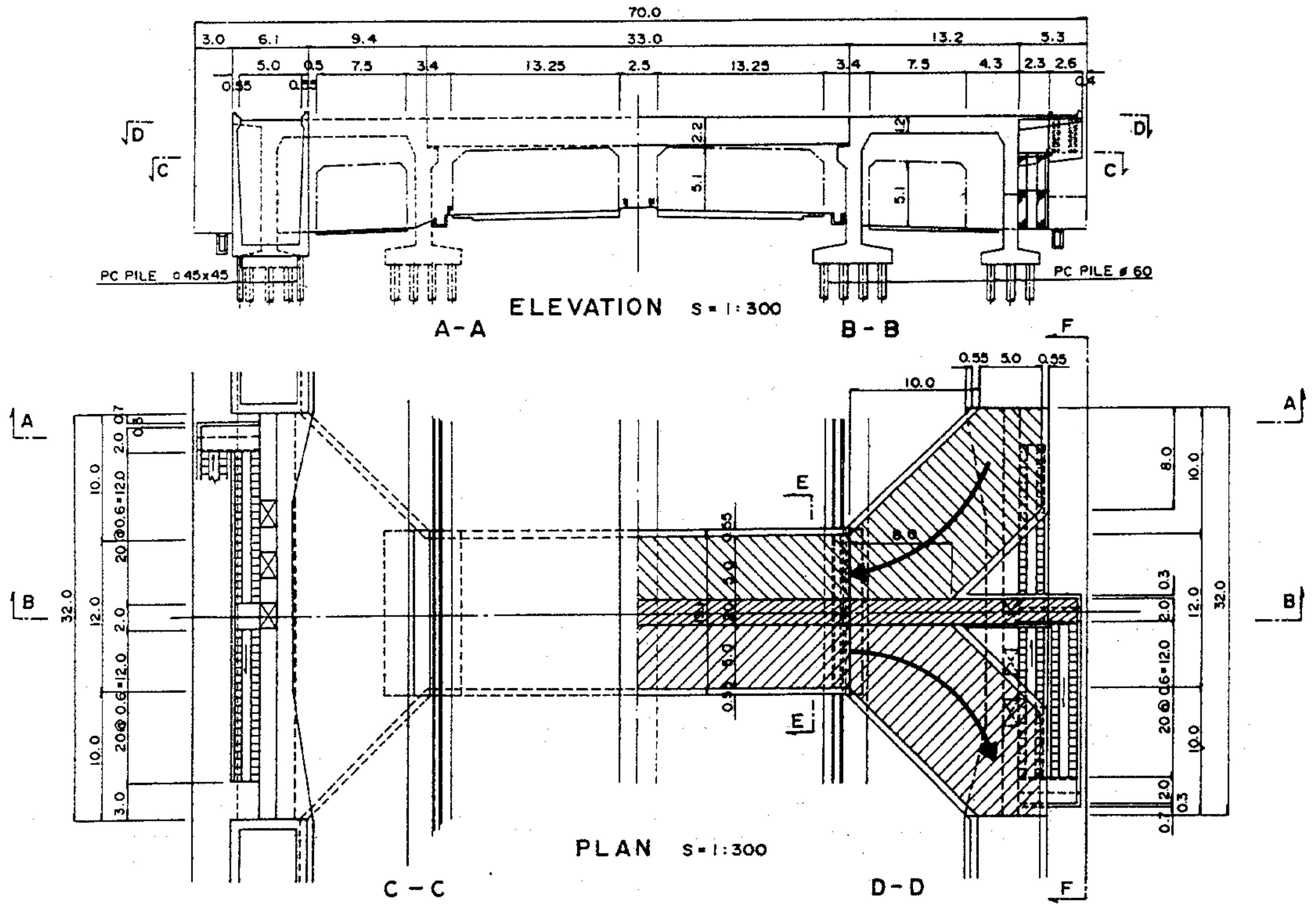
SECTION S = 1 : 200



ELEVATION S = 1 : 200

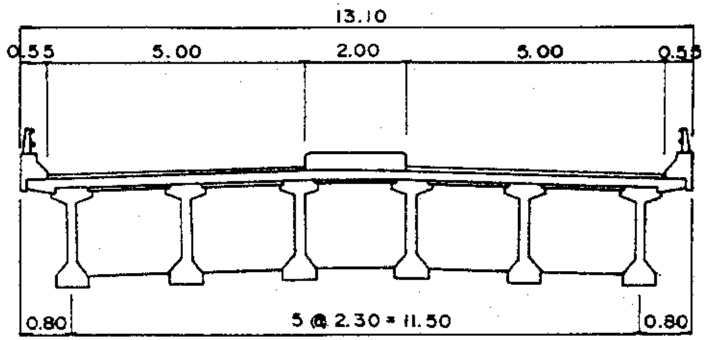
FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.8.8 Piled Slub

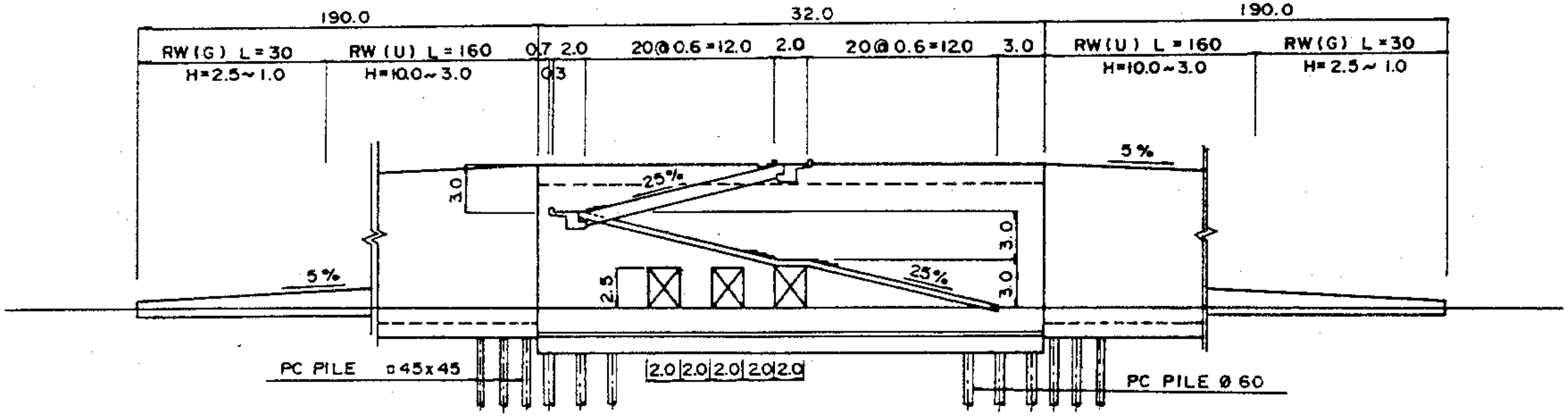


FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.8.9 U-Turn Flyover (1)



SECTION E-E S=1:100



SECTION F-F S=1:100

FEASIBILITY STUDY ON URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT IN JAKARTA METROPOLITAN AREA	**Fig. 10.8.10 U-Turn Flyover (2)**

10.9 Preliminary Design of Road Supporting Facilities

Arterial streets have a traffic function as well as serving as public space. The plans of pedestrian crossing facilities, bus stops, lighting and Traffic Signal are presented for the purpose of guiding the following detailed design.

10.9.1 Pedestrian Crossing Facilities

There are two types of facility planned in the project roads. These are, at-grade crossings painted on the pavement surface and elevated pedestrians bridges. No underpass by box culvert is planned mainly because of security and drainage problems.

The exact form of at-grade crossings will be decided at the detailed design stage after survey of pedestrian-vehicular conflict, but it is expected that three forms of crossing will be provided :

- No facility except road painting is provided and pedestrians must cross the arterial street by using gaps in the traffic flow;

- Vehicular traffic signals are provided but not phase allowance is made for pedestrians. They can cross the arterial streets when traffic is stopped;and

- At areas of high pedestrian-vehicular conflict pedestrians will be provided with either their own traffic crossing or else they will be given a separate phase in the main vehicular signals.

Pedestrian over bridges of the type shown in Fig. 10.9.1 will be provided in accordance with the above policy in order to supplement the at-grade crossings.

As the exact location of pedestrian crossing facilities can significantly affect the convenience of residents in the corridor it is recommended that final locations are decided only after discussions with the relevant authorities.

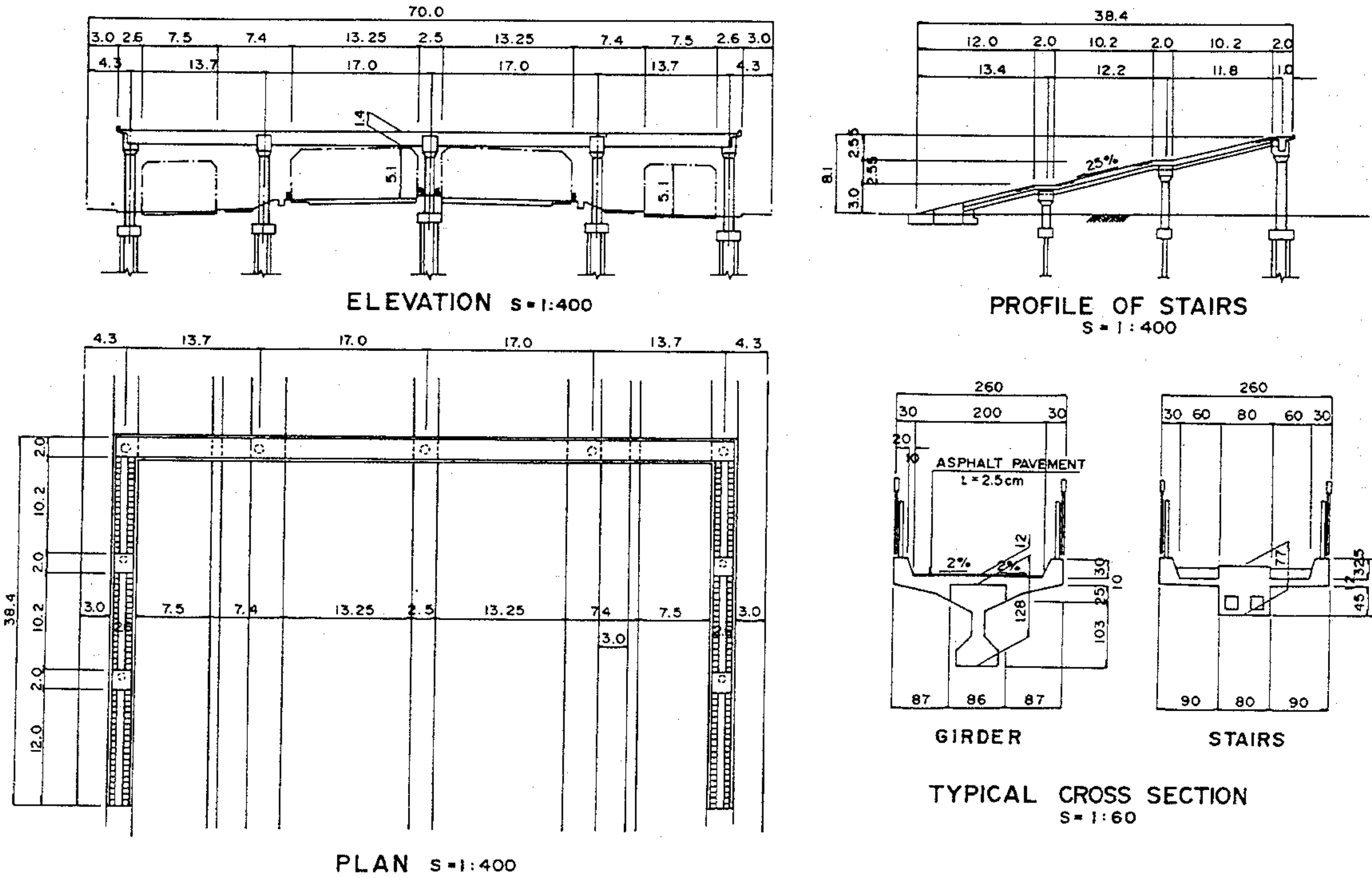
The criteria for selection of the location of the pedestrian over bridges are as follows :

i) Existing demand arising from the social facilities such as schools, markets, official buildings, hospitals and existing at-grade crossing maked by paint, etc.

ii) Interval of the facilities along the corridor,

iii) Width of the side strip to allow the setting of columns, and

iv) Locations not close to minor accesses which would prevent the provision of stair cases.

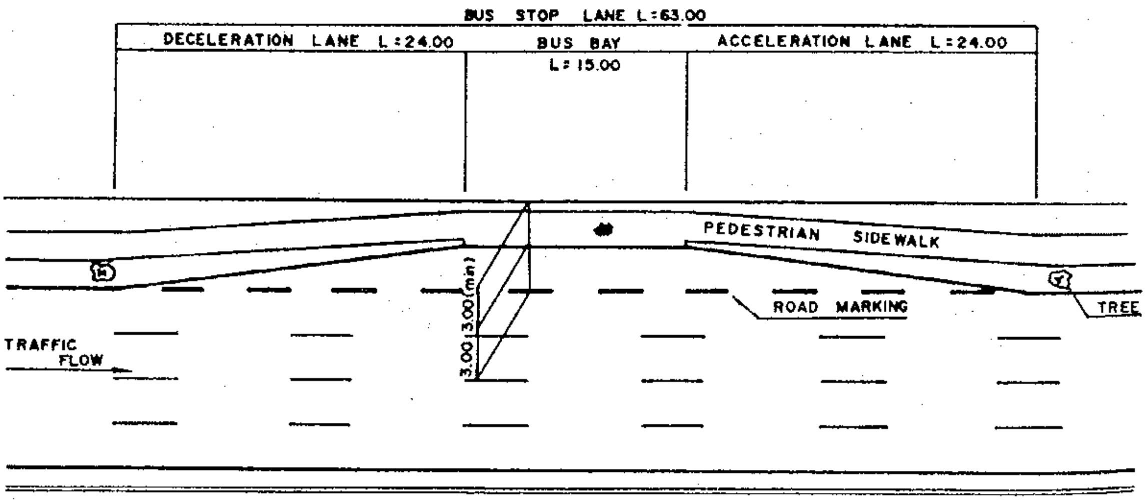


FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig.10.9.1 General View of Pedestrian Bridge

10.9.2 Bus Stops

There are many bus routes on existing roads on the project roads at present but no provision of exclusive space for buses to stop. Traffic flow is therefore sometimes disturbed on the road by buses stopping. To prevent this situation bus stops should be designed to have a stopping bay with tapers at both ends.



A stopping space 15.0 m long with 3 m width is sufficient for one large bus to stop and 24 m length of taper provides minimum disturbance to other vehicles in the through lanes.

Final locations of bus stops shall also be decided after discussions with the relevant authorities and in accordance with the following criteria :

i) Places close to pedestrian crossing facilities, U-turn facilities bridges and at-grade crossings planed in the study, while respecting the existing locations of bus stops as much as possible. This is because bus users usually return to the same place, but on the opposite side of the corridor,

ii) Places where with the provision of a bus-bay there remains enough side strip space within the given ROW, and

iii) To avoid as much as possible places where the stopping and starting movement of buses is likely to be interfered with by vehicles from minor accesses.

A shelter is provided at each bus stop of the type similar to the existing ones used in the CBD of Jakarta.

10.9.3 Lighting

Lighting may improve safety of a highway or street and the ease and comfort of operation thereon. Statistics indicate that nighttime accident rate is higher than that during daytime hours, which may be attributed to impaired visibility to a large degree. There is evidence that in urban area and suburban area, where there are concentration of pedestrians and roadside intersectional interferences, fixed source lighting tends to reduce accidents.

The design standard for road lighting and its application will be described as follows,based on the standard practiced by Ministry of Construction (Japan).

(1) Design Standard of Road Lighting

(a) Location of Lighting Installation

The locations of the installation of lighting facilities are as follows:

- Tollway, arterial and frontage road
- On/off-ramp including toll plaza and
- Underpass

(b) Design Illumination Intensities

The average intensity of illumination are as follows :

- 15 lux for the tollway, arterial and frontage road
- Minimum 20 lux for the toll plaza and
- 15 lux for underpass

(c) Selection of Luminaries

The types adopted are as follows :

Location	Luminaries
Tollway, arterial and frontage road	Semi cut-off type
Toll plaza	Flood light or semi cut-off type
Street	Box type

(2) Selection of Lighting Equipment

(a) Light Source

(i) Tollway, arterial and frontage road
Low pressure sodium lamps are proposed as the light source for both the Toll Road and arterial street for the following reasons :

- The area is rather hazardous since drivers are required to manoeuvre vehicles (i.e. change of lane, deceleration for the stop at the booth acceleration, etc.)

- Easier identification of the vehicle classes by toll collectors and staff and

- Easier identification of paper money.

(5) Toll Building Lighting

The toll building will be provided with fluorescent lighting with illumination levels similar to existing toll buildings.

(7) Lighting Facilities for Traffic Signs

The signboards are planned to be lighted based on road user visibility requirements.

Light sources recommended for the signboards are fluorescent lamps.

The lighting fixtures for the signboards will be fixed on a mounting pole or gantry frame.

10.9.4 Traffic Signals

1) General

Traffic signals shall be installed at the at-grade intersections for traffic control, safety of drivers and the smooth handling of traffic flow.

Design elements to be considered are as follows :

- Signal Installation;
- Signal Equipment; and
- Signal Control System

The sequence of total signal setting is assumed to be carried out by DKI Jakarta.

2) Signal Equipment

The selection of the equipment is in conformity with DKI Jakarta's standards.

i) Upper signal for vehicles (Type-A)

The lenses of signal are standard red, amber and green colored, and the heads are installed on standard poles or overhanging tapered poles. Overhanging poles are 6 m high with arm.

ii) Lower signal for vehicles (Type-B)

The lenses for the lower signal are the same as for the upper signal, but the lower signal is installed at 3.5 m height on the 6 m high pole of an upper signal.

iii) Lower signal for vehicle (Type-C)

The signal head is installed at the top of a 3.5 m high pole and includes additional signals with red arrow and green arrow.

iv) Signal for pedestrian (Type-D)

This is a signal head covered with the symbol of a person, standard red and green colored. The signal head is installed at the top of a 3.5 m high pole.

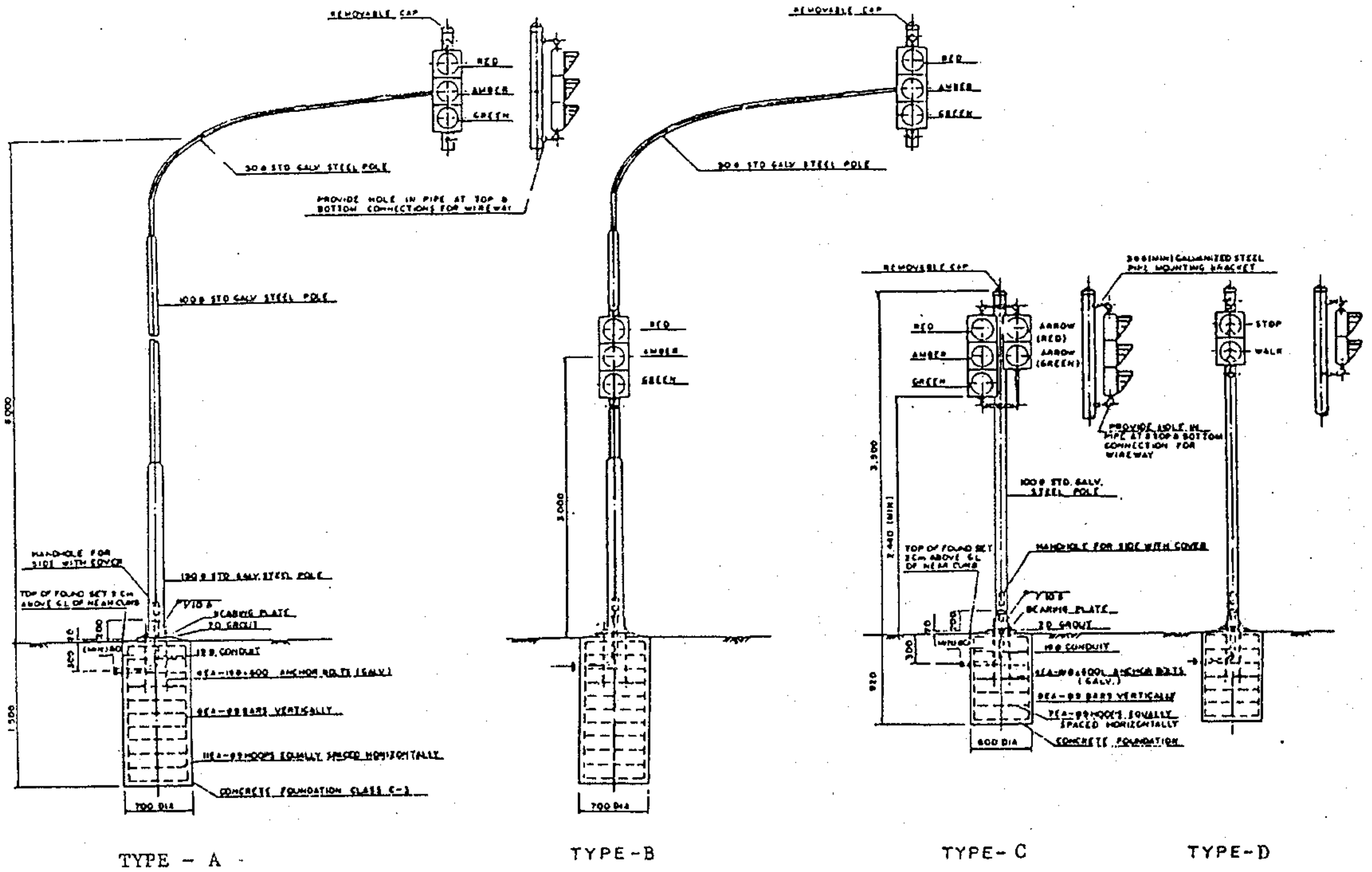
Type of signals are shown in Fig. 10.9.2.

3) Recommendation for Traffic Signal Installation

The recommended places for traffic signal installation are listed in Table 10.9.2.

Table 10.9.2 Location of Signal Installation

Traffic Signal	General Place of Installation
Overhanging tapered pole with signal for vehicles (Type-A)	On the left side of traffic on the arterial street, or frontage road, at the pedestrian crossing.
Signal post for vehicles (Type-B)	a) On the arterial street, or frontage road, on each side of the pedestrian crossing. b) On a roadway entering the arterial street, on the left side of the pedestrian crossing.
Signal post for vehicles (Type-C)	On the side strip of the arterial street or frontage road.
Pedestrian signal (Type-D)	On each side of a pedestrian crossing.



FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.9.2 Types of Traffic Signal

10.10 Preliminary Design of Toll Road Supporting Facilities

10.10.1 Toll Collection Facilities

1) General

For the preliminary design of the toll collection facilities a study of the necessary construction and equipment required for the facilities has been made.

2) Scope of Toll Gate Works

Each toll gate includes the following work items:

- Toll gate structure including pillars and roof;
- Refuge islands;
- Toll booths; and
- Equipment installation in booths.

3) Design Features of Toll Gate

i) Roof Structure

A roof structure to cover the toll booths and collection area is needed for protection from weather. The roof and the supporting pillars for the roof structure will be made of concrete.

The slope of the roof is approximately one percent, and for drainage purposes unplastricized polyvinyl chloride pipe is proposed.

ii) Refuge Island

The refuge island is needed to provide a foundation for the toll booth and protection from approaching vehicles. A manhole and conduit pipes are installed in each refuge island to carry the wiring for the various electrical facilities. The manhole of the refuge islands will be interconnected.

iii) Facilities at the Toll Gate

The following facilities will be provided at the toll gate :

- Signal system for traffic lane control in the toll gate area;
- Toll collection equipment such as vehicle classification equipment, receipt printer, and vehicle detector, all provided in the toll booth;
- Interphone system;
- Surveillance CCTV for the booths and a monitoring device;
- Fresh air supply for booths; and
- Lighting in the toll booths and other covered areas.

4) Toll Collection System

The following is an outline of a suitable comprehensive toll collection system to cover the North-South Axis.

i) The Basic Concept in the Existing Facilities

The basic function at each toll gate is defined as follows :

- To collect the tariff with a flat rate system; and
- To count and record the number of vehicles by classification.

The toll plaza equipment is shown on Fig. 10.10.1.
The vehicle classification are as follows :

Class I	: Sedan
Class II	: Truck & Bus

Detailed information at each toll gate will be directly transferred to the operation centre for the processing of the data.

ii) Recommendations

For the assumed private investor participation in the North-South Axis Toll Road, the organization for operation and maintenance should be self-sufficient and separate from that of Jasa Marga and the other Jakarta Toll Roads. Toll collection and maintenance will generally be carried out independently of Jasa Marga while traffic control functions will be integrated with Jasa Marga.

However, taking into consideration transferring the tollway facilities to Jasa Marga after the expiration of the concession, the scope and design feature of toll collection system for the North-south shall be considered with Jakarta Outer Ring Road and other intra urban tollways.

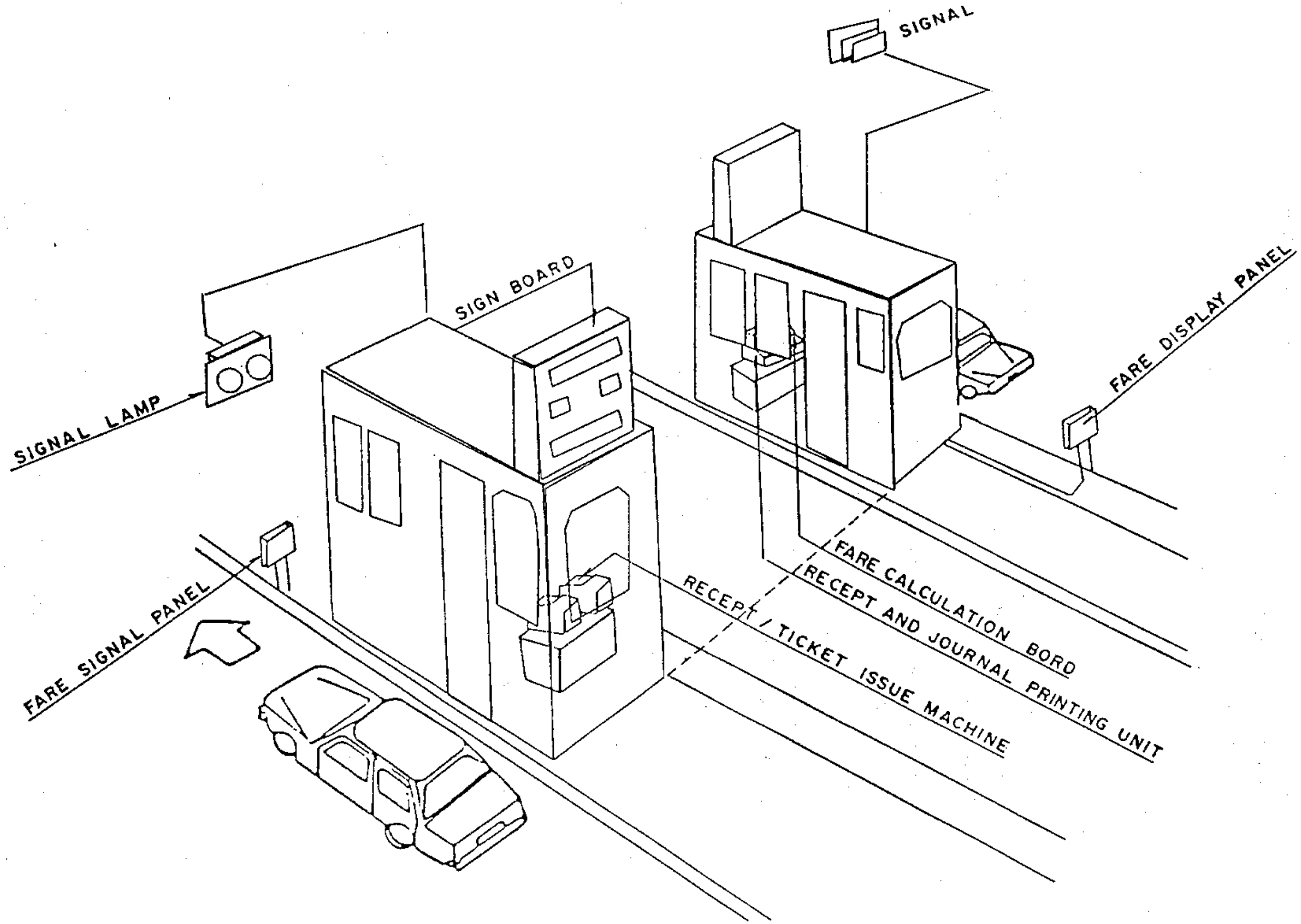
The main points of recommendation are as

- automation of data processing procedure;
- built-up of comprehensive toll collection system; and
- centralization of accounts management

These functions are scheduled to be carried out at the operation centre. The function of each toll gate and operation centre is as follows:

<u>Function of toll gate</u>

- Toll collection and issue of voucher;
- Registration and calculation of the tolls;
- Vehicle counting by loop detector; and
- Registration of the number and type of vehicles.



FEASIBILITY STUDY ON
URBAN ARTERIAL ROAD SYSTEM DEVELOPMENT PROJECT
IN JAKARTA METROPOLITAN AREA

Fig. 10.10.1 Proposed Toll Plaza Equipment

Function of operation centre

- Totalize and check the toll account collected at each unit daily;
- Totalize the number and type of vehicle registered at each unit;
- Check misregistration and discrepancies;
- Real time audit; and
- Prepare a daily journal.

10.10.2 Traffic Control system

1) General

When a traffic delay occurs on a tollway the result is more serious than in the case of the street, since the tollway system is not able to cater readily for a detour or route change for vehicles which are already on the tollway.

Under these conditions, where smooth traffic flow is interrupted, it is difficult to maintain the functions of the tollway of high speed, high efficiency and greater user's benefit.

Thus, it is essential to provide a traffic control system which will ensure proper traffic conditions at all times including :

- Prevention of user's extra traveling time or distance;
- Maintenance of safety, comfort and convenience; and
- Prevention of deterioration of the traffic capacity of the road network as a whole.

2) Basic Concept

The outline of the basic policy is described as follows:

- Establishment of an operation centre;
- Monitoring the traffic condition at specified points by CCTV system;
- Measuring traffic volume at toll gates, interchanges, and on throughways;
- Timely conveyance of information by variable sign boards; and
- Centralization of the traffic control system combined with other relevant systems.

3) Aspects of the System

An effective traffic control system is required for the tollway network to realize the above mentioned requirements.

The system should be expanded progressively after its establishment in order to cope with changing conditions such as expansion of service areas, increase of load handling capacity and upgrading of service level.

In broad terms, the establishment of a traffic control system normally involves organization, tollway patrol systems, traffic surveillance, enforcement of traffic regulations and the provision of various traffic control system devices, equipment and supporting facilities.

The first step in the provision of a traffic control system is to provide the detecting system for the traffic surveillance, and then to establish the optimum system in order to cope with the various situations.

However this study mainly deals with the basic system which should be implemented into the framework of the North-South Axis.

4) Recommendations

i) CCTV System

CCTVs are installed for the purpose of rapid detection of changes in traffic situation. The information is transmitted to the monitoring TV sets in the operation center so that critical spots can be viewed on TV screens by selecting them from the TV operating desk. The recommended locations of the CCTVs are before and after ramp terminals on throughway.

The supporting system for traffic control should be expanded accordingly.

ii) Traffic Detecting System

Presently loop coil type traffic detectors are installed at each toll booth

The traffic volume is detected and the data are transmitted to the operation center to totalize the traffic volumes.

The existing traffic detecting system is utilized mainly for checking the collected toll fares. However, as the traffic volume on the tollway increases other functions would be required of the system. Such functions would include :

- Analysis of traffic flows on the tollway;
- Forecast of the possible traffic congestion (i.e. location and congestion level); and
- Control of traffic signals and variable type information indicators (i.e. matrix signs).

It is recommended that loop or ultrasonic type traffic detectors are provided on through traffic lanes in addition to the detectors to be provided at each on-ramp. The proposed locations of the detectors are in between ramp terminals on throughways. The traffic flow towards areas of congestion should be controlled by matrix signs before on-ramps thus encouraging drivers to voluntarily avoid congested points when necessary.

iii) Selection of Installation Points

The installation points for CCTV cameras and traffic detectors are determined based on the traffic forecast for the tollways. The recommended layout is as follows :

- CCTV cameras are planned to be installed at the centre of the median strip for good visibility of on and off ramps; and
- Traffic detectors are planned for each through lane of the tollway in order to detect traffic volume in one direction at each section.

iv) Summary of the Recommended Functions of the Traffic Control System

Recommended functions of the traffic control system are shown in Fig. 10.10.2 and Table 10.10.1.

The summary of equipment for traffic control including emergency telephone system and traffic signs estimates of each and its rough cost is presented Table 10.10.3.

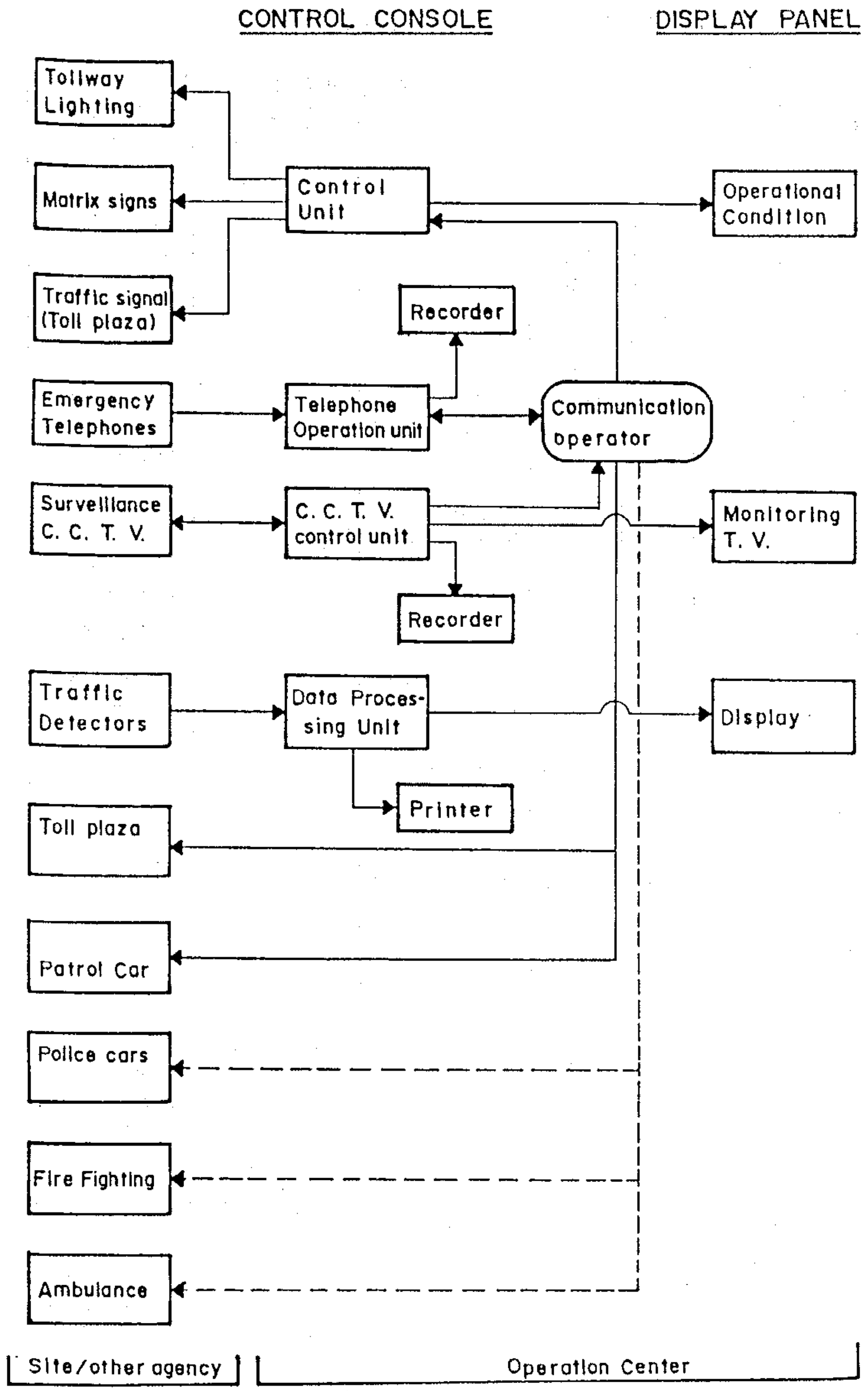


Fig. 10.10.2
Recommended Function of Traffic Control System

Table 10.10.1 Outline of the Recommended Traffic Control Operation System

Facilities	Local	Operation at Operation Center		
		Control Console	Data Processing Unit	Display Panel
Tollway lighting	Controlled mainly at site automatically by timer or photo cell	Subsidiary control	-	On/off indicator
Traffic signals at toll gate	Subsidiary control	Control mainly by the operator	-	Indication of phase in operation
Matrix signs	Subsidiary control	Control mainly by the operator	-	Indication of displayed information by letters on display panel
Emergency telephones	-	Communication with the operator and automatic recording	-	Indication of operating mode by flickering lamp
Surveillance CCTVs	Subsidiary control with local unit installed at the control building	Control mainly by the control unit and recording of selected video with time information	-	Monitor TV screens
Traffic detectors	Installed at each on-ramp and at specified points on throughway	-	Processing of data automatically	Display forecast traffic volumes digitally

10.10.3 Emergency Telephone System

(1) General

Whenever car accidents or breakdowns occur on the Toll Road emergency telephones installed at 0.5 - 1 km intervals on the roadside of the Toll Road can be used to obtain assistance and warn the Toll Road control office.

Installation of a toll road control desk to which the emergency telephones can be linked is therefore required.

(2) Basic System Performance

i) Emergency Telephone Terminal

- The telephone are to be installed at 1 km intervals on each road side of the Toll Road;
- Each telephone will be connected directly to the operation unit of the operation center by picking up the transmitter; and
- The telephone sets are the public telephone type installed in an outdoor telephone booth.

ii) Operation Unit

- A call is indicated by a flickering lamp with an alarm bell;
- Several calls can be received by the operator at the same time;
- Calls can be transferred simply to other agencies such as ambulance, fire fighting, police, etc.; and
- A specified location can be called directly.

Telephone lines for the system can be the public telephone lines of the Corporation of Public Telecommunication of Indonesia (PERUSAHAAN UMUM TELEKOMUNIKASI) or private telephone lines installed by Jasa Marga.

The final details, however, shall be defined in accordance with the requirements for the operation and maintenance procedures of the total tollway system.

A basic diagram of the emergency telephone system is shown in Fig. 10.10.3.

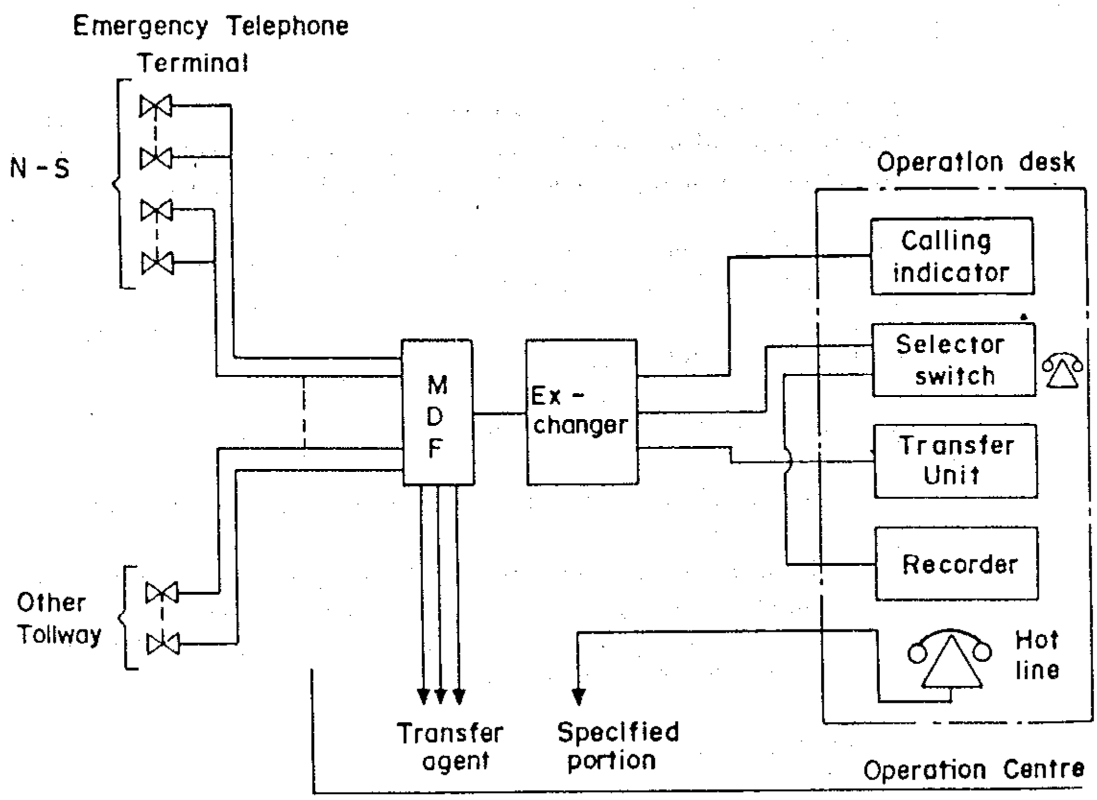


Fig. 10.10.3 Basic Diagram of Emergency Telephone System

10.10.4 Traffic Signs

1) General

Effective signing of the tollway is essential to ensure traffic safety and user's convenience. Factors controlling the effectiveness of signs include legibility (ease in reading the message), target value (factors which draw attention to the sign, such as size and contrast with background), and the priority value (location in relation to other signs).

2) Evaluation of Existing Traffic Signs

The current traffic sign system mainly consists of three categories as follows :

- General information blue sign showing the destination, name of connecting road, location of rampway, etc. and remaining distance to it;
- Restricting red sign showing speed restriction, prohibition of U-turn and crossing of median strip, height restriction, etc.; and
- Warning yellow sign showing work in progress, exits to tollgate, etc.

These are board type guide signs and are without lighting. They are not efficient and are inconvenient for users during darkness.

3) Function of Traffic Sign

A tollway traffic sign is required to fulfill the following functions :

i) Guide Sign

Guide signs convey information to assist drivers, such as destinations and distances, services facilities, and route confirmation. These signs play a very important role in informing drivers in advance of the correct traffic lane for making an exit or entry at on-off ramps and of the location of toll plazas. Overhead signs are provided at certain locations.

ii) Traffic Regulation Sign

Traffic regulation signs play an important role to maintain smooth and safe traffic flow on the tollways. Warning signs are one of the subsidiaries of traffic regulation.

iii) Variable Sign

The variable traffic sign is considered to be more effective than other types for coping with continuous change of traffic conditions and for quickly conveying information to users from detecting devices or at the direction of operators.

4) Types of Variable Message Signs

The variable message sign informs the motorist of road traffic conditions and abnormal conditions such as traffic accidents, repair works and traffic congestion for the purpose of traffic control.

The usual types of variable message sign are as follows :

i) Matrix Type Indicator

The display on the indicator is made up by letters or symbols formed by lamps installed in the indicator.

ii) Screen Type Indicator

The display on the indicator is by means of black printed letters on a white rolled screen. Variable information is transmitted to the motorists by rolling up the screen. Fluorescent lamps installed behind the screen aid night time use of the indicator.

iii) Through Light Type Indicator

The display on the indicator is by means of printed letters on a blackrolled screen with white letters. Variable messages are sent to the motorists by rolling up the screen. Information is display on the indicator at night by incandescent lamps installed behind the screen.

The matrix type variable message sign is preferable for the following reasons:

- Good legibility;
- Excellent for arousing the motorists attention;
- Large number of display patterns;
- Quick change of displayed message; and
- Higher reliability and easier maintenance.

5) Recommendations

Effective tollway signing is of vital importance for the proper operation of the tollway and street network, particularly at on/off-ramps.

Signs must be designed primarily for drivers who are not familiar with the route or with the variable traffic conditions so that they will react promptly, naturally and safely to the design conditions and traffic situation encountered.

When the Toll Road is completed and connected with Jakarta Outer Ring Road it is expected that the traffic demand will be considerably increased.

Thus it becomes necessary to prevent deterioration of the service level of the Toll Road.

In order to strengthen the existing signing system the introduction of high capacity type overhead matrix indicators is recommended.

The recommended types and locations of traffic signs in the vicinity of on/off-ramps are shown in Fig. 10.10.4. The matrix type indicators are to be controlled at the operation center through a remote control system.

Table 10.10.2 shows the characteristics and locations of the recommended signs.

Table 10.10.2 Recommended Sign System

Classification	Type	Installed Locations	Conveyed Information	Support Design
Guide Signs	F-1	On the street near on-ramps	Tollway or on-ramp ahead	Overhead or overhang, portal or pole type
	F-2	On the Toll Road, near exit terminals (inter-changes and off-ramps)	Destinations of tollway and connecting roads	Overhead, portal type
Matrix Signs	M-1	On the Toll Road before off-ramps	Traffic condition of connecting roads	Overhang, pole type
	M-2	On the street before on-ramps	Abnormal traffic or other condi-tions of tollway	Overhead, portal type
	M-3	On the Toll Road near exit terminals (inter-changes and off-ramps)	Abnormal traffic or other condi-tions of tollway and connecting roads	Overhead, portal type
	M-4	On the Toll Road at inter-changes, on/off-ramps, sharp curves, etc.	Speed limitation, lane(s) closure and stop	Pole mounting

Table 10.10.3 Summary of Equipment for Traffic Control System and Estimated Costs

No.	Items	Unit	Quantity	Estimated Cost (M. Rp)		
				Foreign	Local	Total
1	Control Center			8,396	7	8,402
	CPU System	Set	1			
	Software	L.S.	1			
	Wall Map	Each	1			
	Carrier Terminal Station	Each	0			
	Power Supply	L.S.	1			
2	Vehcle Detector System			2,260	160	2,420
	Detector DataProcessor	Each	1			
	Software	L.S.	1			
	Vehcle Detector	Each	124			
3	CCTV System			1,290	91	1,381
	CCTV Central Controller	Each	1			
	CCTV Camera	Each	22			
4	CMS System			10,000	895	10,894
	CMS Central Controller	Each	1			
	Software	L.S.	1			
	Changeable Message Sign	Each	13			
5	Emergency Telephone System			1,425	66	1,491
	Central Controller	Each	1			
	Roadside Telephone	Each	35			
6	Cable System			1,873	3,408	5,281
	Mealic Cable	Km	36			
	Optional Fiber Cable	Km	18			
	Power Cable	Km	26			
	Conduit & Manhole	Km	54			
7	Radio Communication System			550	35	585
	Base Station	Each	1			
	Repeater Station	Each	0			
	Desktop Station	Each	2			
	Mobil Unit	Each	10			
8	Center-to-Center Communication			1,290	245	1,535
	Carrier Terminal Station	Set	1			
	Optional Fiber Cable	Km	18			
9	Contigency			2,708	487	3,196
10	Total			29,792	5,394	35,186

CHAPTER 11 CONSTRUCTION PLANNING

[illegible]

CHAPTER 11 CONSTRUCTION PLANNING

11.1 General

Construction planning has been studied in order to establish technically feasible and cost effective construction methods and to estimate the required construction time schedule. The results of this construction planning study will be utilized in preparation of the construction cost estimates and will be further reflected in establishment of the project implementation schedule.

Some aspects of construction planning have already been taken into consideration in determining the form of construction and type of materials adopted for roads, bridges and viaducts. The reasons behind these decisions are described in Chapter 10. This chapter focuses on construction planning for the designs adopted in Chapter 10.

11.2 Basic Conditions of Construction Planning

(1) Construction Sections

Since the Project necessitates large scale construction work and a high level of investment, it may be desirable both economically and technically to stage the construction over a period of time.

The North-South Axis will be implemented as one section under one toll road investor but implementation of the East-West Axis will be staged according to priority and the time required for land acquisition procedures. To assist with preparation of the overall implementation schedule, construction planning of the East-West Axis is divided into the following sections:

Section EW-1: West JORR IC - Latumeten IC
(Sta. 0+500 - Sta. 9+200, L = 8.70 Km)
Section EW-2: Latumeten IC - Mangga Basar IC
(Sta. 9+200 - Sta. 11+700, L = 12.50 Km)
Section EW-3: Mangga Basar IC - Sunter IC
(Sta. 11+700 - Sta. 20+150, L = 8.45 Km)
Section EW-4: Sunter IC - East JORR Junction
(Sta. 20+150 - Sta. 31+250, L = 11.10 Km)

(2) Type of Construction

As described in Chapter 9, the basic form of construction for the arterial road (tollway) and frontage roads are as shown in Table 11.2.1 below.

Table 11.2.1 Basic Types of Construction

SECTION & APPROX.STA.	LENGTH (km)	FRONTAGE ROADS	ARTERIAL ROAD	BASIC STRUCTURE TYPE
North-South Axis				
Section NS-1				
0+770-5+560	4.79	2 x 2 lanes at-grade	2 x 2 lane viaduct (on 1 level or 2 levels)	Mainly PC U-Girders (some short steel sect's)
Section NS-2				
5+560-12+520	6.96	2 x 2 lanes at-grade	2 x 3 lane viaduct (1 level)	PC I/U-Girders
12+520-17+470	4.95	2 x 2 lanes at-grade	2 x 3 lane viaduct (2 levels)	Steel I-Girders
East-West Axis				
Section EW-1				
0+500-9+200	8.70	2 x 2 lanes at-grade	2 x 3 lanes at-grade mainly	Bridges - PC I-Girders
Section EW-2				
9+200-11+700	2.50	2 x 2 lanes at-grade	2 x 3 lanes at-grade mainly	Bridges - PC I-Girders
Section EW-3				
11+700-11+958	0.26	2 x 2 lanes at-grade	2 x 3 lanes at-grade	
11+958-15+908	4.20	2 x 3 lanes at-grade	2 x 2 lane viaduct (1 level)	PC I-Girders
15+908-16+640	0.70	2 x 3 lanes at-grade	2 x 2 lanes at-grade	
16+640-20+150	3.55	2 x 3 lanes at-grade	2 x 2 lane viaduct (1 level)	PC I-Girders
Section EW-4				
20+150-24+450	4.25	2 x 3 lanes at-grade	2 x 2 lane viaduct (1 level)	PC I-Girders
24+400-31+250	6.85	2 x 2 lanes at-grade	2 x 3 lanes at-grade mainly	Bridges - PC I-Girders

(3) Quantities of Major Work Items

The work quantities of major work items have been estimated in Chapter 10. Selection of construction methods is based on the construction material, work quantities and site conditions, as described in Section 11.3 below.

11.3 Construction Planning

11.3.1 Equipment Intensive Construction

To attain construction economy and an earlier return on the high investment costs, the use of equipment intensive construction methods will be adopted. This will allow completion of the project roads within a shorter period than would otherwise be necessary. A good range of construction equipment is already widely available and in use on major projects in Jakarta. Therefore, the method does not represent a major change from existing practices on similar construction projects.

11.3.2 Earthwork

Since most of North-South Axis is on structure, the comments in this section mainly apply to the East-West Axis where about 14 km of the 31 km length is at grade and earthworks are more substantial.

(1) Major Equipment and Construction Methods

Where work areas are not greatly restricted, conventional earthmoving using the major earthwork equipment shown in Table 11.3.1 is assumed for construction planning. Where reconstruction of frontage roads is required in confined areas or under the constraints of existing traffic, the use of smaller equipment or even a labour intensive method is likely to be required.

Table 11.3.1 Earthwork Equipment

Work Item	Major Equipment	
	Hauling distance less than 100 m	Hauling distance more than 100 m
Clearing and Grubbing	Bulldozer	-
Excavation Loading Hauling	Bulldozer - Bulldozer	Wheel Loader Wheel Loader Dump Truck
Spreading Compaction	Bulldozer/Motor grader Sheep's Foot Roller/Tire Roller	

(2) Construction of Embankments in Soft Ground Areas

In soft ground areas, embankment height using compacted fill is around 2 metres. Embankment construction in these areas should be scheduled for the dry season. No special construction measures are proposed for these low embankments. However, an allowance has been included in the work items and cost estimates for free draining material to be placed in some areas to provide a working platform for embankment construction.

(3) Embankment Materials

Materials obtained from common excavation will be utilized for the embankment as much as possible but it will be necessary for most embankment material to be obtained from borrow areas. A survey of possible borrow pit locations has not been carried under this study. However, a study was carried out under the Intra Urban Expressway and Related Facilities Project and the sites therein identified are considered suitable for this project as well. Table 11.3.2 shows the borrow areas proposed as a source of fill material.

Table 11.3.2 Proposed Source of Embankment Materials

Description	Name of Location or Name of Company	Location
<u>Embankments</u>		
TP No. 1	Kp. Cilenggang	2 km north of Serpong
TP No. 2	Kp. Cilenggang	2 km north of Serpong
TP No. 3	Kp. Buaran/Jelupang/ Lengkong Wetan	2 km north of Serpong
TP No. 4	Kp. Pengasinan	5 km south of Serpong

Materials from these sites have design CBR values ranging from 6.3% to 14.3%, consistent with the 5% assumed in preliminary design calculations for this Project.

Embankment slopes will be stabilised by sodding. Excavated topsoil will be stockpiled and later utilized during this procedure.

The estimated volumes of embankment materials for each section and the approximate haul distances are shown in Table 11.3.3 below. The total volume of borrow (i.e. volume after compaction to required density) from the Serpong area is estimated at approximately 2.2 million m3 and the weighted average hauling distance is approximately 22 km.

Table 11.3.3 Summary of Borrow Material Requirements

Section/Subsection	Length	Embankment Material		
		Borrow	Borrow Pit Location	Approx. Haulage
	(km)	(m3)		(km)
NORTH-SOUTH AXIS	17.63	387,200	Serpong area	18
EAST-WEST AXIS				
Section EW-1:	8.7	1,028,742	Serpong Area	18
Section EW-2:	2.5	73,845	Serpong Area	20
Section EW-3:	8.45	149,509	Serpong Area	30
Section EW-4:	11.1	564,760	Serpong Area	30
Total EW	30.75	1,816,856		23
GRAND TOTAL	48.38	2,204,056		22

11.3.3 Paving Work

Flexible pavement is proposed for all sections not only structure as described in Chapter 10. The only exception is small areas of concrete pavement at toll booth areas.

(1) Major Equipment and Construction Methods

Where work areas are not greatly restricted, conventional pavement construction using the major equipment shown in Table 11.3.4 is assumed for construction planning. This equipment is already available and in use in Jakarta. Where reconstruction of frontage road pavements is required in confined areas or under the constraints of existing traffic, the use of smaller equipment or even a labour intensive method is likely to be required.

Much of the pavement construction will be carried out under the constraints imposed by the need to maintain existing traffic to the extent possible along and across the work area. This will be achieved by a combination of diverting traffic onto temporary pavement and by carrying out as much work as possible overnight when traffic flows are small (refer to Chapter 11.3.5).

Table 11.3.4 Paving Work Equipment

Work Item	Major Equipment
Hauling	Dump Truck
Subgrade Preparation	Motor Grader, Tire Roller, Macadam Roller
Subbase	Motor Grader, Tire Roller, Macadam Roller
Granular Base	Motor Grader, Tire Roller, Macadam Roller
Prime/Tack Coat	Asphalt Distributor
Binder/Surface Course	Asphalt Mixing Plant, Asphalt Finisher, Macadam Roller, Tire Roller
Concrete Pavement (At Toll Gates)	Concrete Batching Plant, Transit Mixer

(2) Pavement Materials

Suitable sources of pavement materials were identified in the Intra Urban Expressway and Related Facilities Project and are summarised in Table 11.3.5.

Table 11.3.5 Proposed Source of Pavement Materials

Description	Name of Location or Name of Company	Location
Coarse aggregates		
Crushed stone	PT. Quarry Mas Utama	W.of Cisadane R. 15 km S-W of Serpong
Crushed stone	PT. Sudamanik	W.of Cisadane R. 18 km S-W of Serpong
Fine aggregates		
Sand and gravel	PD. Harapan Maju	R.Cisadane, 7 km sth.of Serpong
	PT. Danukerto Agung	R.Cisadane, 7 km sth.of Serpong
	PT. Inter Alam	R.Cisadane, 7 km sth.of Serpong
Sand	Kranggan	5 km south.of Serpong
	PT. Hutama Karya	
Sand	P.T. Siti Jatake	7 km west.of Serpong
Asphalt Materials		
Asphalt Cement		Imported
Cutback Asphalt		Imported

Pavement materials are further described below:

a) Subbase Course Material.

Suitable sources of subbase course materials are located west of the Cisadane River, approximately 15 km south-west of Serpong. Crushing should not be necessary considering the nature of the deposits in this area.

b) Base Course Material.

A number of aggregate producers are in operation in the area mentioned above obtaining raw materials from gravel pits. The material meets the requirements assumed for the preliminary designs. The contractor may establish his own pit and crushing/screening plant because of the large volumes required.

c) Asphalt Surfacing.

Asphalt cement and cutback asphalt for pavement surfacing works are usually imported. The contractor will probably establish his own asphalt mixing plant because of the large volume of asphalt surfacing. Suitable aggregates can be obtained from the same sites as for a) and b) above.

The estimated volumes of pavement materials for each section and the approximate haul distances are shown in Table 11.3.6. The total volume of pavement materials from the Serpong area is estimated at approximately 1.5 million m3 and the weighted average hauling distance is approximately 32 km.

Table 11.3.6 Summary of Pavement Aggregate Requirements

Section/Subsection	Length (km)	Pavement Materials							
		Free Draining Material (m3)	Subbase (m3)	Granular Base (m3)	Asphalt Aggregates		Total Material (m3)	Source of Material	Approx. Haulage (km)
					Coarse (m3)	Sand (m3)			
NORTH-SOUTH AXIS	17.63	12,500	107,353	68,370	48,500	178,332	415,055	Serpong area	28
EAST-WEST AXIS									
Section EW-1:	8.7	55,710	123,898	79,199	49,109	164,719	472,635	Serpong area	28
Section EW-2:	2.5	23,086	20,248	12,958	8,827	31,859	96,978	Serpong area	30
Section EW-3:	8.45	20,138	38,859	19,716	18,066	77,352	174,131	Serpong area	40
Section EW-4:	11.1	40,953	98,743	62,782	39,878	136,235	378,591	Serpong area	40
Total EW	30.75	139,887	281,748	174,655	115,881	410,164	1,122,335		34
GRAND TOTAL	48.38	152,387	389,101	243,025	164,381	588,495	1,537,390		32

11.3.4 Bridge and Viaduct Construction

(1) Major Equipment and Construction Methods

Construction methods have been described in Chapter 10 but the important points in terms of construction planning are described below

For steel box girders and I-girders conventional erection methods using temporary bents and truck cranes will generally be adopted. For box girders the use of temporary bents is sometimes prevented by an existing structure or other constraint and in these circumstances the use of a travelling crane mounted on the box girder is proposed. Girder segments are limited generally to about 20 tons and about 10m in length for easier transport and handling. It is necessary to carry out a trial assembly of girder segments prior to erection so that fit and fabrication tolerances can be confirmed. If the girders are fabricated outside of Indonesia then allowance must also be made for temperature differences compared to Indonesia. In addition, it is necessary to carefully survey the level and alignment of segments during erection. Provided these precautions are taken then erection should proceed safely and quickly.

Erection of PC I-girders and U-girders will be achieved using either truck cranes working at ground level or a moveable erection girder mounted on the pier crossheads. These erection methods are commonly used in Indonesia and have been proven by experience.

The major equipment required for bridge and viaduct construction is shown in Table 11.3.7. Most types of equipment are already in use in Jakarta but it may be necessary to import some new types of equipment for the piling because two of the pile types are not commonly used in Jakarta, as described below.

The 100cm diameter cast-in-place concrete piles are to be constructed using the Benoto system whereby a clamshell type excavator removes material from inside a temporary steel casing that is lowered as excavation proceeds. The steel casing is withdrawn after the reinforcing cage is inserted and concrete has been placed.

The proposed bored 60cm diameter spun precast concrete piles are driven by weights as an auger lowered through the hollow pile and equipped with cutting edges excavates at the base. The cutters can be flared out to provide a larger bearing area near the bearing stratum of the pile. The base of the pile is strengthened by injecting concrete through the stem of the auger.

No particular supply problems for equipment are anticipated although it is noted that diesel hammers are currently in short supply in Jakarta. The size and duration of the project will allow some equipment to be imported and an allowance for some imports will be included in the cost estimates.

Table 11.3.7 Bridge and Viaduct Construction Equipment

Work Item	Major Equipment
Piled Foundations	Truck Crane, Diesel Pile Hammer for driven piles, Benoto Type Clamshell Excavator for 100cm CCP piles, Auger/Driver for 600mm spun, pre-cast, bored piles
Structure Excavation	Hydraulic Excavator (Crawler Type), Wheel Loader, Dump Truck
Substructure	Transit Mixer, Concrete Pump Truck, Truck Crane
Concrete Superstructure	90t Truck crane (I-Girders), 150t Truck Crane (U-Girders), Erection Girder, Concrete Pump Truck
Steel Superstructure	100t Truck crane, 50t Traveller Crane, Concrete Pump Truck

(2) Construction Materials

The major construction materials required for the Project and their likely sources are shown in Table 11.3.8. Priority has been given to maximum usage of locally produced materials wherever possible.

Table 11.3.8 Source of Major Structural Materials

Description	Source	Location
<u>Concrete</u>		
Fine and Coarse Aggregates	Refer Table 11.3.5	Refer Table 11.3.5
Cement	Various local producers	
Reinforcement	Various local producers	
Prestressing Cable	Imported	Japan, Korea, etc
<u>Steel Structures</u>		
High Strength Steel Plate for Box Girders and I-Girders	Imported	Japan, Korea, etc
<u>Miscellaneous</u>		
Expansion Joints and Bearings	Imported	Japan, Korea, etc.

Construction materials and sources are further described below:

a) Concrete

Suitable sources of coarse and fine aggregates are available in the Serpong area as previously described. Portland cement is available locally although it is sometimes in short supply. Local supply can be supplemented by imports if necessary.

b) Prestressing Cable

Prestressing cable is not produced in Indonesia as yet and must be imported.

c) Reinforcement

Suitable reinforcement is produced locally and no supply problems are anticipated.

d) Structural Steel

High strength steel plate is not produced in Indonesia at present and must be imported. However, several local contractors have the necessary experience and technical skill in fabrication of steel girders and it should be possible, for some sections at least, for fabrication to be carried out locally.

e) Other Items

Most other items are available or produced locally with the exception of metal bearing shoes and rubber bearing pads which must also be imported.

The estimated quantities of major structural items are shown in Table 11.3.9. Substantial quantities of materials are required but supply should not be a major problem considering the local construction industry in Jakarta. To a large extent major suppliers have already expanded their capabilities because of the large amount of roadworks now under construction in Jakarta and proposed for the near future.

Table 11.3.9 Summary of Major Structural Material Requirements

Location	Length	Cast-in-situ Concrete					PC Girders			PC Piles		Steel Plate
		Cement	Aggregates		Reinforce-ment	Prestress Cable	I-Beam (30m)	U-Beam (30m)	I-Beam (Ped. 24m)	PC (45x45)	PC Spun (60 dia.)	
			Coarse	Fine								
	(km)	(tons)	(m3)	(m3)	(tons)	(kg)	(No.)		(No.)	(m)	(m)	(tons)
NORTH-SOUTH AXIS	17.63	176,669	340,828	294,194	48,611	614,742	1,799	1,638	0	12,496	368,230	58,344
EAST-WEST AXIS												
Section EW-1:	8.7	52,766	109,424	96,009	13,057	24,614	893	0	33	118,961	58,078	0
Section EW-2:	2.5	19,515	37,449	32,274	5,167	224,429	350	135	6	7,131	39,522	715
Section EW-3:	8.45	77,270	147,078	126,317	21,025	826,630	1,048	858	3	3,716	114,314	1,918
Section EW-4:	11.1	62,291	124,100	107,908	16,224	525,211	1,667	0	21	27,389	58,156	0
Total EW	30.75	211,841	418,050	362,508	55,473	1,600,884	3,958	993	63	157,197	270,070	2,633
GRAND TOTAL	48.38	388,510	758,878	656,702	104,084	2,215,626	5,757	2,631	63	172,324	638,300	60,977

11.3.5 Traffic Considerations During Construction

(1) Hauling of Construction Materials.

The construction involves the hauling of a significant quantity of construction materials. Basically the Project Area is provided with a sufficiently dense road network in reasonable condition to meet requirements for transport of materials. However, the existing roads are generally congested during the day and early evening. Therefore, movement of most construction materials, including bulky, heavy and time-sensitive (e.g., ready-mixed concrete) materials in particular, should be scheduled during the night. This already occurs for major construction projects in Jakarta.

Some existing pavements are uneven and lacking in strength and pavement strengthening or repair may be necessary on short lengths of minor roads which will suffer from a large increase in construction traffic. However, construction of new roads apart from short construction access roads is not considered necessary.

The greatest effect on existing roads caused by the movement of construction materials will be transport of construction materials from the Serpong area. Since existing roads are congested, movement of materials should take place during the night. The estimated volume of material which will be hauled from the Serpong area includes borrow material for embankments (approx. 2.2 million m3), pavement and asphalt aggregates (approx. 1.5 million m3) and concrete aggregates (approx. 1.4 million m3), making a total of about 5.1 million m3. Movement of this material will be spread over about two years and will be dispersed over several roads depending on the location of batching plants, stockpile areas, etc. Assuming night haulage, sufficient road capacity should be available. Depending on other projects under construction at the same time, some minor improvements may be advisable.

Delivery of other major items such as precast piles, precast beams, readymix concrete, and steel girders should also be planned for the night to minimise disturbance to existing traffic.

Refer also to Chapter 12 for a further description of traffic matters from the environmental viewpoint.

(2) Maintaining Existing Traffic Flows Through Construction Areas

Almost all of the North-South Axis and a considerable part of sections EW-3 and EW-4 of the East-West Axis are to be constructed on or adjacent to an existing arterial road. These roads are an important component of the existing road network and cannot be closed to traffic. The works must proceed while allowing existing traffic to flow and the only road closures which will normally be acceptable will be during the night when alternative routes are not conjested.

Construction types and construction methods have therefore been chosen such that the duration of works on site is kept to a minimum and that the duration of any disturbance during erection are also kept to a minimum.

It has been assumed that for most roads a minimum of two lanes of traffic in each direction should generally be maintained throughout the construction period. To achieve this minimum where the right of way is restricted, it will be necessary to construct temporary pavement at the edges of the right of way so that permanent works can proceed free of traffic. Areas under traffic will be restored after traffic is diverted back onto completed permanent pavement,

11.4 Construction Time Schedules

In order to assist in evaluating the required project implementation period and in forecasting budget needs, construction schedules were prepared for the North-South Axis and for the four sub-sections of the East-West Axis as described below.

11.4.1 Conditions for Scheduling

In estimating the construction time schedules the following assumptions are made for the construction works.

(1) Working Conditions

The construction time schedules are estimated assuming a working day of 7 hours in accordance with normal work conditions, although it is noted that at construction sites the average actual working time ranges from 7 to 10 hours.

(2) Weather Conditions

According to the rainfall data shown in Table 11.4.1 and 11.4.2 the number of possible working days in a month is assumed as shown in Table 11.4.3 for earthwork and the construction of pavement. For other activities, 25 working days per month is assumed, ie., 30 days less 5 holidays.