Table 9.2 (1) Geometric Design Standard for Interchange Ramps

ITEM	UNIT	INTERCHANGE RAMPS	
Design Speed	Km/h	40	50
Sight Distance	m	40	55
Lane Width	m	3.6	3.6
Median Width	m	2.5	2.5
Inner Shoulder Width	m	0.75	0.75
Outer Shoulder Width	m	3.0	3.0
Minimum Radii	m	50	90
Minimum Radius for Curve not Requiring Transition Curve	m	140	220
Minimum Radius for Curve not Requiring Superelevation	m	800	1,300
Maximum Gradient	%	6(8)	5.5(7.5)
Minimum Vertical Curve Length	m	40	50
Crossfall of Pavement	%	2	2
Crossfall of Shoulder	%	4	4
Maximum Superelevation	%	10	10

Note : ( ) shows absolute minimum values

Table 9.2 (2) Geometric Design Standard for Throughway in the Vicinity of Interchange Ramp Terminal

ITEM		UNIT	THROUGHWAY DESIGN SPEED	
			120 km/h	100 km/h
For Throughway				
Minimum Radii		m	2,000(1,500)	1,500(1,000)
Minimum Vertical Curve	(Crest)	m	45,000(23,000)	25,000(15,000)
	(Sag)	m	16,000(12,000)	12,000(8,000)
Maximum Gradient		%	2	2
For Ramp Adjacent to Nose				
Minimum Radii		m	250	200
Minimum Parameter of Clothoid Curve		m	90(70)	70(60)
Minimum Vertical Curve	(Crest)	m	2,000(1,400)	1,800(1,100)
	(Sag)	m	1,500(1,000)	1,500(850)
Minimum Vertical Curve Length		m	70(50)	65(45)
Deceleration Lane				
Length of Deceleration Lane		m	100	90
Length of Taper		m	100	100
Acceleration Lane				
Length of Acceleration Lane		m	200	180
Length of Taper		m	70	60

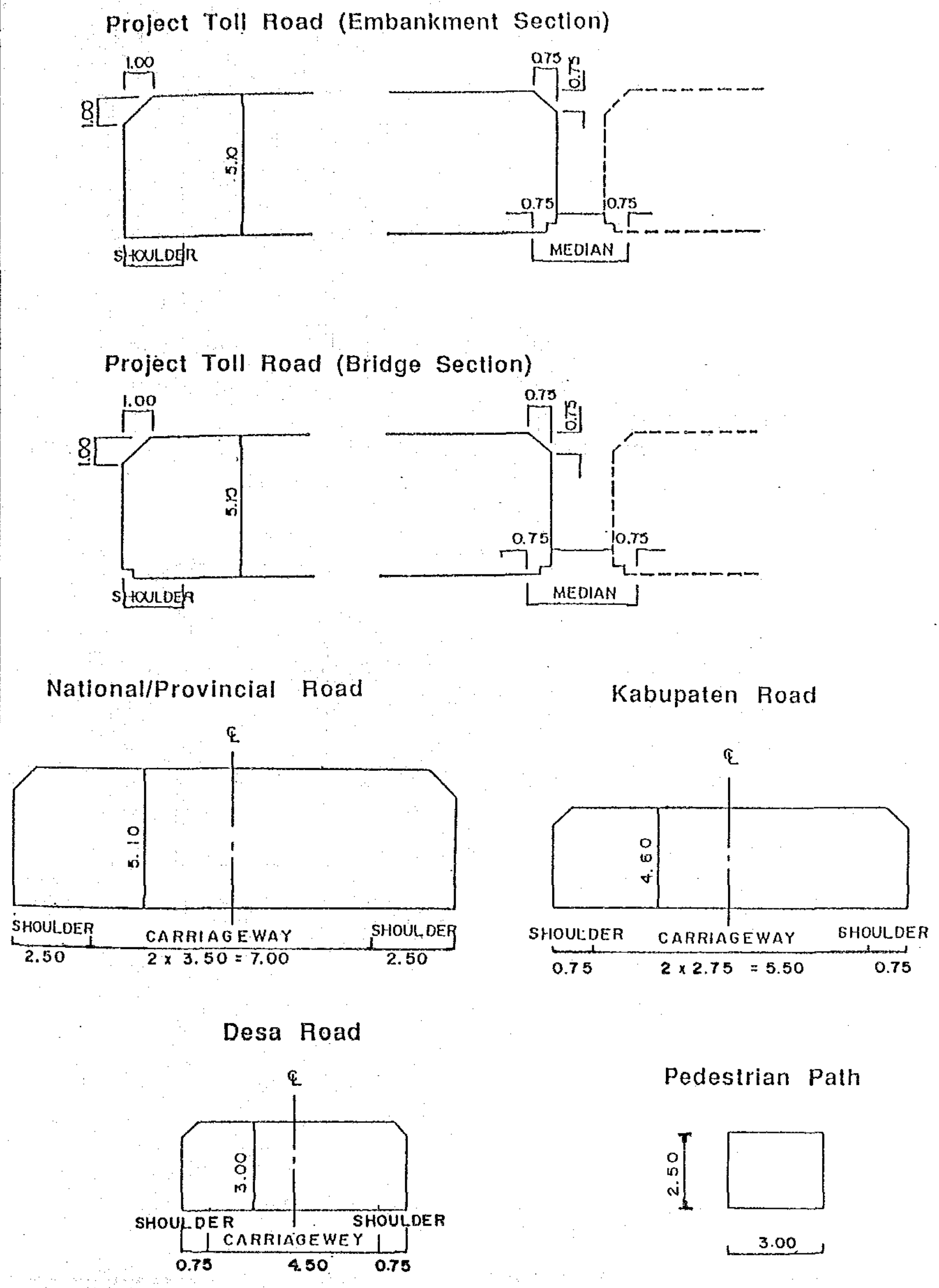
Note : ( ) shows absolute minimum values.

(3) Clearance Limits

The limits of horizontal and vertical clearance of the Toll Road and other roads are illustrated in Fig. 9.1. A 5.1 m vertical clearance is adopted for the Toll Road and national/provincial roads, 4.6 m for Kabupaten road, 3.0 m for desa road and 2.5 m for pedestrian path.

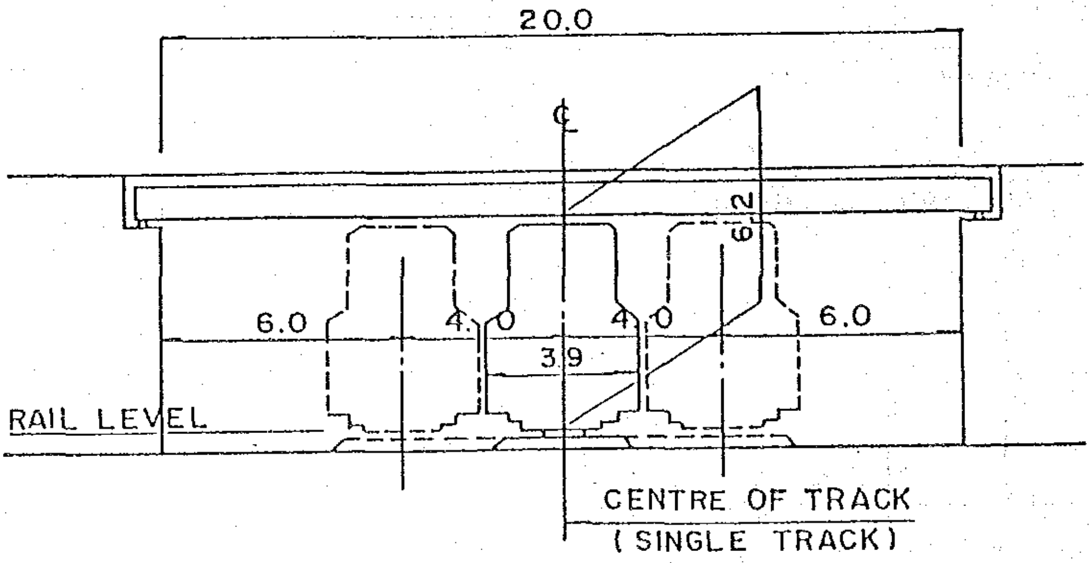
The clearance at railway crossing is shown in Fig. 9.2, with a 6.2 m vertical clearance.

The clearance at the crossing with electric power transmission line is shown in Fig. 9.3. The headrooms above the clearance of highways are 4.5 m above protection net over the Toll Road for 70 KV transmission lines and 9 m for 150 KV transmission lines (the existing transmission lines to be crossed by the Toll Road are of 70 KV and of 150 KV).



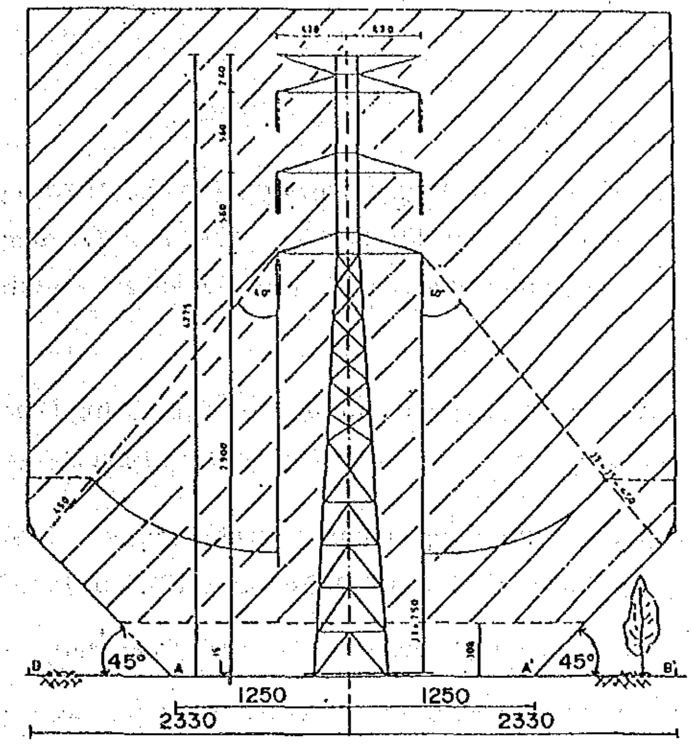
SURABAYA - MOJOKERTO TOLL ROAD PROJECT	**Fig. 9.1 Clearance Limits**

Existing Single Track
(Future Double Track Is Considered)

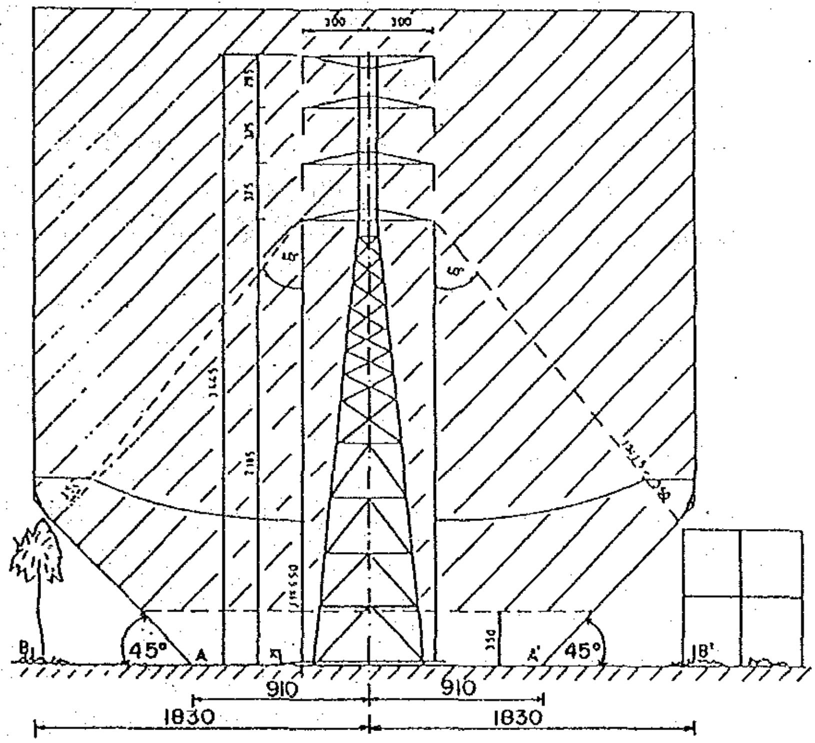


SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 9.2 Clearance at Railway Crossing

150 KV



70 KV



Source: Peraturan Umum Instalasi Listrik Indonesia, 1987 (PUIL 1987)

SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 9.3 Clearance Limits of Pylons of Electric Power Transmission Lines

9.2.2 Bridge Design Standard

(1) Loading Specifications

The "Loading Specifications for Highway Bridges (No. 12/1970)", published by Bina Marga in March 1970, was revised in February 1988 (the "Loading Specifications for Highway Bridge Design") and this together with the following addenda are currently in use in Indonesia.

- General Explanation and Interim Guide for Using Loading Specifications for Highway Bridges (No. 12/1970), 1974, by Bina Marga;
- Explanation and Supplemental Specifications of Loading Standard for Highway Bridges (no. 12/1970), February 1977, by Bina Marga; and
- Revision to Loading Specifications, 1980, Bina Marga, Draft.

The bridge design in the Project will be executed based on these specifications, more specifically, the following loads and are to be applied in computing the stresses:

- Primary Loads
- Secondary Loads
- Certain Circumstance Loads

Bina Marga intends to modify the above loading specifications to reflect recent changes of variables (i.e. axle load limit, etc.) and to apply international unit system (SI). The "Bridge Design Code" for trial use has been already prepared but not yet finalized.

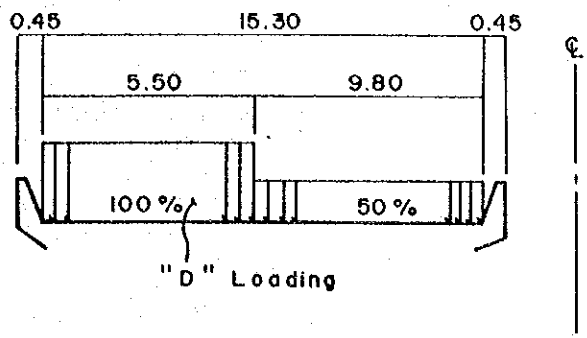
(2) Primary Loads

a) Loading Classifications

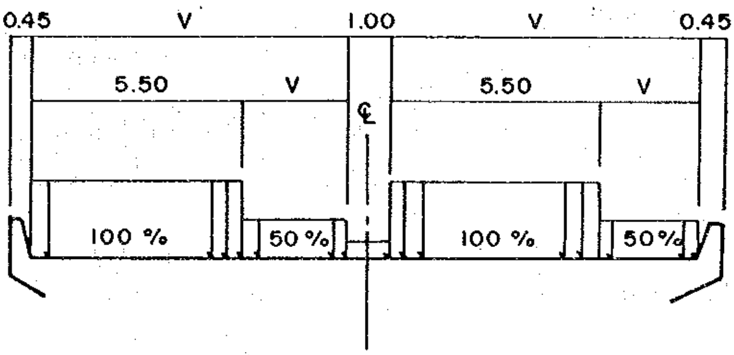
Class I Loading, 100% "T" Load and 100% "D" Load (BM-SPC, 1977) will be applied.

b) Application of "D" Loading

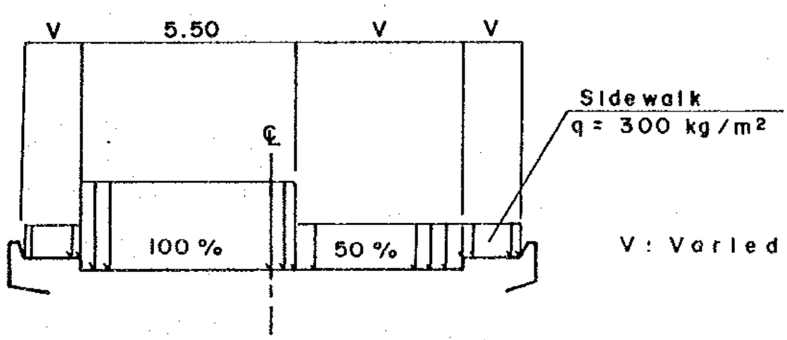
The reduction in "D" load intensity is illustrated in Fig. 9.4 for computing the maximum positive and negative bending moments due to "D" load on a continuous beam with multi-supports, the loading is as illustrated in Fig. 9.5. Only one (1) line load shall be applied to each bridge.



THROUGHWAY BRIDGE



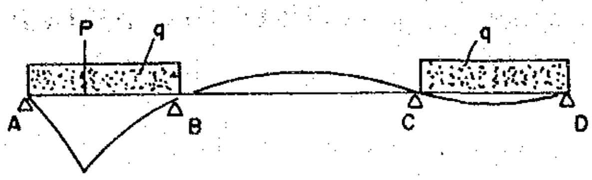
OVERBRIDGE (WITH MEDIAN)



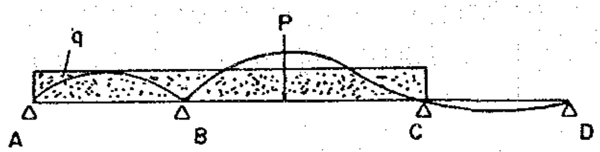
OVERBRIDGE (MITHOUT MEDIAN)

SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 9.4 Reduction of "D" Loading

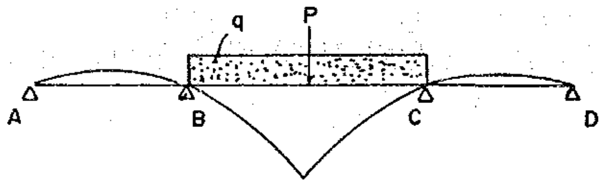
At Side Span



At Support B



At Center Span



Note : P denotes line load and q denotes uniform load

SURABAYA - MOJOKERTO TOLL ROAD PROJECT	**Fig. 9.5 Loading for Maximum Positive and Negative Bending Moment**

c) Sidewalk Loading

Sidewalk floors are designed for a live load of 500 kg/m^2. However girders and other members are designed for a live load of 300 kg/m^2.

d) Impact

To provide the dynamic strength and vibration influence, stresses produced by the "D" loading shall be multiplied by an impact coefficient. The impact coefficient is applied only to the line load P = 12 ton per load lane width (2.75 m). "T" loading and uniform load "q" of "D" loading are not applied for impact.

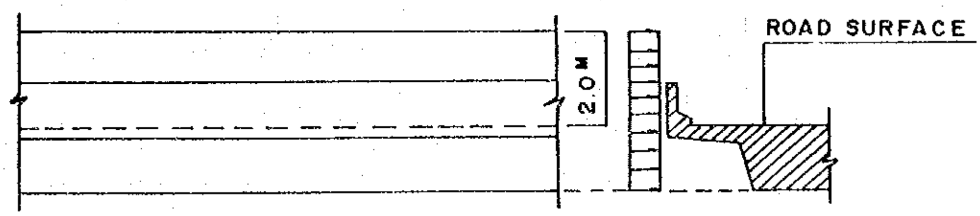
e) Load Distribution

The load distribution shall be calculated by the orthotropic plate or grid girder method whenever detailed structural analysis is necessary.

(3) Secondary Loads

a) Wind Load

- 100 kg/m^2 wind load will be applied to the vertical exposed area
- When consideration of the wind load on vehicles is necessary, such additional exposed area is determined in accordance with the following condition (BM-SPC, 1988) :



b) Thermal Forces

The assumed ambient temperature for design purposes is 28°C. Steel structures will be checked for a temperature variation of ± 30°C and concrete structures for a variation of ± 15°C.

c) Brake and Traction

Provision will be made for the effect of a longitudinal force of five percent (5%) of the "D" loading, without impact, for all lanes carrying traffic headed in the same direction. All lanes will be considered as loaded for bridges likely to become one directional in the future. The longitudinal force will be assumed to be located 1.80 meters above the bridge surface (BM-SPC, 1988).

(4) Certain Circumstance Loads

a) Earthquake Forces

The project site is covered by Region I in accordance with these loading specifications and the earthquake coefficient is determined as follows (BM-SPC, 1980) :

DESCRIPTION	EARTHQUAKE COEFFICIENT
For structures founded on spread footings on soil with a bearing capacity 5 kg/cm^2 or over	
- Concrete construction	0.086
- Steel construction	0.068
For structures founded on spread footings on soil with a bearing capacity less than 5 kg/cm^2	
- Concrete construction	0.150
- Steel construction	0.115
For structures to be constructed above pile foundation	
- Concrete construction	0.200
- Steel construction	0.160

Bina Marga has recently been considering the use of earthquake resistant design which is modified by referring to AASHTO's Guide Specification for Seismic Design of Highway Bridges, 1983.

b) Centrifugal Forces

Structures on curves will be designed for a horizontal centrifugal force equal to a percentage of the "D" loading, without impact, in all traffic lanes. The centrifugal force shall be applied 1.80 meters above the bridge floor and be determined by the following formula (BM-SPC, 1988) :

$$S = 0.57 \frac{V^2}{R}$$

Where S : The centrifugal force percentage of "D" loading without impact
V : The design speed in kilometers per hour
R : The radius of the curve in meters

c) Collision Force

To calculate the collision forces on a pier due to a vehicle, each of the following two horizontal collision force criteria will be applied (BM-SPC, 1988).

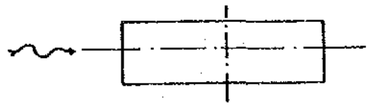
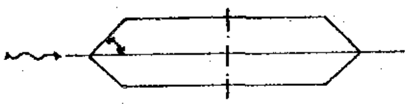
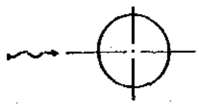
- Longitudinal to the traffic lane : 100 ton
- At 90 degrees to the traffic lane : 50 ton

The collision forces are considered as being applied at a height of 1.20 meters above the roadway surface.

All piers and other members of the structure which are subject to forces caused by flowing water shall be designed to resist the maximum stresses induced thereby. The effect of flowing water on piers shall be calculated by the following formula :

$$pa = k \times va^2$$

Where pa = *flowing water pressure (ton/m2)*
va = velocity of water in accordance with hydraulic analysis (m/sec.)
k = coefficient depending on the shape of the pier which is determined from the following table :

Shape of pier	Shape of Pier	k
Square section		0.075
Angle end < 30°		0.025
Circular section		0.035

The forces induced by floating materials shall be determined from the result of site research. The force induced by navigational traffic shall be determined by special consideration.

(5) Other Design Loadings

For other design loadings relevant specifications of Bina Marga will be applied. For those aspects of loading details not covered by the specifications of Bina Marga, the following specifications will be referred to :

- Specifications for Highway Bridge, Japan,
- Standard Specifications for Highway Bridges adopted by the American Association of State Highway and Transportation Officials (AASHTO).

(6) Materials

The use, basic strengths and the allowable stresses of concrete, reinforcing steel and prestressing steel are presented in Appendix A-9.1.

9.2.3 Pavement Design Standard

The Government has the following pavement design standards for flexible pavement and rigid pavement.

- Guide for flexible pavement design (Pedoman Penentuan Tebal Perkerasan Lentur Jalan Raya, No. 01/PD/B/1983) published by Bina Marga
- Guide for rigid pavement design (Pedoman Perencanaan Perkerasan Kaku (Beton Semen, 1985) published by Bina Marga

The former guide for flexible pavement design is based on the AASHTO Interim Guide for Design of Pavement Structures 1972 with adjustments to meet the situations in Indonesia. The latter guide for rigid pavement design is based on the Australian standard with fatigue ratio as a criteria.

These standards were reviewed in comparison with the AASHTO Guide for Design of Pavement Structure 1986 (both for flexible pavement and rigid pavement) by the Study Team. The results indicated that in case of flexible pavement, the Indonesian standard produces a larger pavement thickness than the AASHTO guide. Overlay thickness can not be reasonably estimated with it. While, in case of rigid pavement, the Indonesian standard produces a thinner pavement than the AASHTO guide, but it is considered too thin compared with the actual thickness of concrete pavement constructed in similar projects in Indonesia. The use of the Indonesian standard is questionable for the design of highways carrying such heavy traffic as on the Toll

Road. Based on these results, it is recommended to apply AASHTO's Guide 1986 for the pavement design, as was agreed by the Technical Committee.

Also, over-loading problems were analyzed based on the factual information on the existing Surabaya-Gempol Toll Road, since one of the major issues in the pavement design is in the assumption of axle load distribution in the total vehicle fleet. This issue is discussed in Section 9.8 of this Chapter.

The following design policies are agreed with the Technical Committee:

- Increased axle load from 8 ton to 10 ton for single axle load and from 15 ton to 18 ton for tandem axle shall be considered.
- In estimating cumulative ESAL, 10% contingency for possible over-loading shall be incorporated.
- Flexible pavement shall be adopted for the entire pavement design.

9.2.4 Drainage Design Standard

(1) *Design Rainfall Intensity*

The present flood control scheme of the Brantas river is formulated in accordance with the design flood discharge of 50 year return period and both the Porong and the Surabaya rivers are controlled rivers having levee systems at both banks. Therefore, the rainfall analyses were made only for the following return periods of maximum rainfall for design of the drainage system for the Toll Road as described in Section 6.4.

Drainage System	Return Period
• Tributaries of the Porong and Surabaya rivers	25 years
• Neighboring basin	5 years
• Surface water drainage	3 years

The estimated design rainfall intensity described in Section 6.4 and shown in Fig, 6.10 represents point rainfall which is applicable for the basin up to 4 km^2. Average rainfall intensity for the basin which has an area more than 4 km^2 will be reduced by an adjustment factor referring to Fig. 9.6.

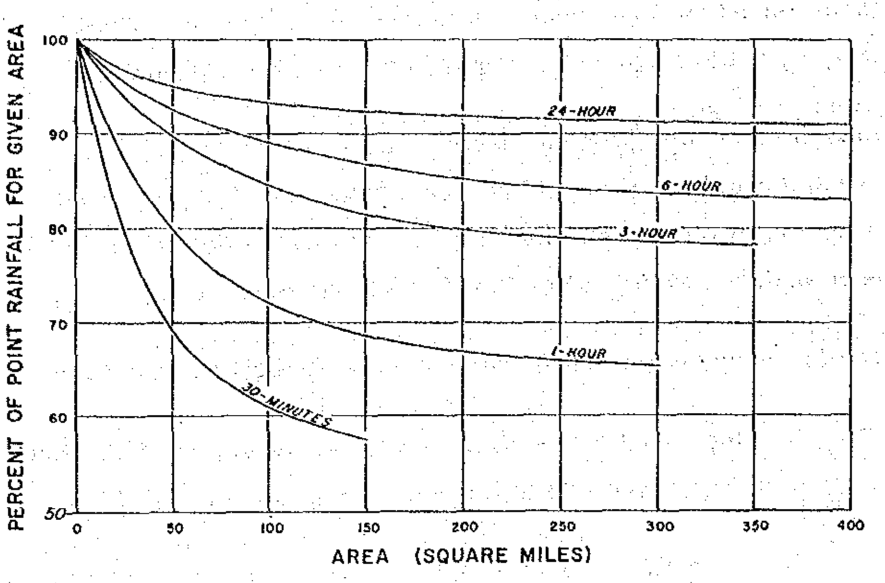


Fig. 9.6 Area-Depth Curves for Use with Duration-Frequency Values

(U.S. Weather Bureau)

(2) Run-Off Estimation Method

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 rivers and waterways to be crossed by the road.

Estimation of run-off for each from neighboring basin/area is based on the rational formula.

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

where. Q : Discharge (m^3/sec)
α : Adjustment factor (refer to Fig. 9.6)
f : Run-off coefficient
I : Rainfall Intensity (mm/hour)
A : Catchment area (km^2)

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 and roadside slope	0.9
Commercial area	0.8
Industrial and residential area	0.5
Irrigated paddy field	0.5
Village and military area	0.3
Gentle slope hill	0.3
Open space (forest and cemetery)	0.2

9.2.5 Design Standard of Road Lighting

(1) Location of Lighting Installation

Lighting installations for the Toll Road cover the following locations:

- Junction and interchanges including rampway
- On/off ramps including toll plazas
- At-grade intersections between the arterial road and interchange approach

(2) Design Illumination Intensities

The average intensities of illumination used in the design of the installations are as follows:

- 15 lux for throughways of the Toll Road
- 10 lux for junction and interchange ramps
- 10 lux for on/off ramps
- 20 lux for toll plazas
- 20 lux for at-grade intersections

9.3 Highway Capacity and Number of Lanes

9.3.1 Results of Traffic Forecast

The Toll Road traffic was forecast as summarized below (refer to Chapter 8):

Section	Toll Road Traffic (vehicles/day) Year 2005	Year 2015
Mojokerto IC - Krian IC	41,500	78,800
Krian IC - Driyorejo IC	41,400	81,800
Driyorejo IC - Lakarsantri IC	41,500	72,300
Lakarsantri IC - Surabaya JC	29,200	55,100

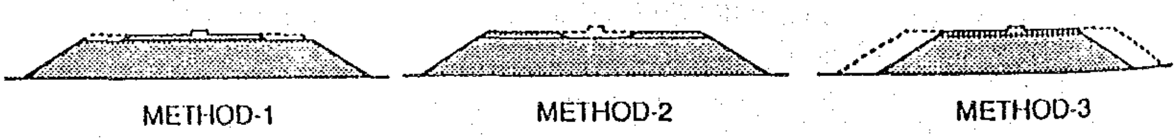
Among the above 4 sections, the estimated traffic on the section in the east of the Inner Ring Road (Lakarsantri IC - Surabaya JC) is lower than the other sections due to possible diversion of traffic through the Inner Ring Road.

9.3.2 Highway Capacity

The highway capacity of the Toll Road was examined based on the Highway Capacity Manual (Special Report 209, Transportation Research Council) as shown in Table 9.3, which indicates that a 4-lane cross section has a capacity of 48,000 vehicles/day and a 6-lane cross section 72,000 vehicles/day. These figures suggest a 4-6 lanes stage construction in a 25-year time span of the Project life (presumed opening of the Toll Road is in 1996).

9.3.3 Stage Construction

There are three alternative methods to widen the initial 4-lane carriageways to ultimate 6-lane carriageways as shown below.



Method-1 Initially earthwork for the ultimate stage (6-lane width) construction and 4-lane pavement at inside. The future pavement widening at outer lanes.

Table 9.3 Analysis of Highway Capacity

Description		Design Speed (km/hr)	
		120	100
Type of Terrain	(L, R, M)	Level	Level
Highway Classification	Classification	Freeway	Freeway
	Rural/Suburban/Urban	Rural	Suburban
Lane Width (m)		3.60	3.60
Lateral Clearance (m)	Outer	3.00	3.00
	Inner	1.50	1.50
Heavy Vehicles Composition (%)	Trucks	30	30
	Buses	8	8
	Recreational Vehicles	0	0
Passenger Car Equivalent	Er for Trucks	1.7	1.7
	Eb for Buses	1.5	1.5
	Er for RV's	1.6	1.6
Adjustment Factors	fw for Lateral Clearance	1.00	1.00
	fhv for Heavy Vehicles	0.80	0.80
	fp for Driver Population	1.00	1.00
Basic Capacity	(pcu/hr/lane)	2,000	2,000
Possible Capacity	(veh/hr/lane)	1,600	1,600
v/c Value for Level of Service C		0.77	0.69
Design Capacity	(veh/hr/lane)	1,232	1,104
Peak Factor	K (%)	8.0	8.0
Directional Factor	D (%)	60	60
Peak Hour Factor (PHF)		0.95	0.95
Daily Traffic Capacity for 4-lane (veh)		48,000	44,000
Daily Traffic Capacity for 6-lane (veh)		72,000	66,000

Method-2	Initially earthwork for the ultimate stage construction and 4-lane pavement at outside. The future pavement widening at inner lanes.
Method-3	Both earthwork and paving executed only for 4-lane cross section in the initial stage. Future widening of earthwork and pavement on both sides.

Among these 3 methods, Method-1 and Method-2 have the higher degree of completion in the initial stage construction. Selection of the stage construction method is dependent on the required timing of the development of additional lanes. If the predicted timing of widening is in the near future (within 10 years after opening), Method-1 or Method-2 is normally adopted. In the discussion with the Technical Committee, it was concluded to adopt Method-2 taking possible accelerated traffic increase in future into account. Method-2 has the following advantages compared with Method-1.

- Enhancement of traffic safety by wider median in the initial stage
- Elimination of demolition and reconstruction of interchange ramps
- Less initial cost
- Easier widening

For bridges and viaducts, it is recommended to construct the structure with 6-lane width in the initial stage, taking into account marginal cost saving and deterioration of traffic safety during the widening of structures.

9.4 Preliminary Geometric Design

9.4.1 Geometric Design Policies

Basic design policies to be applied to the Toll Road were established after detailed study of surrounding conditions. Horizontal and vertical alignment designs were achieved by carrying out integral studies on geometric, structural, hydrological/drainage and geological aspects and by maintaining close contact and cooperation with the concerned local government (Tk. II) and other authorities.

The outline of design policies and controls for the determination of horizontal and vertical alignment are described as follows.

- Safe and efficient movement of high volumes of traffic at the specified design speed (i.e. 120 Km/hr and 100 Km/hr) shall be attained by the provision of good roadway alignment.

- Where vertical and horizontal curves occur in combination or in close proximity to each other, consideration should be given to designing a flowing alignment by providing good coordination of these curves.

- The military area near Sta. 32 shall be avoided.

- Excavation in expansive clay soils area shall be avoided as much as possible.

- Countermeasures shall be provided to maintain the functions of the existing rivers, waterways, irrigation canals/channels and public facilities (i.e. roads., railways and utilities) which will be crossed by the Toll Road.

9.4.2 Horizontal Alignment Design

(1) Major Controls

The horizontal alignment of the optimum route obtained through the route selection process (refer to Chapter 7) was refined based on a study of 1:5,000 scale topographical maps of the area and field investigations. The following major factors are considered in the refinement of the horizontal alignment.

- To avoid as much as possible the existing public facilities such as schools, hospitals, mosques and government offices.

- To avoid Kedurus retarding pond at Sta. 35+000 - 36+ 000.

- To avoid developing factory areas in the north of the Surabaya river and the existing large factory complex at Sta. 37+600.

- To minimize the demolition of existing housing complexes at Kedurus and Karang Pilang.

(2) Summary of Design Features

As a result of the detailed horizontal alignment design, the total length of the Toll Road is measured at 38.32 km against 37.1 km counted in route selection stage. This difference does not change the conclusion of the optimum route.

A summary of design features of horizontal alignment of the Toll Road is shown in Table 9.4.

Table 9.4 Summary of Design Features of Horizontal Alignment of the Toll Road

ITEM	UNIT	TOLL ROAD SECTION	
		Mojokerto IC - Lakarsantri IC	Lakarsantri IC - Surabaya JC
Design Speed	Kph	120	100
Toll Road Length	km	32.0	6.3
Minimum radii	m	2,000	2,000
Minimum clothoid (A)	m	1,000	800
Minimum clothoid length	m	333	320
Minimum curve length	m	1,280 (26+550 - 27+830)	840 (33+130 - 33+970)
Maximum Curve Length	m	5,485 (11+150 - 16+635)	1,210 (36+495 - 37+385)
Maximum tangent length	m	2,400 (8+740 - 11+140)	–
Minimum tangent length between different direction curves	m	1,280 (26+550 - 27+830)	–
Minimum tangent length between same direction curves	m	1,220 (18+380 - 19+600)	–
Maximum superelevation	%	3	2

9.4.3 Vertical Alignment Design

(1) Major Elements Affecting the Design

The crossings with the existing facilities (i.e. roads, railway lines, rivers, waterways, irrigation canals and water mains) are principal controls for vertical alignment design and careful studies were carried out based on specific on-the-ground field surveys (list of crossing facilities, refer to Appendices A-9.2 and A-9.3). A summary of the existing facilities is shown in Table 9.5.

Table 9.5 Summary of Facilities to be Crossed by the Planned Toll Road

DESCRIPTION	CLASSIFICATION	LOCATIONS
Roads and Railway Lines	Toll Road	1
	National Road	2
	Planned Inner Ring Road	1
	Provincial Road	2
	Kabupaten Road	4
	Desa/Local Road	99
	Inspection Road	5
	PJKA Railway Line	1
	Sugarcane Railway	3
Rivers and Waterways	River	8
	Stream	13
	Major Irrigation Canal	3
	Minor Irrigation Canal	32
	Drainage Canal	20
	Drainage Ditch	21
Water Pipe Line	D = 1,300 mm	1

In parallel with the survey of the facilities to be crossed, evaluation of the results of bridge study, hydrological survey and soils and materials investigations and studies proceeded.

(2) Basic Guidelines

The following basic guidelines were established for the Toll Road vertical alignment design:

- The Porong and the Surabaya rivers and major irrigation canals are provided with inspection roads; required vertical clearance shall be maintained in the Toll Road design.
- Existing national roads and provincial roads are to be overcrossed (i.e. the Toll Road above) to avoid adverse effect to the existing traffic.
- Overcrossing (i.e. the Toll Road under) may be provided for Kab. roads and Desa roads, where it is effective to lessen the embankment requirement of the Toll Road construction.
- Severance of local communities will be avoided by the provision of box culverts.
- A minimum embankment height of 2 m above the existing ground shall be provided in technical irrigation areas to ensure the preservation of the irrigation systems.
- The embankment height shall be kept as low as possible in soft ground areas to reduce treatment effort as well as to shorten the construction period.
- Excavation of expansive soils in the north of the Surabaya river shall be avoided if the situations permit.

(3) Summary of Design Features

A summary of design features of vertical alignment of the Toll Road is presented in Table 9.6.

Table 9.6 Summary of Design Features of Vertical Alignment of the Toll Road

ITEM	UNIT	TOLL ROAD SECTION	
		Mojokerto IC - Lakarsantri IC	Lakarsantri IC - Surabaya JC
Design Speed	Kph	120	100
Toll Road Length	Km	32.0	6.3
Maximum Gradient	%	2.0	2.0
Minimum Vertical Curve Length (crest)	m	200	420
Minimum Vertical Curve Radii (crest)	m	30,000	30,000
Minimum Vertical Curve Length (sag)	m	200	120
Minimum Vertical Curve Radii (sag)	m	18,200	18,900

9.5 Cross Section Design

9.5.1 Cross Section Elements

(1) Number of Traffic Lanes

Cross section design is influenced primarily by the need to accommodate the required number of traffic lanes. The cross section design is based on the following number of traffic lanes:

Initial stage development : 4-lane
Ultimate stage development : 6-lane

(2) Cross Section Element

The outline of cross sectional elements are briefly described as follows:

- Number of lanes : 6-lane in ultimate stage
- Lane width : 3.6 m
- Widths of shoulders : 3.0 m for outer and 1.5 m for inner
- Median : 2.5 m raised median width in the ultimate stage
- Crossfall of pavement : 2.0% (i.e. normal crown)
- Crossfall of outer shoulder : 4.0%
- Crossfall of inner shoulder : 2.0% or same as the superelevation
- Maximum superelevation : 3.0% for 120 Km/hr design speed and 2.0% for 100 Km/hr design speed
- Side slopes : refer to Subsection 9.5.2
- Drainage channels : refer to Subsection 9.5.3

(3) Designation of Finished Grade

Finished grade of the Toll Road is designated by "F.G" and is positioned at the end of the inner shoulder (at raised median side) in the ultimate stage. The finished grade in the profiles shows the elevation in meters at this "F.G" point. A 2.0% of crossfall and required superelevation (downward or upward to the outer shoulder) will be provided based on this elevation.

9.5.2 Side slopes

(1) Side Slope in Embankment Section

Site conditions (i.e. right-of-way acquisition) do not permit the use of flat slopes. A minimum side slope of 1:2 (i.e. for lateritic soils and embankment height less than 7.0 m) was adopted in the design.

(2) Side Slope in Cut Section

A back slope of 1:1.5 was adopted based on an evaluation regarding the soil stability (i.e. silty sand and tuffaceous clay), cutting depth (i.e. 5.0 m at maximum) and normal highway construction practices in the region.

9.5.3 Drainage Channels and Erosion Control

(1) Drainage Channels

The design incorporates safety, good appearance and economy of maintenance. Flat side slopes and rounding design was adopted. Wide median is available in the initial Toll Road development stage. Median drainage was taken into consideration in the cross section design. Provision of intercepting ditches is considered in the design where long distance overland flow is anticipated.

(2) Erosion Control

Rainwater which falls on the traveledway flows away laterally under the influence of the cross slope or superelevation. A common rule for drainage where the traveledways are situated on earth embankment is to let the flow continue off the shoulders and down the side slopes to the paved side ditches. Protection with sodding (i.e. strip sodding in the construction) is adopted in the design. Cut slopes are designed in a similar manner. The median in the initial stage is to be sodded also. The center strip of the median is intended to be solid sodding since the area will form a swale line to the median drain inlet and water flow will be concentrated.

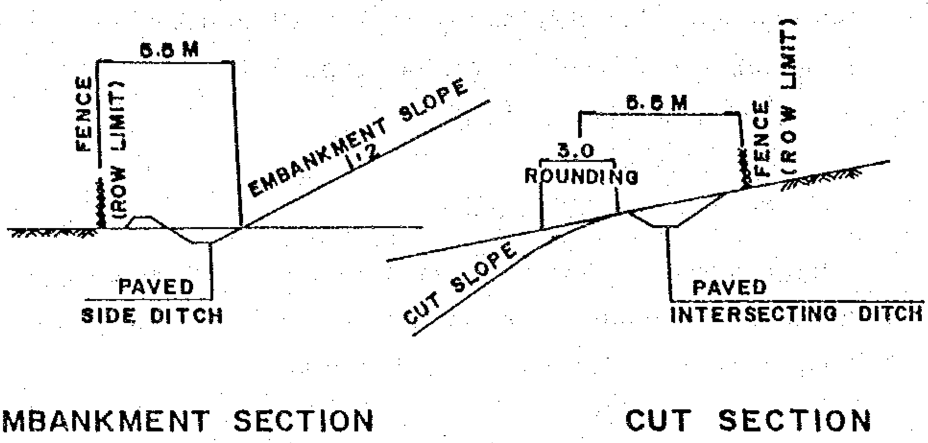
9.5.4 Typical Cross Sections and Right-Of-Way Width Requirement

(1) Typical Cross Sections

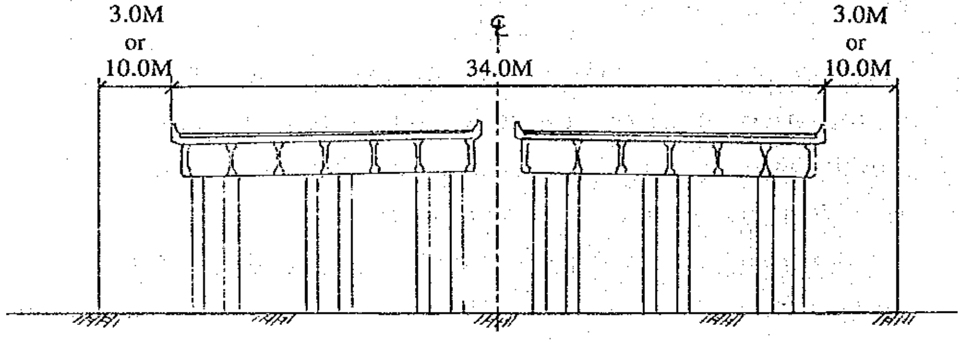
Recommended typical cross sections of the Toll Road are shown in Fig. 9.7. The left halves of the sections illustrate the Toll Road on earth embankment, and the right halves illustrate the Toll Road in cut sections.

(2) Right-Of-Way Requirement

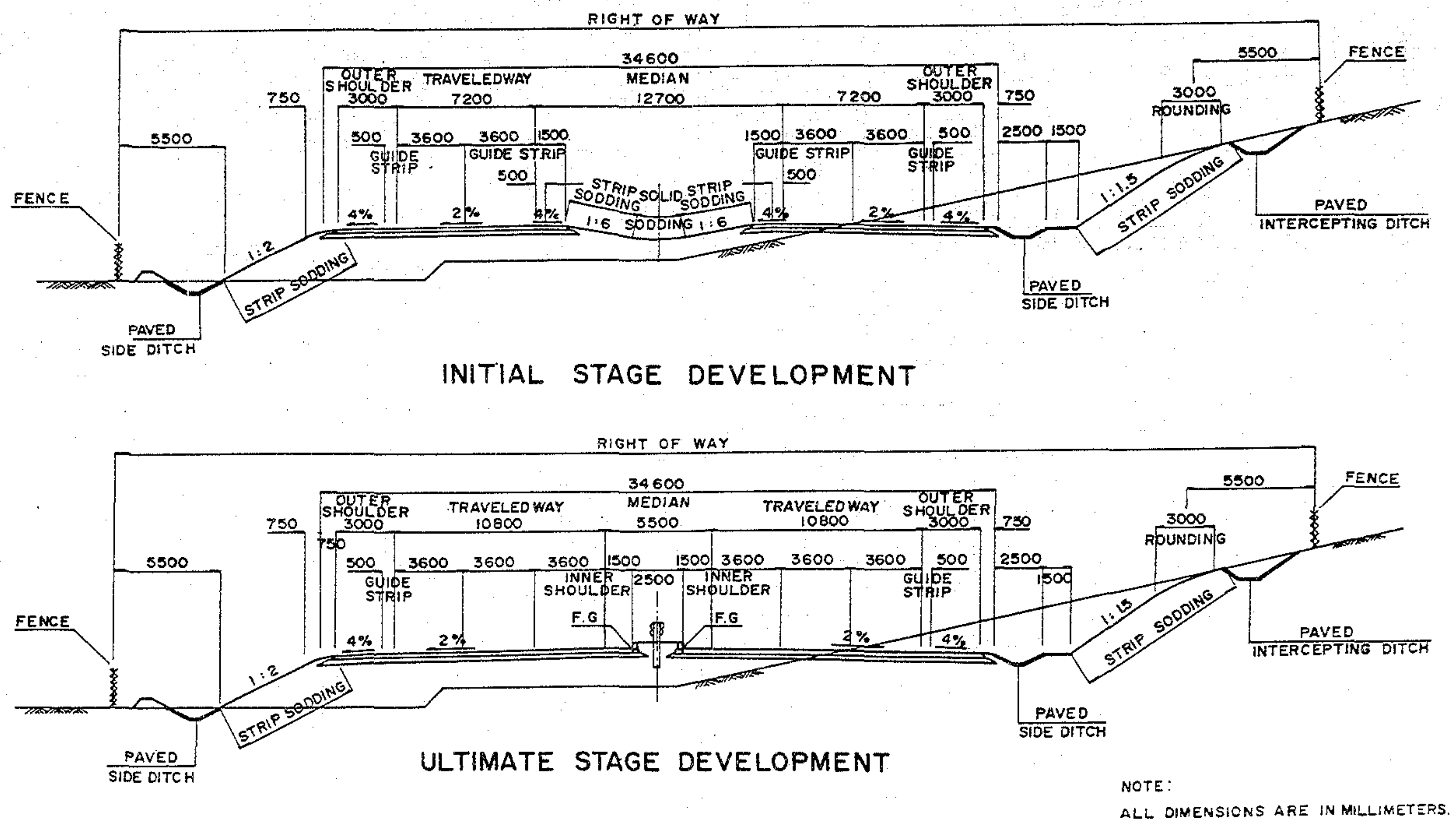
Right-of-way limit in earth embankment section and cut section is determined by the following rules.



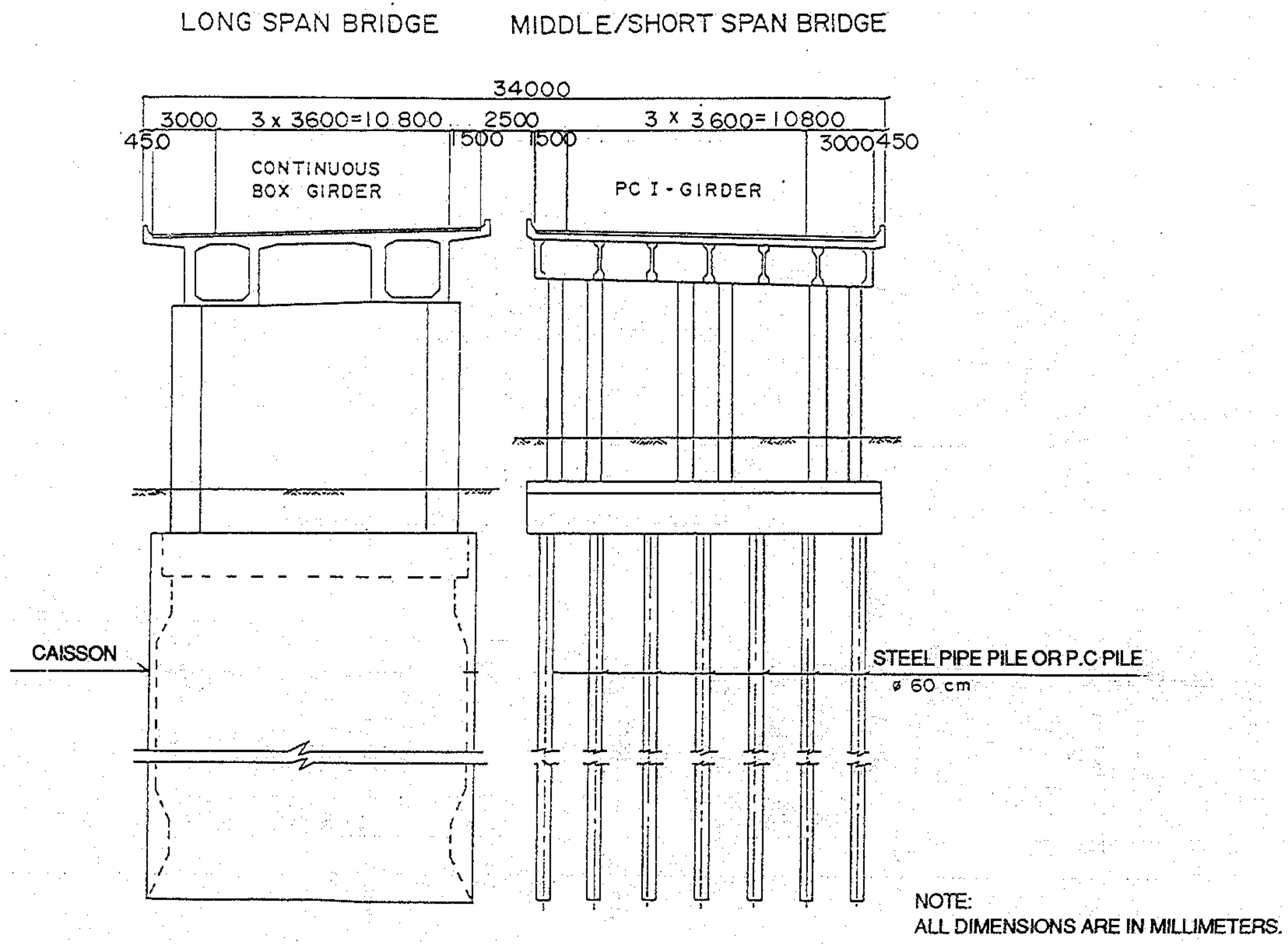
A constant 3.0 meters allowance on both sides to the total deck width was adopted for the determination of ROW limit in bridge and viaduct sections, except for the sections passing through the housing areas in Surabaya where 10.0 m allowance was adopted for provision of buffer zone in connection with preservation of environment against such adverse impacts as noise and vibration.



BRIDGE SECTION



SURABAYA - MOJOKERTO TOLL ROAD PROJECT | Fig. 9.7 (1) Typical Cross Sections (Earthwork Section)



SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 9.7 (2) Typical Cross Sections (Bridge Section)

9.6 Preliminary Design of Interchanges

9.6.1 General

There are two categories of interchanges; i) tollway-to-tollway interchange (Junction : JC) and ii) tollway-to-artery interchange (Interchange : IC). A Junction is planned at the connection between the Toll Road and the Surabaya-Gempol Toll Road which has direct/high-speed connection but without provision of toll gates. Interchanges are planned at the crossings with arterial highways (including planned highways) to collect/distribute the Toll Road traffic from/to the arterial highway network in the Project Area, normally with provision of toll gates.

This section describes the preliminary design of the junction and interchanges planned on the Toll Road together with the related studies.

9.6.2 Toll Levy System

The Toll Road will constitute a part of the Trans Java Tollway System, a system of regional toll roads. Therefore, it is understood that basically the Toll Road will be operated under a distance-proportional toll levy system.

The Toll Road will be connected at Surabaya JC with the Surabaya-Gempol Toll Road which is operated under two different kinds of toll levy system, the section north of Waru IC under a flat tariff toll levy system (as urban toll road section) and the section south of Waru IC under a distance-proportional toll levy system (as regional toll road section). There is a mainline toll barrier on Waru IC at the boundary of these two different systems.

Surabaya JC is located in the section of flat tariff toll levy system of the Surabaya-Gempol Toll Road. Therefore, it is necessary to provide a mainline toll barrier on the Toll Road in the west of Surabaya JC.

There are two options about the toll levy system on the eastern section of the Toll Road, with a distance-proportional toll levy system as the basic system, as follows:

Option-1 : To operate the entire length of the Toll Road under a distance-proportional toll levy system

Option-2 : To operate the section in the east of the Inner Ring Road under a flat tariff toll levy system combined with the flat tariff section of the Surabaya-Gempol Toll Road.

The area inside the planned Inner Ring Road is considered as an urban area. Therefore, it is reasonable and recommendable to operate the eastern section of the Toll Road under a flat tariff toll levy system (Option-2), for the convenience of urban toll road users whose trip length is relatively short.

However, selection between the above two options is suspended in this study, because it depends on the development of the Inner Ring Road and the proposal of possible private investors for the development of the Toll Road. Regarding the Inner Ring Road, there is no definitive plan yet. Though it is assumed as a non-toll artery in this Study, according to the present plan of Bappeda Tk. II of Kod. Surabaya, there still remains the possibility to operate it as a tollway. The alignment of the Inner Ring Road around the crossing with the Toll Road was discussed and virtually fixed with Bappeda.

9.6.3 Location of Interchanges

Five interchanges including those on both ends (Mojokerto IC and Surabaya JC) were planned in the stage of route selection (refer to Table 9.7 and Fig. 9.8). The shortest interval is 5.6 km between Driyorejo IC and Lakarsantri IC and the longest is 20.7 km between Mojokerto IC and Krian IC.

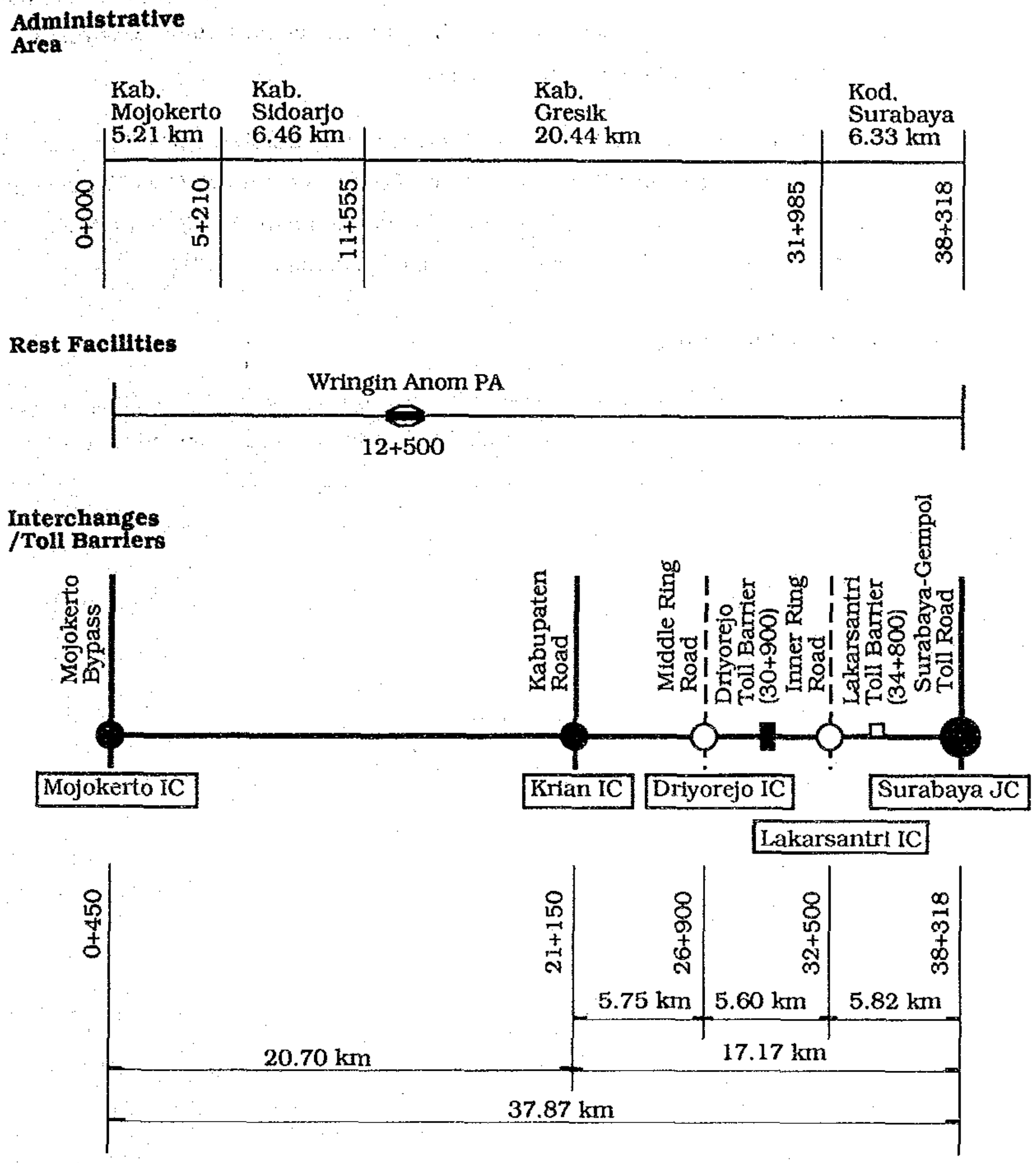
Table 9.7 List of Interchanges

No.	Name of Interchange	Sta.	Distance (km)	Connecting Road
1	Mojokerto IC	0+450		Mojokerto Bypass
2	Krian IC	21+150	20.70	Kabupaten Road
3	Driyorejo IC	26+900	5.75	Planned Middle Ring Road
4	Lakarsantri IC	32+500	5.60	Planned Inner Ring Road
5	Surabaya JC	38+320	5.82	Surabaya-Gempol Toll Road

These intervals fall in the following standard range, referring to toll roads under a distance-proportional toll levy system in Japan and in eastern U.S.A. Therefore, the planned arrangement of interchanges is judged appropriate.

Standard Interval of Interchange

- Urban areas, major industrial areas 5-10 km
- Flat area with dotted small towns 15-25 km
- Rural areas, mountainous area 25-30 km



SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 9.8 Location of Interchanges

There is no major point of trip generation or attraction in the 20.7 km stretch between Mojokerto IC and Krian IC and no interchange is planned in the present plan. However, there is the possibility to provide an additional interchange in this stretch depending on the growth of traffic demand. Since the alignment of the Toll Road is favorable throughout this stretch, there will be no serious constraints for the provision of such additional interchange.

It is to be noted that only Mojokerto IC, Krian IC and Surabaya JC will be constructed in the initial stage construction of the Toll Road. Lakarsantri IC will be constructed together with the Inner Ring Road (presumed opening is in 1999) and Driyorejo IC together with the Middle Ring Road (presumed opening is in 2009).

9.6.4 Layout of Interchanges

A summary of interchange layout is presented in Fig. 9.9. The location of interchange, forecast directional on/off traffic volume, recommended type, required number of toll gate lanes are shown on these figures.

Fig. 9.9 (1) Interchange Layout (1)

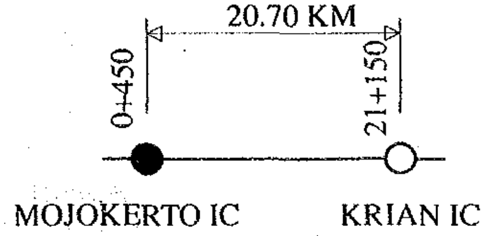
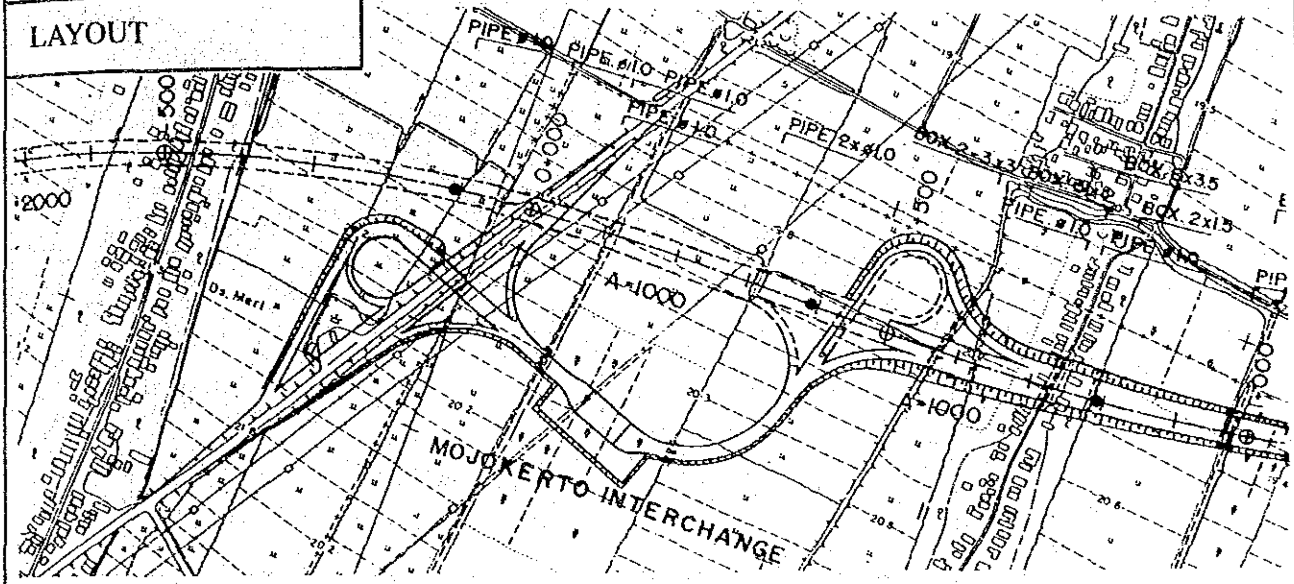
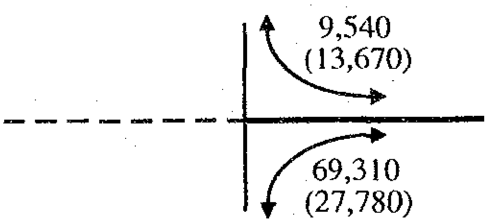
NAME	MOJOKERTO INTERCHANGE	
LOCATION		
LAYOUT		
CONNECTING ROAD	NAME/CLASS	MOJOKERTO BYPASS (NATIONAL HIGHWAY)
	DESIGN SPEED	60 KM/HR
ON/OFF TRAFFIC IN 2015(2005)	TOLL ROAD  Total 78,850 (41,450)	
NOS OF TOLL GATE LANES FOR 2015 (2005)	ON : 3 (2) OFF : 5 (3) REVERSIBLE : 1 (-) TOTAL : 7 (5)	
TYPE AND CHARACTERISTICS	**Double Trumpet Type** (B-Type on Toll Road Side) - Southeast quadrant is used taking directional traffic and land availability into accont - On the Toll Road side, 2 ramps will be constructed in the initial stage construction. The other 2 ramps including a loop ramp will be constructed at the time of westward extension of the Toll Road. - All ramps are of 2-lane. - Nos of toll booths are estimated for about 30% of on/off traffic assuming westward extension of the Toll Road.	

Fig. 9.9 (2) Interchange Layout (2)

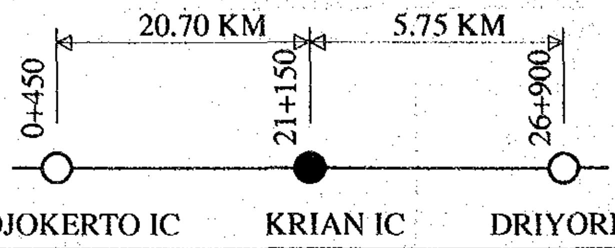
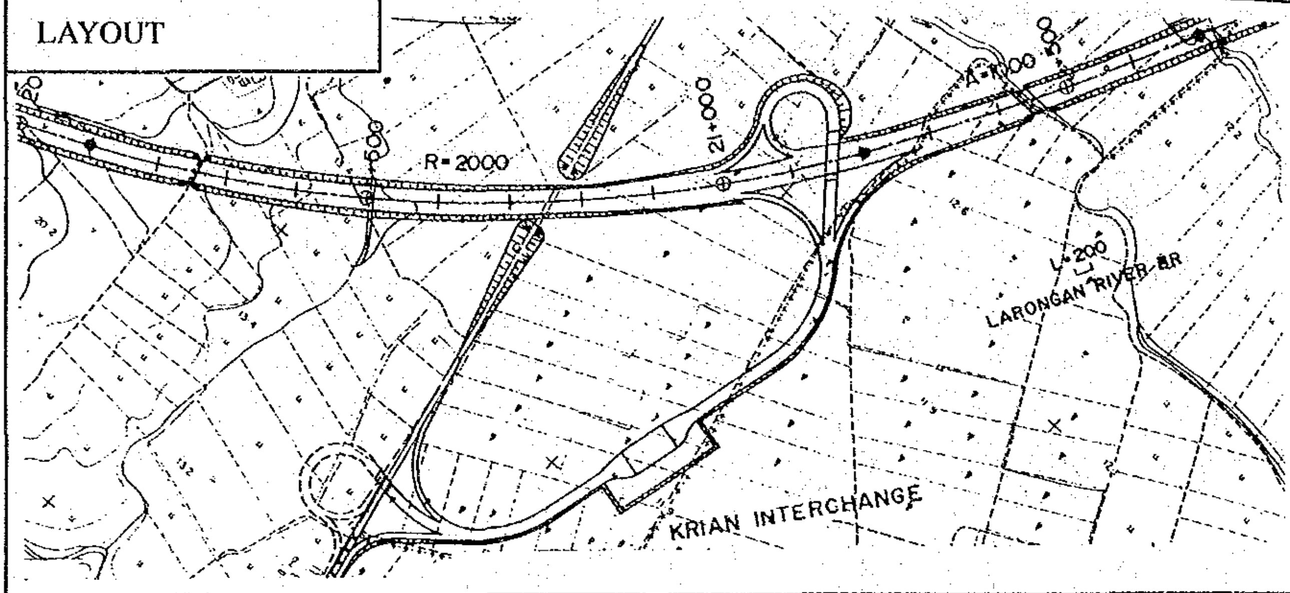
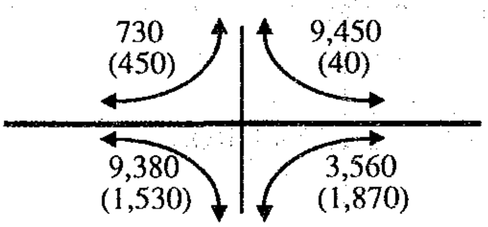
<table>
<tr><td>NAME</td><td colspan="2">KRIAN INTERCHANGE</td></tr>
<tr><td>LOCATION</td><td colspan="2">
</td></tr>
<tr><td>LAYOUT</td><td colspan="2">
</td></tr>
<tr><td rowspan="2">CONNECTING ROAD</td><td>NAME/CLASS</td><td>KABUPATEN ROAD</td></tr>
<tr><td>DESIGN SPEED</td><td>40 KM/HR</td></tr>
<tr><td>ON/OFF TRAFFIC
IN 2015(2005)</td><td colspan="2">
</td></tr>
<tr><td>NOS OF TOLL GATE
LANES FOR 2015 (2005)</td><td colspan="2">ON : 3 (2) OFF : 5 (2) REVERSIBLE : 1 (-) TOTAL : 7 (4)</td></tr>
<tr><td>TYPE AND
CHARACTERISTICS</td><td colspan="2">Double Trumpet Type (A-Type)
- Due to large on/off traffic predicted, double trumpet type is selected. For this layout, widening of the existing road leading to Krian city is required.
- Southeastern quadrant is selected taking topographic condition, dominant directional traffic in 2005 and better services to Krian city into account, though large traffic in north-east direction is predicted in 2015.
- All ramps are of 1-lane.</td></tr>
</table>

Fig. 9.9 (3) Interchange Layout (3)

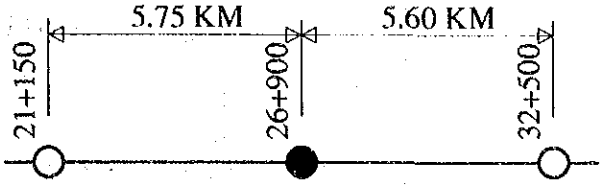
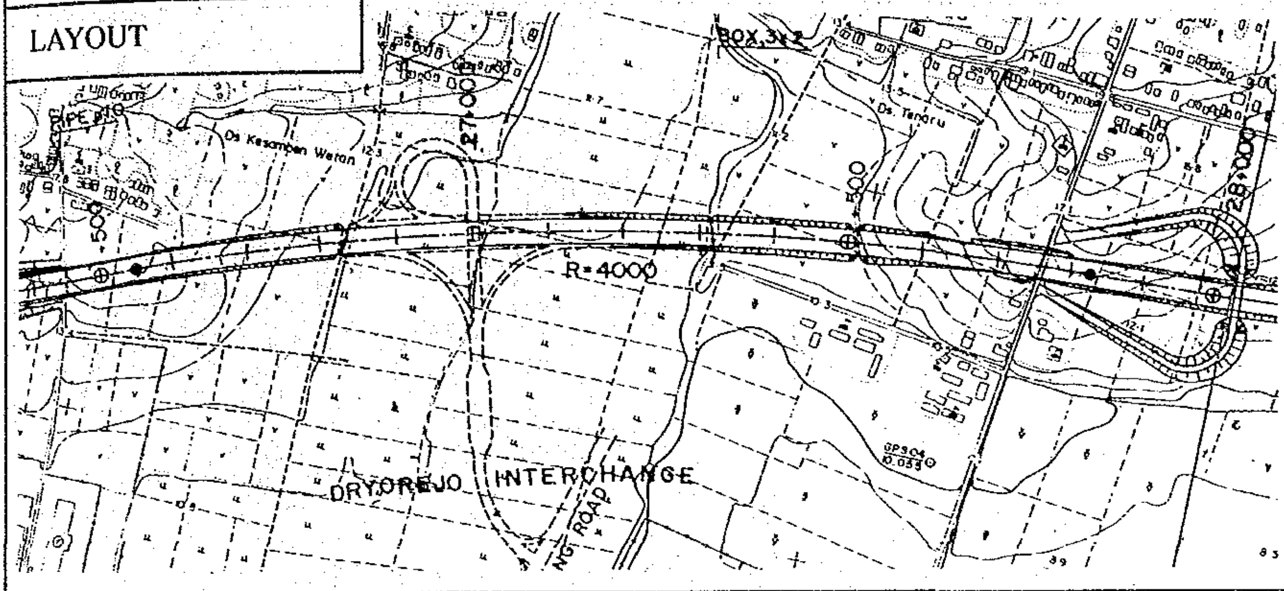
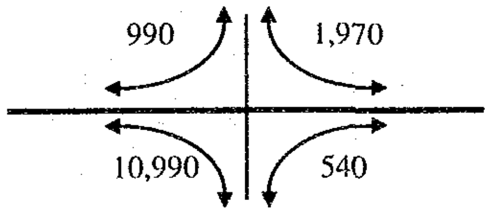
<table>
<tr><td>NAME</td><td colspan="2">DRIYOREJO INTERCHANGE</td></tr>
<tr><td>LOCATION</td><td colspan="2">
</td></tr>
<tr><td>LAYOUT</td><td colspan="2">
</td></tr>
<tr><td rowspan="2">CONNECTING ROAD</td><td>NAME/CLASS</td><td>SURABAYA MIDDLE RING ROAD</td></tr>
<tr><td>DESIGN SPEED</td><td>60 KM/HR</td></tr>
<tr><td>ON/OFF TRAFFIC
IN 2015</td><td colspan="2">
</td></tr>
<tr><td>NOS OF TOLL GATE
LANES FOR 2015</td><td colspan="2">ON : 2   OFF : 3   REVERSIBLE : 0   TOTAL : 5</td></tr>
<tr><td>TYPE AND
CHARACTERISTICS</td><td colspan="2">SingleTrumpet Type (A-Type)
- To be provided at the time of the construction of the Middle Ring Road (presumed opening in 2009).
- Southwestern quadrant is selected taking dominant directional traffic and topographic condition into account.
- Relatively large movement is predicted in west-south direction on the condition that the Middle Ring Road will be connected to the north of Sidoarjo and diversion of traffic to/from the southern and eastern areas of the Province will occur.</td></tr>
</table>

Fig. 9.9 (4) Interchange Layout (4)

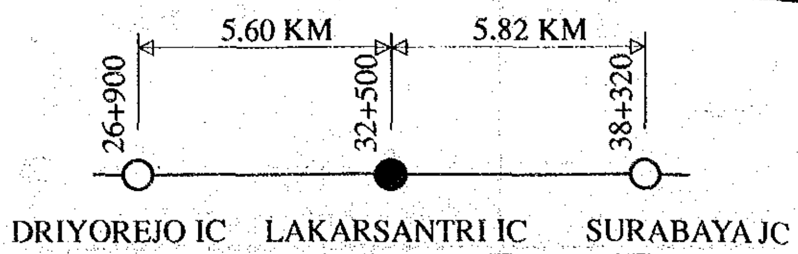
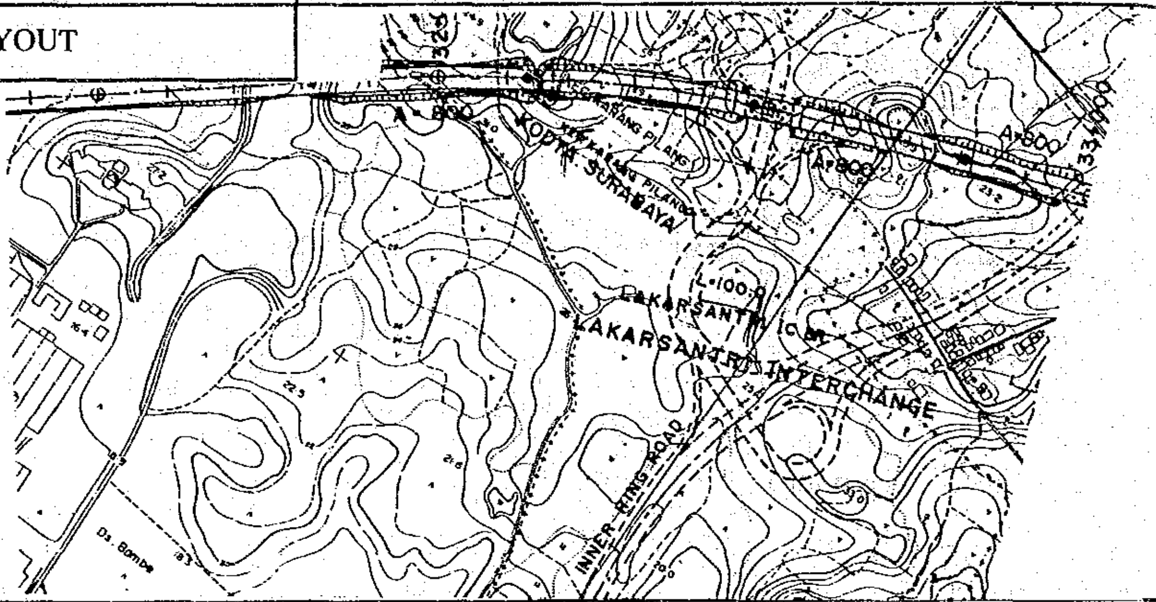
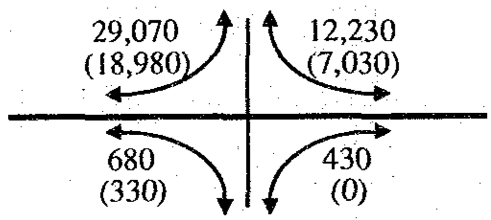
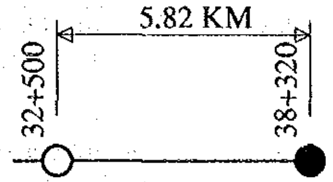
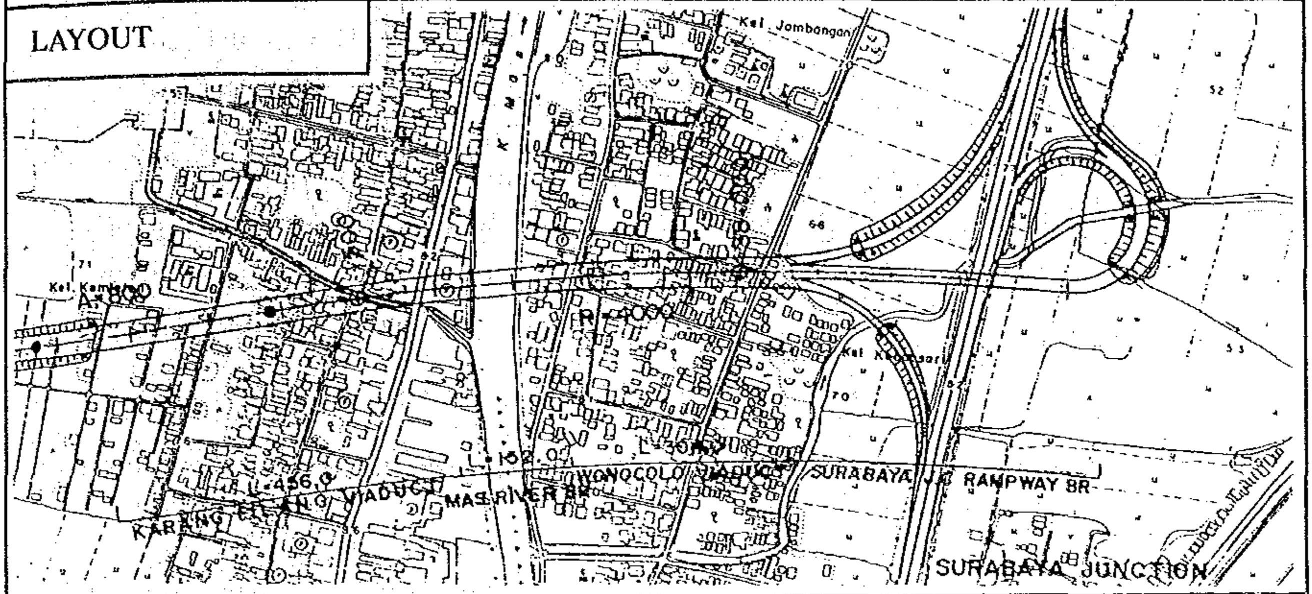
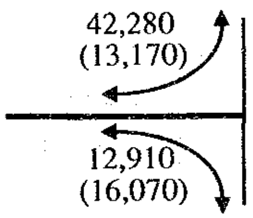
<table>
<tr><td>NAME</td><td colspan="2">LAKARSANTRI INTERCHANGE</td></tr>
<tr><td>LOCATION</td><td colspan="2">
</td></tr>
<tr><td>LAYOUT</td><td colspan="2"></td></tr>
<tr><td colspan="3">
</td></tr>
<tr><td rowspan="2">CONNECTING ROAD</td><td>NAME/CLASS</td><td>SURABAYA INNER RING ROAD</td></tr>
<tr><td>DESIGN SPEED</td><td>60 KM/HR</td></tr>
<tr><td>ON/OFF TRAFFIC
IN 2015(2005)</td><td colspan="2">
</td></tr>
<tr><td>NOS OF TOLL GATE
LANES FOR 2015 (2005)</td><td colspan="2">ON : 6 (4) OFF : 14 (8) REVERSIBLE : 1 (1) TOTAL : 19 (11)</td></tr>
<tr><td>TYPE AND
CHARACTERISTICS</td><td colspan="2">Double Trumpet Type (A-Type)
- To be provided at the time of the construction of the Inner Ring Road (presumed opening in 1999).
- Southeastern quadrant is selected taking topographic condition, location of the existing villages and highway into account though the forecast dominant directional traffic suggests the use of northwestern quadrant.
- No toll gate facility is planned under the scenario of flat tariff toll levy system for the section in the east of this interchange.
- Nos of toll booths shown above is for the mainline toll barrier gate located in the west of this interchange.</td></tr>
</table>

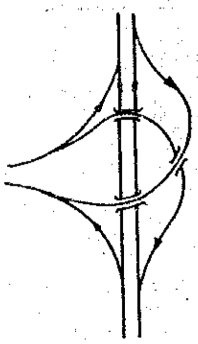
Fig. 9.9 (5) Interchange Layout (5)

NAME	**SURABAYA JUNCTION**	
LOCATION	 LAKARSANTRI IC SURABAYA JC	
LAYOUT		
CONNECTING ROAD	NAME/CLASS	SURABAYA-GEMPOL TOLL ROAD
	DESIGN SPEED	100 KM/HR
ON/OFF TRAFFIC IN 2015(2005)	TOLL ROAD 	Total 55,190 (29,240)
NOS OF TOLL GATE LANES IN 2015 (2005)	ON : 7 (4) OFF : - (-) REVERSIBLE : - (-) TOTAL : 7 (4)	
TYPE AND CHARACTERISTICS	**Trumpet Type** - Selected as this type is more economical in comparison with Y-type. - All ramps are of 2-lane. - Radius of loop ramp is 90 m for design speed of 50 km/hr. - Nos of toll booths shown above is for the mainline barrier gate, 3.5 km west of the junction, for the assumed flat tariff toll levy system in the eastern section of Lakarsantri IC.	

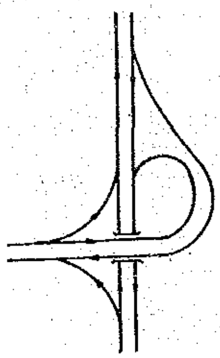
1) Surabaya Junction

Surabaya Junction is a 3-leg interchange which connects the Toll Road with the existing Surabaya-Gempol Toll Road. There is little possibility to extend ramps eastward.

Y-type and trumpet type are conceivable types of layout of this junction.



Y-Type



Trumpet Type

From these two conceivable types, trumpet type was selected based on the following reasons:

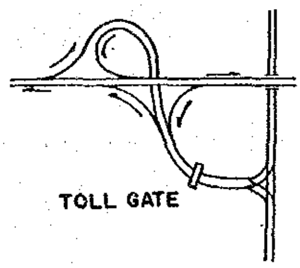
- Y-type requires three grade separation structures, two over the Surabaya-Gempol Toll Road and one over an interchange ramp. Construction cost is much higher than trumpet type which requires only one grade separation structure over the Surabaya-Gempol Toll Road.
- The level-of-service on the loop ramp in Trumpet Type is lower than that of semi-direct ramp of Y-type, however it is allowable for the projected level of southbound traffic, which is smaller in comparison with northbound traffic.
- Trumpet type usually requires more land than Y-type, but no serious constraint exists at the planned location.

A loop ramp will be used for the on-ramp for southbound traffic following the general rule of the more direct alignment favoring the heavier traffic volume (northbound traffic) and the loop the lesser volume. The radius of loop ramp is 90 m for the design speed of 50 km/hr for the ramps of a junction as discussed in Subsection 9.2.2. All ramps will be designed with a dual-lane carriageway.

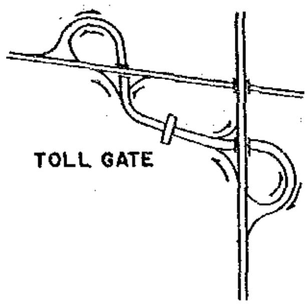
2) Interchanges

Four Interchanges (tollway-to-artery) are planned; Mojokerto IC for the connection with Mojokerto bypass, Krian IC with the Kabupaten road leading to Krian city, Driyorejo IC with the planned Middle Ring Road and Lakarsantri IC with the planned Inner Ring Road.

Under the distance-proportional toll levy system, it is necessary to provide toll gates, on-ramp gates for issuing magnetic cards and off-ramp gates for collecting toll. The type of interchange which provides integrated on/off ramp gates at one location is advantageous as it is economical and efficient for tollway operation and management. The type which allows such arrangement is normally a trumpet type, single- or double-trumpet depending on the volume of on/off traffic. which has been applied for all the interchanges. This type is applied for most of the interchanges on the Surabaya-Gempol Toll Road and is desirable from the view point of system consistency.



Single Trumpet Type



Double Trumpet Type

For three of the interchanges, excluding Driyorejo IC (single-trumpet type), the double-trumpet type was applied because of large forecast on/off traffic which exceeds 20,000 vehicles per day in 2015.

The layout of the trumpet type can be A-type (loop ramp for on-ramp) and B-type (loop ramp for off-ramp), selection of which depends on the directional traffic volume forecast. For the direction of heavier traffic, semi-direct ramp was used as a general rule. In case of no significant difference in directional traffic, A-type is selected. Based on the results of traffic forecast, A-type was selected for Krian, Driyorejo and Lakarsantri ICs and B-type for Mojokerto IC. The radius of the loop ramp is 50 m for design speed of 40 km/hr.

Mojokerto IC has a distinctive characteristic. In the initial stage operation before the westward extension of the Toll Road, on/off traffic of this interchange is large since all the Toll Road traffic from/to the western area of Mojokerto will use this interchange. Therefore, a trumpet was designed for grade-separation on the connecting road (Mojokerto Bypass) side, though no grade-separation is required on the Toll Road side in the initial stage.

3) Number of Toll Booths

The required number of toll booths at tollway-to-artery interchanges and at the toll barrier was estimated on the following conditions:

a) Design Traffic : traffic in 2015

b) Service Level

- Service Time :
  - On-ramp : 6 seconds
  - Off-ramp : 14 seconds
- Waiting queue : 3 vehicles

9.6.5 Location of Toll Barrier

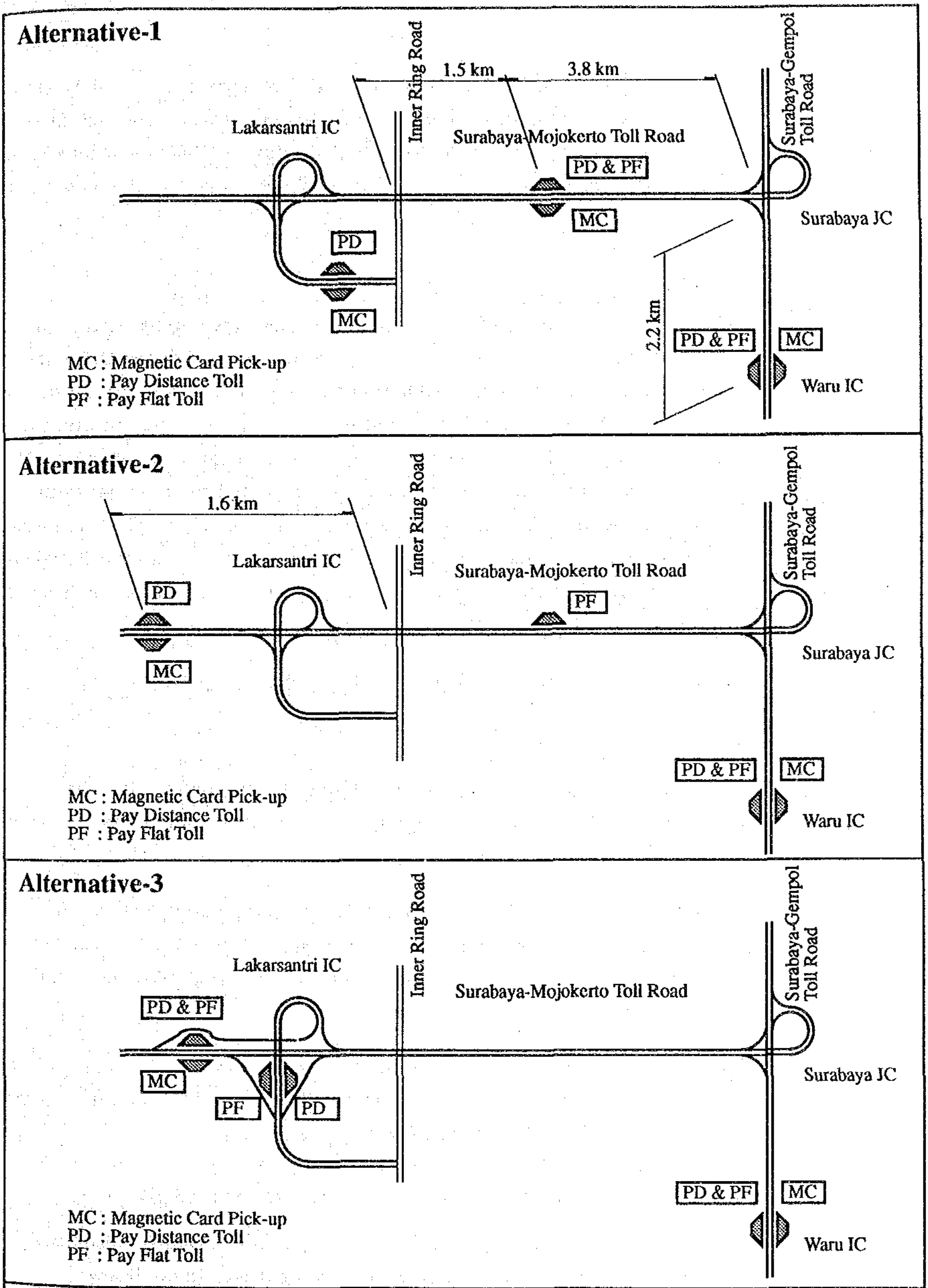
There are three alternative locations of toll barrier in connection with the toll levy system of the Toll Road discussed in Subsection 9.6.2 (refer to Fig. 9.10).

Alternative-1

A toll barrier will be located between Surabaya JC and Lakarsantri IC, 3.8 km west of Surabaya JC, on the assumption that the entire length of the Toll Road will be operated under a distance-proportional toll levy system. The westbound vehicles will pick up magnetic cards and the eastbound vehicles will pay the distance-proportional toll of the Toll Road plus flat toll of the Surabaya-Gempol Toll Road at this barrier.

Alternative-2

This alternative is for the case that the section in the east of Lakarsantri IC will be operated under a flat tariff system as an urban toll road section, combined with the same tariff section of the Surabaya-Gempol Toll Road. A mainline toll barrier will be located at 1.6 km west of Lakarsantri IC. This toll barrier is for issuance of magnetic cards for entry and collection of toll for exit



SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 9.10 Toll Levy System and Location of Toll Barrier

for the section under a distance-proportional toll levy system in the west of Lakarsantri IC. Another mainline toll barrier will be required in this alternative on the eastbound lane between Surabaya JC and Lakarsantri IC for collection of flat tariff toll. On the other hand, no toll gate facility is required at Lakarsantri IC.

Alternative-3

The section in the east of Lakarsantri IC will be operated under a flat tariff toll levy system the same as Alternative-2. The two toll barriers in Alternative-2 are combined and a mainline toll barrier will be located on Lakarsantri IC, the same type of arrangement as the toll barrier in Waru IC on the Surabaya-Gempol Toll Road. This toll barrier will issue magnetic cards to all the westbound vehicles and collect distance-proportional toll plus flat tariff toll from eastbound vehicles except those which exit at Lakarsantri IC. Toll gates for collection of flat tariff toll from on-traffic to the east and for collection of distance-proportional toll from off-traffic from the west will be provided on the ramps of Lakarsantri IC.

A comparison of the above three alternatives is described below.

a) Users Convenience

The number of toll transactions should be minimized for the users convenience, the maintenance of operational efficiency and enhancement of traffic safety.

For the convenience of urban toll road users (short trip users) who use the section in the east of Lakarsantri IC, Alternative-2 or -3 is more preferable minimizing the number of toll transactions to encourage utilization of the toll road and voluntary payment of tolls.

In case of Alternative-2, long trip users from the west of Lakarsantri IC are obliged to make toll transactions twice in a distance of 3.9 km, but it makes clear the connection of the two different toll levy systems.

b) Number of Toll Gate Lanes

Number of toll gate lanes at toll barrier(s) and Lakarsantri IC was estimated for each alternative based on the forecast traffic in 2015, as shown below.

Toll gate	Alt.-1	Alt.-2	Alt.3
Mainline Toll Barrier			
Lakarsantri IC - Surabaya JC	15	19	-
West of Lakarsantri IC	-	7	-
On Lakarsantri IC	-	-	14
Ramps of Lakarsantri IC	12	-	8
Total	27	26	22

Alternative-3 needs less number of toll booths than the other alternatives, putting toll facilities together at one location, which implies less construction cost and less operation cost than the others.

c) Future Extension of Toll Booths

Stage installation of toll facilities is usual practice, initial stage installation with 5th to 10th year after the opening as the planning year and extension of facilities in the next stage based on a review of the requirements. In case of Alternative-3, future extension of toll booths is limited by the interchange ramps constructed in the initial stage. Interchange ramps should therefore be designed securing sufficient area for future extension of toll booths.

d) Control of Overloaded vehicles

The Surabaya-Gempol Toll Road has experienced serious overloading which has a large affect on the durability of the pavement structure. In order to control and eliminate overloading, Jasa Marga plans to install axle load meters at every on-ramp gate of the Surabaya-Gempol Toll Road. Such measure should also be introduced to the Project Toll Road.

In the case of Alternative-2, Lakarsantri IC needs no toll gate facility. However, the facility for axle load control might be required to exclude overloaded vehicles.

e) Revenue Sharing

At present, the Government is actively pursuing private sector participation in the construction and operation of toll roads. In the case of the introduction of private sector participation to the Toll Road, a reasonable revenue sharing system should be established with the Surabaya-Gempol Toll Road.

In the case of Alternative-1, revenue sharing is clear. Flat toll collected on the mainline toll barrier will belong to the Surabaya-Gempol Toll Road.

In case of Alternative-2 and -3, it is necessary to divide the revenue on the flat tariff section of the Toll Road based on agreement between Jasa Marga and the private sector participant, since the flat tariff toll levy system can provide only the two data elements of entry point and toll paid (always constant). Jasa Marga's 100% investment for the construction and operation of this section can be another reasonable solution to eliminate the revenue sharing problem.

Recommendation

As mentioned in Subsection 9.6.2, it can be recommended to operate the eastern section of the Inner Ring Road under a flat tariff toll levy system. From this viewpoint, Alternative-2 or -3 is to be selected. It still remains a possibility to operate the Inner Ring Road as a tollway, though it is planned as non-toll at present according to Bappeda of East Java Provincial Government and the Study assumes as such. In the case that the Inner Ring Road is operated as a tollway, the layout of Lakarsantri IC in Fig. 9.9 (4) should be changed and Alternative-3 above can not be applied directly.

Based on the above considerations, it is recommended to locate a mainline toll barrier in the west of Lakarsantri IC at Sta. 30+900 following the concept of Alternative-2 in the initial stage construction, leaving room for flexibility regarding the planning of the Inner Ring Road and the toll levy system in the eastern section of the Toll Road. Even if the Inner Ring Road is operated as a tollway, the recommendation regarding the location of the mainline toll barrier is unchanged. If the concept of Alternative-2 is valid at the time of the construction of the Inner Ring Road and Lakarsantri IC, another toll barrier for the flat tariff section can be constructed at Sta. 34+800.

9.6.6 Rest Facilities

Rest facilities are generally classified into two categories. One is Service Area (SA) which provides sufficient services for drivers and passengers including such facilities as parks, public lavatories, restaurants, stores, gas /service stations. The other is Parking Area (PA) providing limited facilities such as parking lots, public lavatories and stands.

Since the lengths of the toll roads in operation in Indonesia are still short, such facilities are limited at present (There are small parking areas along the Jakarta-Cikampek Toll Road. Installation of parking areas is planned on the Surabaya-

Gempol Toll Road in the south of Waru IC). Jasa Marga has plans to install such facilities and is formulating a standard for the provision of rest facilities.

According to the Japanese standard, the intervals of rest facilities is as follows:

Rest Facilities	Standard	Maximum Limit
- Intervals for all rest facilities	15 km	25 km
- Intervals for service areas	50 km	100 km

Referring to the above, a parking area is planned at Sta. 12+500 between Mojokerto IC and Krian IC. The proposed scale of the parking lot will be that which accommodates 40 passenger cars and 20 large-sized vehicles. However, it is recommended to exclude this parking area from the initial stage construction, since the total length of the Toll Road is only 38 km and utilization of such a parking area is unclear. Its construction shall be reviewed later based on an examination of the actual utilization records of the parking area planned on the Surabaya-Gempol Toll Road. No Service area is planned in the stretch of the Toll Road.

9.7 Preliminary Design of Bridges and Culverts

9.7.1 General Description of Bridge Types

(1) Superstructure

The superstructures of the throughway, rampways and overbridges should be designed to meet the following general requirements.

a) Structural Requirements

The general relationship between span length and bridge type is shown in Fig. 9.11.

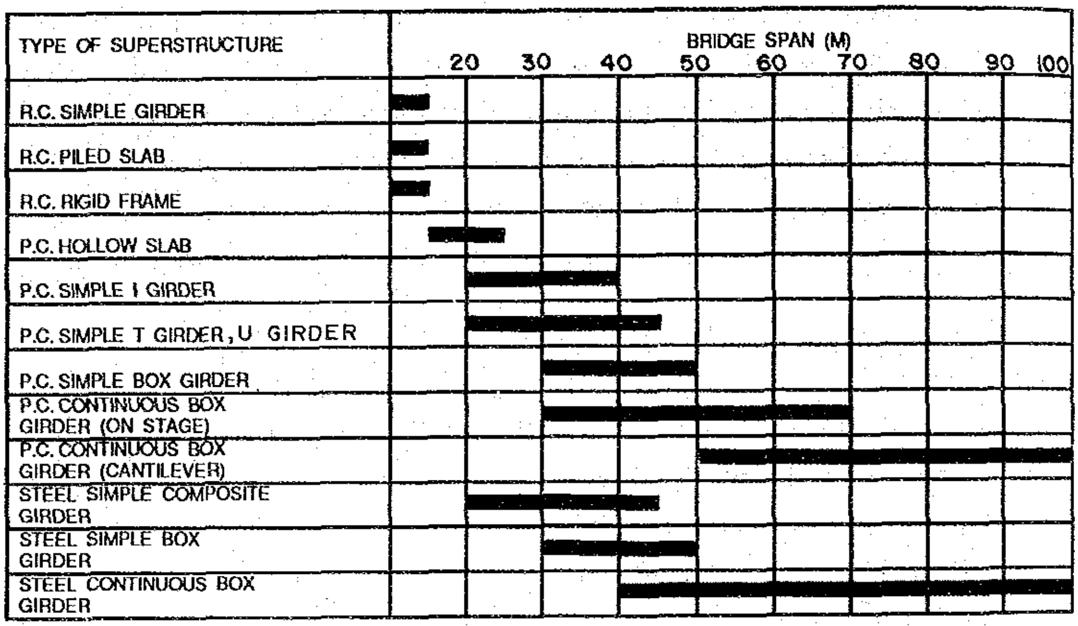


Fig. 9.11 Standard Spans for Various Types of Bridge

The minimum span length of a bridge is generally determined by the nature of the roads, railway lines or rivers over which the bridge is required to pass; the soil condition, and factors relating to the surroundings. For a bridge over an unimproved river, a careful study should be made of the river course and flow characteristics. The span length is one of the most important factors in determining the bridge type. Once the span length is fixed then the choice of bridge type is limited.

A beam or girder has a desirable ratio of depth to the length of span which will result in minimum construction cost, and this depth ratio is generally adopted.

However, for the main span of a bridge where the depth is critical for determining the vertical alignment of the road which will affect the total cost of the structure, the minimum depth is selected.

b) Environmental Requirements

Careful considerations are necessary to preserve the existing environment of man-made facilities (i.e. irrigation canals, public facilities such as road network and railway lines) and to avoid adverse effect to existing rivers.

From the aesthetic point of view, a bridge type which harmonizes with the surrounding environment should be adopted. For flyover bridges, the structural appearance from the underside is also considered.

c) Construction Requirement

The constructional and maintenance aspects are important factors in the selection of the bridge type. Concrete bridges are generally recommended in the Project because of their durability and freedom from maintenance as well as availability of domestically produced cement and reinforcing bars.

The cantilever method is considered for bridges over the major rivers. The pre-cast method is an effective way to shorten the construction period. If the construction period is limited, the type of bridges is determined by taking into account the speed of construction.

d) Construction Economy

The most economical type of bridge was finally selected from the alternatives which satisfy the conditions mentioned above. To compare the costs of various bridge types, the total construction costs of the superstructure, substructure and approaches are considered, together with maintenance costs.

(2) Substructure

The substructure of throughway bridges, rampway bridges and overbridges should be designed to meet the following general requirements.

a) Abutment

Reinforced concrete is usually used for abutments. In general the type of abutment is determined based on the relationship between height and the suitability of abutment type as shown in Fig. 9.12.

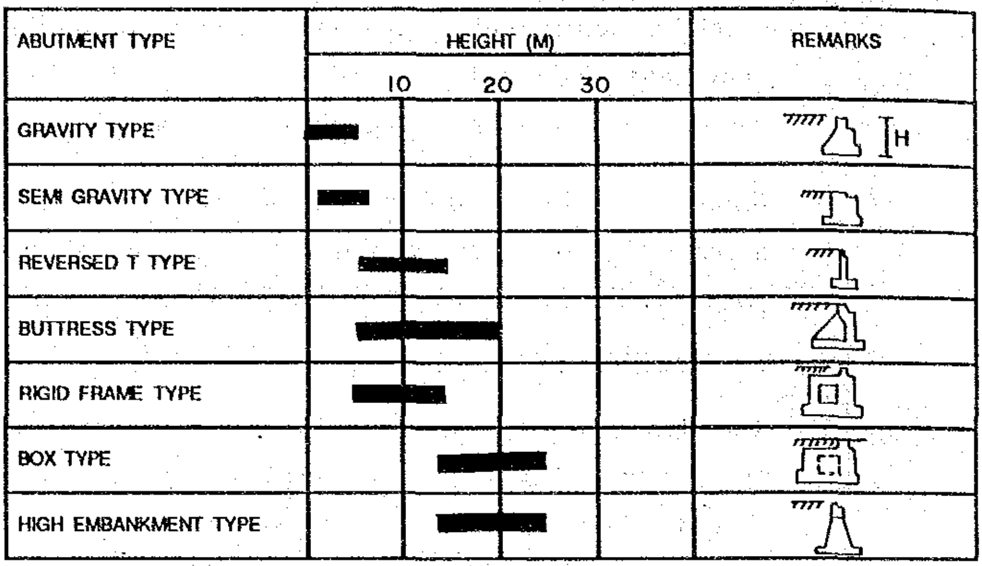


Fig. 9.12 Range of Heights for Various Types of Abutment

b) Pier

Reinforced concrete piers are generally used unless special conditions must be met. The appearance of the piers is an important factor in determining which type should be used, especially for flyovers.

Pile bent pier is adopted at many old river/canal bridges in Indonesia. This is because of its low construction cost. This type causes a whirlpool effect and often abnormal scouring near the pier, and the flow area is decreased because of detained logs and trash in front of the pier. Rigid frame pier causes a whirlpool effect also. Rigid frame pier with inner wall improves the situation to a certain extent. Wall type pier is recommended for river/canal piers in this Project to provide smooth flow of water at the piers.

c) Types of Foundation

The foundation type is determined mainly by subsoil conditions, the loading to be supported and economic criteria. Generally a direct foundation is used where the depth of the supporting strata is less than 5 m, whereas, a piled foundation is employed for depths more than 5 m.

9.7.2 Design Features of Bridges and Viaducts

(1) Superstructure Design

a) Precast PC I-Girder Bridge/Viaduct

The I-girder bridge was selected from among the precast bridge types of PC I-, U- and T-girders based on its economy and ease of construction. Girders are composite type and a Gerber structure with reinforced concrete cantilevered pier decks was adopted. Span length ranges between 12.5 - 40.0 m and standardization of girders was considered in the design.

b) PC Box Girder Bridge

By the requirement of the river authority, 3-span continuous PC box girder bridges (40 m - 60 m - 40 m) were adopted for the Porong and Surabaya rivers to minimize disturbance to the existing river flows.

(2) Substructure Design

a) Abutment

The height of abutments ranges from 5 to 10 m, therefore the reversed T-type abutment was adopted.

b) Piers

Except for the long span bridges for the Porong and Surabaya rivers, column type pier was adopted for all bridges and viaducts since the appearance is less clumsy and bulky.

Wall type piers were adopted for the above long span river bridges to provide smooth flow of water near the piers.

c) Foundations

Pile foundations are necessary due to adverse sub-surface soil conditions in the Project Area. The adoption of any of the following three types of piling is generally possible but the utilization of a reversed circulation drill will be disadvantageous because of longer construction period and the adverse environmental effect of the excavated mud.

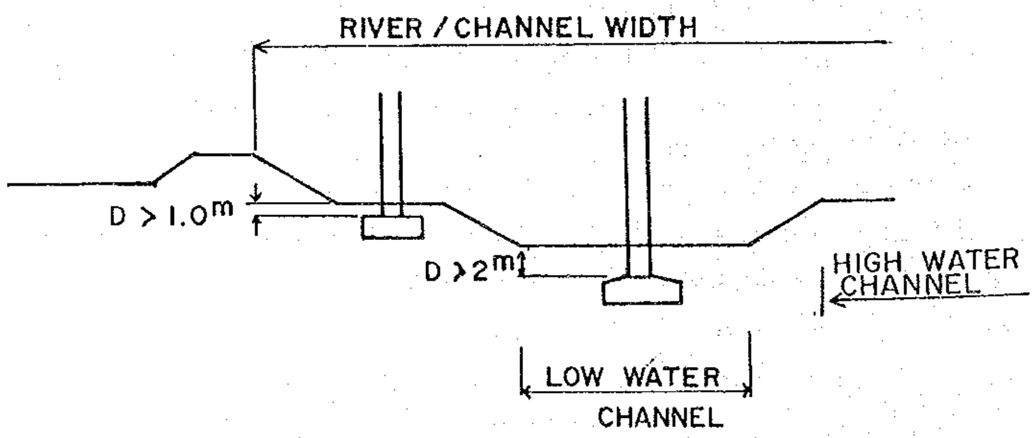
- Precast PC piles
- Steel pipe piles
- Cast-in-place concrete piles with reversed circulation drilling

Precast PC pile (ø 60 cm) was generally adopted except for in the soft ground areas. Steel pipe pile (ø 60 cm) was used in the soft ground areas where the depth of adverse soils is more than 30 m (i.e. Karang Pilang Viaduct, Mas River Bridge and Wonocolo Viaduct).

Open caisson was adopted due to the excessively large external forces at the fixed end of the long span bridges over the Porong and Surabaya rivers. These foundations should be constructed during the dry season when the water level becomes lower to minimize construction cost as well as to mitigate the adverse environmental effect.

d) Cover of Foundation Slabs

Pier/abutment foundation slabs are required to keep appropriate soil cover to avoid possible displacement by scouring near the structure due to tractive forces. Soil cover of one (1) meter or two (2) meters is considered as shown below.



e) Revetment Protection

Revetment protection was designed at the crossings of major rivers and canals as shown in Fig. 9.13.

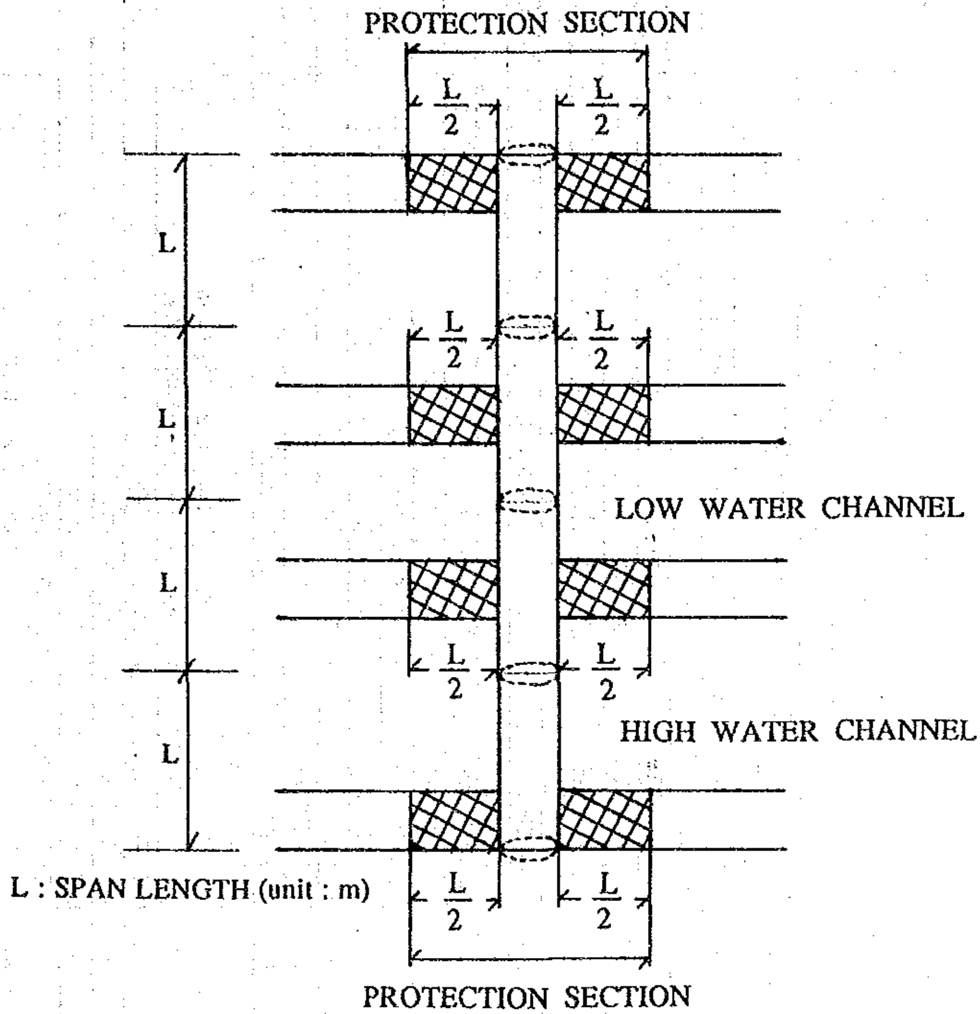


Fig. 9.13 Revetment Protection

(3) Summary of Design Features of Bridges and Viaduct

Design features of bridges, viaducts and overbridges are summarized in Tables 9.8 and 9.9.

Table 9.8 Summary of Design Features of Bridges and Viaducts

NO.	BRIDGE NAME	STATION FROM		STATION TO	BRIDGE TYPE	WIDTH (m)	SPAN ARRANGEMENT	BRIDGE LENGTH (M) CONT.	PC-I S > 30 m	PC-I S ≤ 30 m
1	MOJOKERTO I.C RAMPWAY BR.		-		PC I-GIRDER	19.9	35		35	
2	SADAR RIVER BRIDGE	3 + 045	-	3 + 095	PC I-GIRDER	2 x 15.3	12.5 + 25 + 12.5			50
3	RAILWAY BRIDGE	3 + 683	-	3 + 703	PC I-GIRDER	2 x 15.3	20			20
4	PORONG RIVER BRIDGE	4 + 857	-	5 + 367	PC I- & CONT. BOX	2 x 15.3	6@35 + 2@40 + 40 + 60 + 45 + 40 + 35	145	365	
5	TARIK BRIDGE	7 + 720	-	7 + 740	PC I-GIRDER	2 x 15.3	20			20
6	PLOSO CANAL BRIDGE	8 + 690	-	8 + 710	PC I-GIRDER	2 x 15.3	20			20
7	MANGETAN VIADUCT	10 + 233	-	10 + 585	PC I-GIRDER	2 x 15.3	10@35		350	
8	MANGETAN CANAL BRIDGE	10 + 585	-	10 + 695	PC I-GIRDER	2 x 15.3	35 + 40 + 35		110	
9	BALONG BENDO VIADUCT	10 + 695	-	11 + 485	PC I-GIRDER	2 x 15.3	10@35 + 11@40		790	
10	SURABAYA RIVER BRIDGE	11 + 485	-	11 + 625	CONTINUOUS BOX	2 x 15.3	40 + 60 + 40	140		
11	WRINGIN ANOM VIADUCT	11 + 625	-	11 + 870	PC I-GIRDER	2 x 15.3	7@35		245	
12	KEDUNGANYAR RIVER BRIDGE	12 + 990	-	13 + 015	PC I-GIRDER	2 x 15.3	25			25
13	KRIAN I.C RAMPWAY BRIDGE	21 + 160			PC I-GIRDER	15.7	15 + 2@22.5 + 15			75
14	KRIAN ACCESS ROAD BRIDGE		-		PC I-GIRDER	11.5	20			20
15	LARONGAN RIVER BRIDGE	21 + 435	-	21 + 455	PC I-GIRDER	2 x 15.3	20			20
16	KEDONDONG RIVER BRIDGE	22 + 023	-	22 + 048	PC I-GIRDER	2 x 15.3	25			25
17	TENGAH RIVER BRIDGE	22 + 373	-	22 + 393	PC I-GIRDER	2 x 15.3	20			20
18	LAKARSANTRI IC BRIDGE	32 + 450	-	32 + 550	PC I-GIRDER	2 x 15.3	20 + 30 + 30 + 20			100
19	LAKARSANTRI VIADUCT				PC I-GIRDER				160	80
	EAST-BOUND	32 + 950	-	33 + 200		15.3	30 + 25 + 25 + 4@35 + 30			
	WEST-BOUND	32 + 960	-	33 + 190		15.3	35 + 25 + 25 + 40 + 3@35			
20	KARANG PILANG VIADUCT	37 + 150	-	37 + 606	PC I-GIRDER	2 x 15.3	12@38		456	
21	MAS RIVER BRIDGE	37 + 606	-	37 + 758	PC I-GIRDER	2 x 15.3	4@38		152	
22	WONOCOLO VIADUCT	37 + 758	-	38 + 062	PC I-GIRDER	2 x 15.3	8@38		304	
23	SURABAYA I.C RAMPWAY BR.		-		PC I-GIRDER	9.45	3@30			90
		38 + 062	-	38 + 500		1x19.9	38 + 7@40 + 4@30		318	120
		38 + 600	-	38 + 620		1x19.9	20			20
			-			9.45	5@30			150
	TOTAL							285	3,285	855
	GRAND TOTAL								4,425 m	

Table 9.9 Summary of Design Features of Overbridges

NO.	STATION	CROSSING ANGLE	WIDTH (m)	LENGTH (m)	REMARKS
1	1 + 450	90°	6	75	Desa Road
2	5 + 975	90°	6	75	Desa Road
3	6 + 865	90°	6	75	Desa Road
4	14 + 535	90°	6	75	Desa Road
5	15 + 324	90°	6	75	Desa Road
6	20 + 755	60°	7	86.6	Kabupaten Road
7	22 + 740	90°	6	75	Desa Road
8	23 + 155	90°	6	75	Desa Road
9	25 + 950	90°	6	75	Desa Road
10	30 + 550	90°	6	75	Desa Road
11	33 + 780	60°	7	86.6	Kabupaten Road

9.7.3 Design Features of Culverts

(1) RC Box and RC Portal Frame Culverts

RC box culverts were adopted for the crossings of waterways, irrigation channels, minor roads/foot paths and sugarcane railway lines as well as for drainage purposes. An opening will be provided at the median of the Toll Road for light intake in the case of roadway/railway culverts.

A RC portal frame culvert was adopted for protection of an existing underground water main (ø 1.3 m) at Sta. 35 (refer to Fig. 9.14).

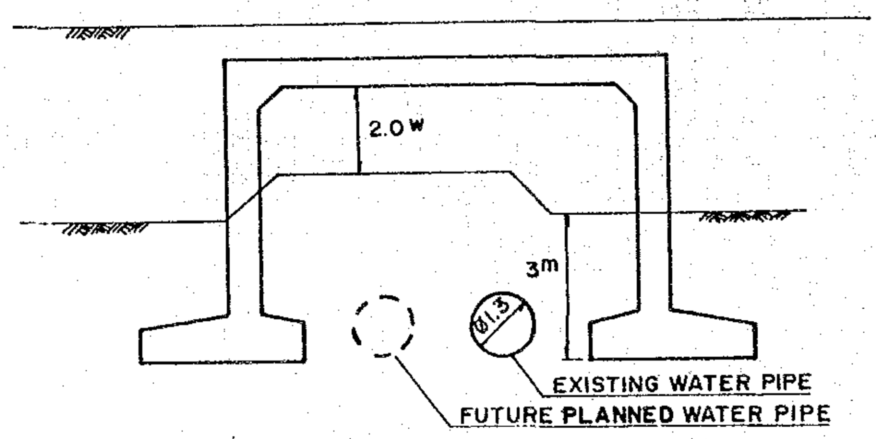


Fig. 9.14 RC Portal Frame Culvert for Water Main Protection

Both the RC box and portal frame culverts are designed with direct footing/bottom slab support without piling to avoid unequal settlement near the structures.

(2) RC Pipe Culvert

RC pipe culverts were adopted for the crossings of small waterways and irrigation channels as well as for general drainage purposes. The maximum size of RC pipe adopted is 1.0 m diameter including dual type. The following concrete foundation /encasement is recommended for the RC pipe culverts:

Earth cover < 3.0 m	:	120° Concrete foundation
Earth cover > 3.0 m	:	Concrete encasement

(3) Summary of Design Features of Culvert

A summary of the design features of RC box, portal frame and pipe culverts is presented in Appendices A-9.4, A-9.5 and A-9.6.

9.8 Preliminary Design of Pavement

9.8.1 Pavement Type

Since the Toll Road will be realized by new construction receiving little disturbance from existing traffic, either flexible pavement or rigid pavement may be applied.

General characteristics of flexible pavement and rigid pavement are compared in Table 9.10. The major considerations in selecting the pavement type for the Toll Road are discussed below:

a) Time Constraint

For a total of 20-30 years performance period of pavement, adoption of multi-stage construction, i.e. initial construction for a 10-year design life with periodic overlays to extend the performance period, is usual in the case of flexible pavement, while single-stage construction is normally adopted in the case of rigid pavement.

b) Construction Economy

The initial investment cost of rigid pavement is higher than that of flexible pavement by about 25 % due to the difference of design life of initial stage construction. However, flexible pavement requires future overlay and higher annual maintenance cost than rigid pavement. In a comparison of discounted total investment costs consisting of initial construction cost and maintenance cost, rigid pavement is more advantageous than flexible pavement, total investment cost of flexible pavement in present value discounted at 15% per year being about 20% higher than that of rigid pavement (cost comparison by the Study Team, refer to Working Paper "Preliminary Discussion on Design Standards, October 1990").

Table 9.10 Comparison of General Characteristics of Flexible Pavement and Rigid Pavement

Item	Flexible Pavement	Rigid Pavement
Design Life	10 years for initial construction. Multi-stage construction strategy shall be applied to extend service period by overlays.	20-30 years. Single stage construction strategy shall be applied.
Resistance against deformation and wear	Deformation in the form of rutting.	Deformation is unlikely. Wear resistance is extremely good.
Sensitivity to overloading	More sensitive than rigid pavement.	
Noise and vibration	Less than rigid pavement.	Noise due to joints and vibration due to rough surface sometimes cause public nuisance in residential areas.
Brightness	Surface reflection is weak and inferior.	Bright in darkness.
Surface smoothness	Better than rigid pavement and provides more comfortable riding condition.	
Construction operation	Less constraints for construction operation than rigid pavement.	The following constraints shall be taken into account for continuous and effective operation since equipment fleet is generally larger than that for flexible pavement. 1) Subgrade construction is smooth and continuous in the embankment construction 2) Less bridge/viaduct structures
Maintenance	Frequent maintenance is required but method is simple.	Once damage occurs, rather heavier repair is required. Rigid pavement is less suitable for soft ground and adverse surface soils areas.
Construction Economy	Initial stage construction cost is lower than rigid pavement.	Initial stage construction cost is higher than flexible pavement because of longer design life. The cost of alteration/repairs is higher than flexible pavement.

c) Design Limitation in Soft Ground Area

Normally, rigid pavement is not adopted in soft ground and adverse surface soils areas, because should structural failure occur due to unequal settlement of embankment, this type of pavement requires costly and troublesome repairs such as jacking-up of concrete slab, injection with cement/epoxy resin mortar, overlay with bituminous pavement, etc.

According to the results of geological investigation (refer to Section 6.3), soft ground areas exist in a stretch between Sta. 9+000 and Sta. 13+500 near the crossing with the Surabaya river (soft ground layer is 18.5 m thick) and in a stretch between Sta. 34+000 and Sta. 38+300 in a low plain area in the easternmost stretch of the Toll Road (soft ground layer is 23.5 m thick). The estimated total settlement is 90 cm for the former and and 115 cm for the latter in the case of 3 m high embankment. It is unsuitable to construct rigid pavement in these areas.

d) Local material utilization

Bituminous material for the construction of high standard pavement is always imported whereas portland cement is manufactured in Indonesia. In view of local material utilization, adoption of rigid pavement is preferable.

e) Overloading of Traffic

Flexible pavement is more sensitive to overloading than rigid pavement. If axle load control of illegally overloaded trucks is difficult, rigid pavement is preferable. Strict axle load control can be expected for the Toll Road as programmed for the Surabaya-Gempol Toll Road.

Recommendation

Stressing the lower initial investment cost, suitability in soft ground areas and more comfortable riding condition, it is recommended to employ flexible pavement for the Project, on the condition that axle load control can be realized.

9.8.2 Thickness Design of Flexible Pavement

The thickness design of flexible pavement was made based on the AASHTO Guide for Design of Pavement Structure 1986.

1) Design Variables and Conditions

The following major design variables and conditions were established for the thickness design.

a) Time Constraints

For the 20 years analysis period, a two-stage construction alternative was considered. The performance period selected for the initial flexible pavement structure is 10 years. Overlay will be designed to extend the pavement life for the remaining 10 years. The presumed opening year of the Toll Road is 1996.

b) Forecast Traffic

Since there are no significant differences among the forecast traffic on the sections of the Toll Road, the following traffic volume forecast on the stretches between Krian IC and Driyorejo IC was used for the thickness design as representative.

Forecast Traffic (ADT) for Pavement Design

	Year 1995	Year 2005	Year 2015
Passenger Vehicle	3,940	19,300	43,880
Bus	1,270	1,470	2,070
Pick-up	880	6,630	13,670
Truck	6,010	13,970	22,130
Total	12,100	41,370	81,750

c) Axle Load Model

It is a fact that many trucks are overloaded throughout Indonesia, with respect to the permitted maximum loading of 8 ton for single axle and 15 ton for tandem axle, which largely affects the durability of pavement.

The results of an axle load survey on the Surabaya-Gempol Toll Road in May 1990 indicated that 12% of a total 23,052 single axles and 10% of a total 287 tandem axles were overloaded (Gempol-Surabaya direction, refer to Table 9.11).

Table 9.11 Number of Axles in Each Weight Group on Surabaya-Gempol Toll Road (24-hour traffic on 20-21, May 1990)

AXLE WEIGHT (TON)	A-LINE (GEMPOL-SURABAYA)		B-LINE (SURABAYA-GEMPOL)	
	NO. OF AXLES		NO. OF AXLES	
	SINGLE AXLE	TANDEM AXLE	SINGLE AXLE	TANDEM AXLE
<0.5	765 (3.3%)	10 (3.5%)	179 (0.8%)	0 (0.0%)
0.5-1	10,916 (47.4%)	14 (4.9%)	5,328 (23.1%)	2 (0.7%)
1-2	2,811 (12.2%)	15 (5.2%)	2,882 (12.5%)	15 (5.2%)
2-4	2,486 (10.8%)	59 (20.6%)	1,554 (6.7%)	110 (38.3%)
4-6	2,331 (10.1%)	26 (9.1%)	747 (3.2%)	44 (15.3%)
6-8	943 (4.1%)	16 (5.6%)	695 (3.0%)	9 (3.1%)
8-10	682 (3.0%)	20 (7.0%)	460 (2.0%)	21 (7.3%)
10-12	223 (1.0%)	50 (17.4%)	167 (0.7%)	19 (6.6%)
12-14	151 (0.7%)	47 (16.4%)	34 (0.1%)	10 (3.5%)
14-16	388 (1.7%)	18 (6.3%)	26 (0.1%)	0 (0.0%)
16-18	587 (2.5%)	8 (2.8%)	8 (0.0%)	0 (0.0%)
18-29	769 (3.3%)	4 (1.4%)	9 (0.0%)	0 (0.0%)
TOTAL	23,052 (100.0%)	287 (100.0%)	12,089 (52.4%)	230 (80.1%)

Serious overload is by large trucks having 2 axles with a heaviest single axle load of more than 18 ton. As a result, the calculated ESAL factor was 6.35 per vehicle from 71,452 ESAL for 11,252 vehicles in 24-hour traffic (refer to Table 9.12, ESAL was estimated for flexible pavement based on the "AASHTO Guide for Design of Pavement Structures 1986"). The axle weight of the traffic in the Surabaya-Gempol direction was lighter, with a calculated ESAL factor of 0.514 per vehicle, though there were still overloaded axles, about 10% of the total.

The same tendency was observed on the Jakarta-Merak Toll Road. According to an axle weight survey in March 1988, the number of overloaded axles was 11.4% of the total number of axles, and 84% of the total in terms of 18-kip ESAL. The calculated ESAL factor was 0.863 per vehicle (trucks and buses).

Under such situations, one of the major issues in the pavement design is in the assumption of axle load distribution in the total vehicle fleet. It is proposed to assume the axle load model as shown in Fig. 9.15, taking the following factors into consideration.

- According to information from Jasa Marga, it is planned to install axle load meters in the next year on every on-ramp of the Surabaya-Gempol Toll Road to control and prohibit overloading. The same type of traffic control will be introduced for the project Toll Road.

Table 9.12 ESAL by Vehicle Group (24-Hour Traffic on Surabaya-Gempol Toll Road on 20-21, May 1990)

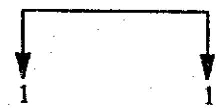
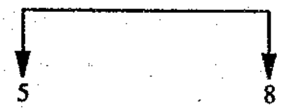
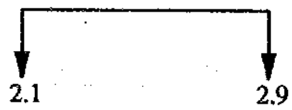
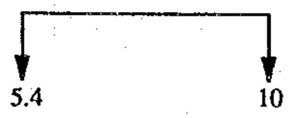
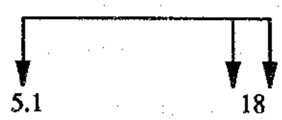
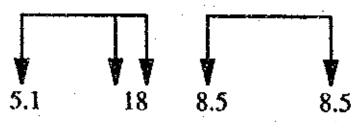
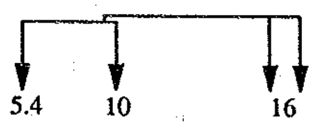
GROUP OF VEHICLE	A-LINE(GEMPOL-SURABAYA)					B-LINE(SURABAYA-GEMPOL)				
	NO. OF VEHICLES		NO. OF ESAL		ESAL FACTOR	NO. OF VEHICLES		NO. OF ESAL		ESAL FACTOR
1	6,827	(60.7%)	23.96	(0.0%)	0.0035	4,056	(68.8%)	6.54	(0.2%)	0.0016
2	3,335	(29.6%)	67,765.69	(94.8%)	20.3195	940	(15.9%)	992.32	(32.8%)	1.0557
3	87	(0.8%)	573.52	(0.8%)	6.5922	82	(1.4%)	125.68	(4.2%)	1.5327
4	3	(0.0%)	14.30	(0.0%)	4.7667	0	(0.0%)	0.00	(0.0%)	-
5	323	(2.9%)	1,505.51	(2.1%)	4.6610	189	(3.2%)	1,178.82	(38.9%)	6.2371
6	0	(0.0%)	0.00	(0.0%)	-	0	(0.0%)	0.00	(0.0%)	-
7	8	(0.1%)	88.20	(0.1%)	11.0250	1		73.79 *		73.7900
8	18	(0.2%)	50.70	(0.1%)	2.8167	29	(0.5%)	14.17	(0.5%)	0.4886
9	0	(0.0%)	0.00	(0.0%)	-	0	(0.0%)	0.00	(0.0%)	-
10	1	(0.0%)	0.06	(0.0%)	0.0600	1	(0.0%)	0.06	(0.0%)	0.0600
11	0	(0.0%)	0.00	(0.0%)	-	0	(0.0%)	0.00	(0.0%)	-
12	612	(5.4%)	1,003.74	(1.4%)	1.6401	587	(10.0%)	632.89	(20.9%)	1.0782
13	38	(0.3%)	426.51	(0.6%)	11.2239	10	(0.2%)	76.68	(2.5%)	7.6680
TOTAL	11,252	(100.0%)	71,452.19	(100.0%)		5,894	(100.0%)	3,027.16	(100.0%)	

Source : Dynamic Axle Weight Survey, Jasa Marga

Note : * Doubtful (too big) and excluded in total figure.

VEHICLE TYPE

1 Cars, Cars with Trailer
2 Rigid 2-Axle Goods
3 Rigid 3-Axle Goods
4 Rigid 4-Axle Goods
5 Rigid 2-Axle Goods with 1, 2 or 3-Axle Trailer
6 Rigid 3-Axle Goods with 2 or 3-Axle Trailer
7 Artic 2-Axle Tractor with 1-Axle Trailer
8 Artic 2-Axle Tractor with 2-Axle Trailer
9 Artic 2-Axle Tractor with 3-Axle Trailer
10 Artic 3-Axle Tractor with 1 or 2-Axle Trailer
11 Artic 3 Axle Tractor with 3-Axle Trailer
12 Bus or Coach and Super Coach
13 Other Vehicles up to 11 Axles

NO.	VEHICLE TYPE	MODEL OF LOAD DISTRIBUTION (TON)
1	PASSENGER CAR PICK-UP MINI-BUS	
2	LARGE BUS	
3	MIDDLE-SIZED TRUCK	
4	LARGE TRUCK (1)	
5	LARGE TRUCK (2)	
6	TRAILER (1)	
7	TRAILER (2)	

SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 9.15 Axle Load Model

- It is planned by the Government to increase the allowable axle load from 8 ton to 10 ton for single axle and from 15 ton to 18 ton for tandem axle for the important road links which are to be called "MST (Muatan Sumbu Terberat : Heaviest Axle Load) 10 ton Road Network". Regarding this matter, a report "Vehicle Weights and Dimensions, Proposals and Draft Legislation for New Limits" was prepared by the Directorate General of Land Transport and Inland Waterways of the Ministry of Communications in October 1990, which was referred to in setting up the axle model of trucks shown in Fig. 9.15.

The ESAL factor is calculated at 0.757 for the forecast traffic in 1995 and the axle load model established, as shown in the table below:

Vehicle Type	Axle Load	1995 Traffic (ADT)	ESAL Per vehicle	ESAL Per Day
P/C, Mini Bus, Pick-up	1+1	4,820	0.0007	3.4
Large Bus	5+8	1,270	1.168	1,483.4
Medium Truck	2.1+2.9	3,310	0.017	56.3
Large Truck (2-Axle)	5.4+10	1,800	2.778	5,000.4
Large Truck (3-Axle)	5.1+18(T)	720	2.464	1,774.1
Drawbar Trailer	5.1+18(T) +8.5+8.5	90	5.130	461.7
Semi-Trailer	5.4+10 +16(T)	90	4.197	377.7
TOTAL		12,100		9,157.0

Note :
- ESAL is estimated for flexible pavement based on the AASHTO Guide 1986 (10% contingency is incorporated in estimating ESAL).
- SN =6 and Pt = 2.5 are assumed.

d) Roadbed Soil Characteristics and Design Sections

As described in the preceding section, the length of cutting sections is limited in the construction of the Toll Road. Pavement structures will be constructed on embankment for most stretches.

The largest part of the embankment materials will be obtained from the borrow pits located in the southeast of Mojosari, except for a 9.0 km stretch in the hilly areas between Sta. 25+000 and Sta. 34+000 which has cutting sections so that embankment materials will be obtained from road excavation and nearby borrow pits in the hilly areas.

According to the results of soils and materials investigation, the CBR of the embankment materials from nearby borrow pits in the hilly areas along the above 9.0 km stretch (clayey soil) ranges from 5.3 and 6.2. The embankment materials from the borrow pits in the southeast of Mojosari (sandy soil) is excellent material with CBR ranging from 28.0 to 31.6.

Taking into account the above different condition of embankment material, thickness design was prepared for the following two design sections.

Design Section		Design CBR
1 :	Sta. 0+000 - Sta. 25+000 and Sta. 34+000 - Sta. 38+300	10
2 :	Sta. 25+000 - Sta. 34+000	5

The design CBR of 10 for Design Section 1 was estimated by the following calculation for a combination of the existing ground having CBR of 5 and the embankment with selected materials from the borrow pits in the southeast of Mojosari for which CBR of 20 and minimum thickness of 100 cm below pavement structure was assumed.

$$CBR_m = ((h1 \times CBR1^{1/3} + h2 \times CBR2^{1/3})/100)^3$$
$$= ((50 \times 20^{1/3} + 50 \times 5^{1/3})/100)^3 = 10$$

2) Results of Thickness Design

The results of thickness design are summarized as shown below (Details are shown in Appendix A-9.7). For the sections where embankment will be constructed with the materials from the borrow pits in the southeast of Mojosari, subbase is omitted since the the materials are of high quality (Design Section 1).

	Design Section 1	Design Section 2
Initial Stage		
Asphalt Concrete	22 cm	22 cm
Granular Base	25 cm	20 cm
Granular Subbase	-	25 cm
Second Stage		
Asphalt Concrete Overlay	14 cm	15 cm

3) Alternative Design

According to the recent practice of Bina Marga, a combination of a 3 cm layer of Split Mastic Asphalt and ATB (Asphalt Treated Base) with Asphalt Cement Modifier is designed instead of conventional asphaltic concrete, for the MST 10 ton road network.

Split Mastic Asphalt is specially formulated for improving durability, skid resistance, flexibility, strength, rutting resistance, and oxidation resistance, having the following characteristics:

- High chipping content (aggregate size over 2 mm) about 75%, with open grading
- Thick bitumen film
- Use of cellulose fiber additive (mix proportion of 0.2 - 0.3%, to be mixed during the dry mixing of aggregate) to increase the bitumen viscosity

Asphalt Cement Modifier, a dark brown petrochemical based liquid, is a chemical catalyst capable of affecting a gradual change to the modular structure of asphalt cement to produce an asphaltic mix with the following properties (dosage rate is 1.75 ± 0.25%):

- Decreased temperature susceptibility
- Improved high temperature strength
- Improved deformation resistance
- Greater adhesion

A 3 cm layer of Split Mastic Asphalt (layer coefficient of 0.35) plus a 27 cm layer of ATB with Asphalt Cement Modifier (layer coefficient of 0.30) is equivalent to the above 22 cm layer of asphaltic concrete (layer coefficient of 0.42), the use of which shall be examined further in the final engineering stage.

9.9 Relocation of Roads, Waterways and Irrigation Channels

(1) Necessity of Relocation

Major roads, rivers/waterways and irrigation canals which are crossed by the Toll Road are provided with bridges, viaducts and culverts and are not affected by the Project. However, relocation work (i.e. reconstruction) is unavoidable due to site conditions and consideration necessary for construction economy.

(2) Relocation of Roads and Sugarcane Railway

The lengths of road and sugarcane railway relocation totals 4,070 meters as follows (refer to Appendix A-9.8):

Kabupaten Road	125 m
Desa Road	3,360 m
Sugarcane Railway	585 m
Total	4,070 m

(3) Relocation of Waterways and Irrigation Channels

Relocation of 965 meters of waterways and irrigation channels in total length is planned as shown in Appendix A-9.9.

9.10 Toll Road Supporting Facilities

9.10.1 Categories of Supporting Facilities

The objective of road supporting facilities is mainly to maintain smooth and safe traffic flow for the benefit of the users. The following supporting facilities are considered to realize these objectives:

a) Road furniture such as guardrail , road markings and traffic signs
b) Traffic Signs
c) Road Lighting

9.10.2 Road Furniture

(1) Guardrail

The major purpose of guardrail is to protect uncontrolled vehicles from running off the Toll Road and to protect the facilities such as bridge piers from damage by such vehicles. Guardrail is planned to be installed at the following locations:

- High embankment sections (H>4.0 m)
- Bridge and box culverts
- Bridge piers and guide sign posts

(2) Road Markings

Markings are particularly important to help control traffic in urban and suburban areas. The standards of Bina Marga/Jasa Marga for marking currently in use are considered. Traffic markings include pavement markings, object markings and reflector markers.

(3) Traffic Signs

The use of three kinds of signs are considered, namely, regulatory signs, warning signs and guide signs to enhance traffic safety and for the convenience of users.

Regulatory signs and warning signs are directly in accordance with the Government's regulations or traffic laws. Guide signs convey to drivers information such as destinations and distances, service facilities and route confirmation.

9.10.3 Road Lighting

(1) Objective of Road Lighting

The objective of the provision of lighting facilities is to reduce the number of traffic accidents occurring during the hours of darkness and to make the Toll Road more attractive to potential users.

(2) Location of Lighting Installations

Lighting installations for the Project cover the following locations:

- Junctions and Interchanges including rampways
- On/Off Ramps including toll plazas
- Bridges and viaduct in urban areas, as necessary.

9.11 Length by Structural Type and Major Work Quantities

(1) Length by Structural Type

As a result of the preliminary engineering design, the total length of the Toll Road is measured at 38.32 km, out of which 34.26 km (89.4%) is of earthwork sections and the remaining 4.06 km (10.6%) is of bridge/viaduct sections, as shown in Table 9.13.

In earthwork sections, cut sections are limited to the stretches between Sta.14+200 and Sta.14+900 and between Sta.28+600 and Sta.33+900, where the Toll Road passes through hilly areas in the north of the Surabaya river.

Table 9.13 . Length by Structure Type

Section		Total Length (km)	Earthwork Section Fill (km)	Earthwork Section Cut (km)	Earthwork Section Total (km)	Bridge Section (km)
SECTION 1						
Mojokerto IC - (Sta. 0+000)	Krian IC (Sta. 21+000)	21.00	17.62 (83.9%)	1.10 (6.2%)	18.72 (89.1%)	2.28 (10.9%)
SECTION 2						
Krian IC - (Sta. 21+000)	Surabaya JC (Sta. 38+318)	17.32	13.84 (79.9%)	1.70 (9.8%)	15.54 (89.7%)	1.78 (10.3%)
Total		38.32	31.46 (82.1%)	2.80 (7.3%)	34.26 (89.4%)	4.06 (10.6%)

(2) Work Quantities of Major Work Items

Table 9.14 shows the work quantities of major work items for the construction of the Toll Road , dividing into 2 sections; Section 1 between Mojokerto IC and Krian IC and Section 2 between Krian IC (Krian IC is included in Section 2) and Surabaya JC.

As for the interchanges, the construction of Mojokerto IC, Krian IC and Surabaya JC are included in the estimated work quantities while Driyorejo IC and Lakarsantri IC are excluded.

9.12 ROW Acquisition and Utility Relocation/Protection

(1) ROW Acquisition

The required ROW acquisition for the construction of the Toll Road was estimated as shown in Table 9.15. The ROW width varies from 50 to 80 m depending on the embankment height and cutting depth in earthwork section. A 40 m constant ROW width (3 m from the edge of structure) will be secured for bridge/viaduct sections, except for the sections passing through housing areas. A wider ROW, 10 m from the edge of structure, will be secured along the bridge/viaduct sections passing through housing areas in Surabaya for the provision of a buffer zone of green belt, pedestrian path, etc, in connection with the preservation of the environment. The ROW acquisition required for the construction of the interchanges is included in the estimation.

Table 9.14 Work Quantities

DESCRIPTION	UNIT	Section 1 Mojokerto IC to Krian IC (Sta. 0 - 21)	Section 2 Krian IC to Surabaya JC (Sta. 21 - 38.3)	Total
1. EARTHWORK				
Clearing & Grubbing	m2	788,200	834,000	1,622,200
Common Excavation	m3	209,000	347,600	556,600
Borrow Material, L= 5km	m3	-	578,000	578,000
Borrow Material, L=25km	m3	2,883,100	-	2,883,100
Borrow Material, L=29km	m3	-	646,000	646,000
Borrow Material, L=36km	m3	-	674,600	674,600
Sand Mat	m3	142,600	187,400	330,000
Sand Drain Pile, D=40cm	m	365,100	719,500	1,084,600
2. BRIDGES				
Superstructure				
Continuous Box Girder	m2	8,720	-	8,720
PC I-Girder, S≥30m	m2	57,600	39,100	96,700
PC I-Girder, S<30m	m2	5,310	12,780	18,090
Overbridge, W=7.0m	m2	610	1,130	1,740
Overbridge, W=6.0m	m2	2,250	1,350	3,600
Substructure				
Abutment	m3	9,510	8,030	17,540
Pier	m3	47,970	35,420	83,390
Foundation				
PC Pile, D=0.6m	m	142,730	51,350	194,080
Steel Pipe Pile, D=0.6m	m	-	88,200	88,200
Caisson Foundation	m3	8,410	-	8,410
3. DITCHES AND CULVERTS				
Drainage				
Paved Ditch	m	43,400	38,600	82,000
Pipe Culvert, D=0.6m	m	1,540	1,275	2,815
Pipe Culvert, D=1.0m	m	2,415	910	3,325
Box Culvert, 2x(3.0mx3.0m)	m	315	-	315
Box Culvert, 4.5mx2.5m	m	415	95	510
Box Culvert, 3.0mx2.0m	m	391	190	581
Box Culvert, 2.0mx1.5m	m	75	640	715
Roadway/Utility Protection				
Box Culvert, 6.0mx3.5m	m	435	180	615
Box Culvert, 3.0mx3.0m	m	489	356	845
Portal Culvert, 8.0mx5.5m	m	-	35	35
4. PAVEMENT				
Subgrade Preparation	m2	563,200	491,900	1,055,100
Subbase	m3	34,400	75,800	110,200
Granular Base	m3	102,100	80,100	182,200
Prime/Tack Coat	kg	1,380,300	1,208,100	2,588,400
Binder/Surface Course	ton	231,100	202,500	433,600
Asphalt Cement	ton	15,000	13,200	28,200
Concrete Pavement, T=30cm	m2	2,500	9,500	12,000
5. MISCELLANEOUS				
Relocation of Sugarcane Railway	m	585	-	585
Relocation of Waterway	m	670	295	965
Sodding	m2	537,200	489,200	1,026,400
Concrete Block Slope Protection	m2	11,100	5,450	16,550
Guardrail	m	19,520	8,780	28,300
Delineater	m	84,000	69,300	153,300
Marking	m2	18,500	18,200	36,700
Guide Signs	each	7	17	24
Regulatory & Warnig Signs	km	21.0	17.3	38.3
ROW Fence and ROW Pegs	m	42,000	34,600	76,600
Kilometer Post	each	21	17	38
Tollway Lighting	m	5,300	13,300	18,600
Toll Booths	each	6	24	30
Tollgate Office	m2	400	800	1,200
Operation & Maintenance Office	m2	0	1,500	1,500

Table 9.15 Summary of ROW Acquisition

(m2)

District	Developed Area	Village (Kampung) Area	Farmland	Vacant Land	Total
Section 1 (Sta. 0+000 - Sta. 21+000)					
Kab. Mojokerto	0	26,500	409,900	10,200	445,600
Kab. Sidoarjo	0	51,700	307,500	6,300	365,500
Kab. Gresik	0	93,700	468,000	1,000	562,700
Sub-total	0	170,900	1,185,400	17,500	1,373,800
Section 2 (Sta. 21+000 - Sta. 38+320)					
Kab. Gresik	0	41,400	812,400	42,900	896,700
Kod. Surabaya	49,800	47,900	236,900	128,400	463,000
Sub-total	49,800	89,300	1,049,300	171,300	1,359,700
Total	49,800	260,200	2,234,700	188,800	2,733,500

(2) Relocation/Protection of Utilities

The followings are major public utilities affected by the construction of the Toll Toad.

- Electric Power Transmission Lines
- Water Main
- Electric Cables and Telephone Lines

a) Electric Power Transmission Lines

The Toll Road crosses the existing PLN electric power transmission lines (70/150 KVA) , 11 lines at 5 locations. At these locations, it is necessary to construct additional pylons on the side(s) of the Toll Road as estimated in the following in order to secure the required headroom as discussed in Subsection 9.2.1 of this Chapter.

Station		Number of Lines Crossed	Additional Pylons
Sta. 0+050	- Sta. 0+270	3 lines	3 Pylons
Sta. 4+350	- Sta. 4+400	2 lines	2 Pylons
Sta. 25+550	- Sta. 25+610	2 lines	3 Pylons
Sta. 33+950	- Sta. 34+040	3 lines	6 Pylons
Sta. 36+900		1 line	1 Pylon
Total		11 lines	15 Pylons

b) Water Main

The Toll Road crosses the existing water main, 1.3 m in diameter, from Kalang Pilang Water Treatment Plant to Surabaya city, crossing at Sta. 34+950. A portal culvert is planned for its protection after discussion with PDAM (Perusahaan Daerah Air Minum, Tk. II, Kod. Surabaya).

c) Aerial Electric Cables and Telephone Lines

Along the national/provincial roads, kabupaten roads and desa road to be crossed by the Toll Road, 107 locations in total, aerial electric cables (25 KVA usually) and telephone lines are running. At the crossings, they will be reconstructed with underground facilities.

Chapter 10

CONSTRUCTION PLANNING

CHAPTER 10

CONSTRUCTION PLANNING

10.1 General

The study of construction planning mainly comprises i) establishment of construction method and ii) preparation of construction time schedule. The result of the study will be utilized in the construction cost estimates and further reflected in the establishment of a project implementation schedule.

10.2 Basic Conditions of Construction Planning

(1) Stage Construction

Since the Project necessitates large scale construction work, it is desirable both economically and technically to phase the construction over a period of time. The development of the Toll Road is therefore planned in two stages in order to optimize the investment schedule:

Stage 1	:	Construction of a 4-lane Toll Road for the entire length
Stage 2	:	Widening of pavement, from 4-lane to 6-lane, for the entire length.

(2) Framework of Construction Planning

In view of the fact that the major part of the Toll Road construction will be completed in the initial stage development, the construction planning is developed in the framework of Stage 1 construction.

(3) Construction Sections

For the convenience of construction planning, the Toll Road is divided into the following two sections and work quantities are estimated by section:

Section 1	:	Sta. 0 + 000 - Sta. 21 + 000 (Mojokerto IC - Krian IC, L = 21.00 Km)
Section 2	:	Sta. 21 + 000 - Sta. 38 + 318 (Krian IC - Surabaya JC, L = 17.32 Km)

(4) Quantities of Major Work Items

Selection of construction method is based on the actual work quantities and site conditions. The work quantities of major work items are as shown in Table 9.14 in Chapter 9.

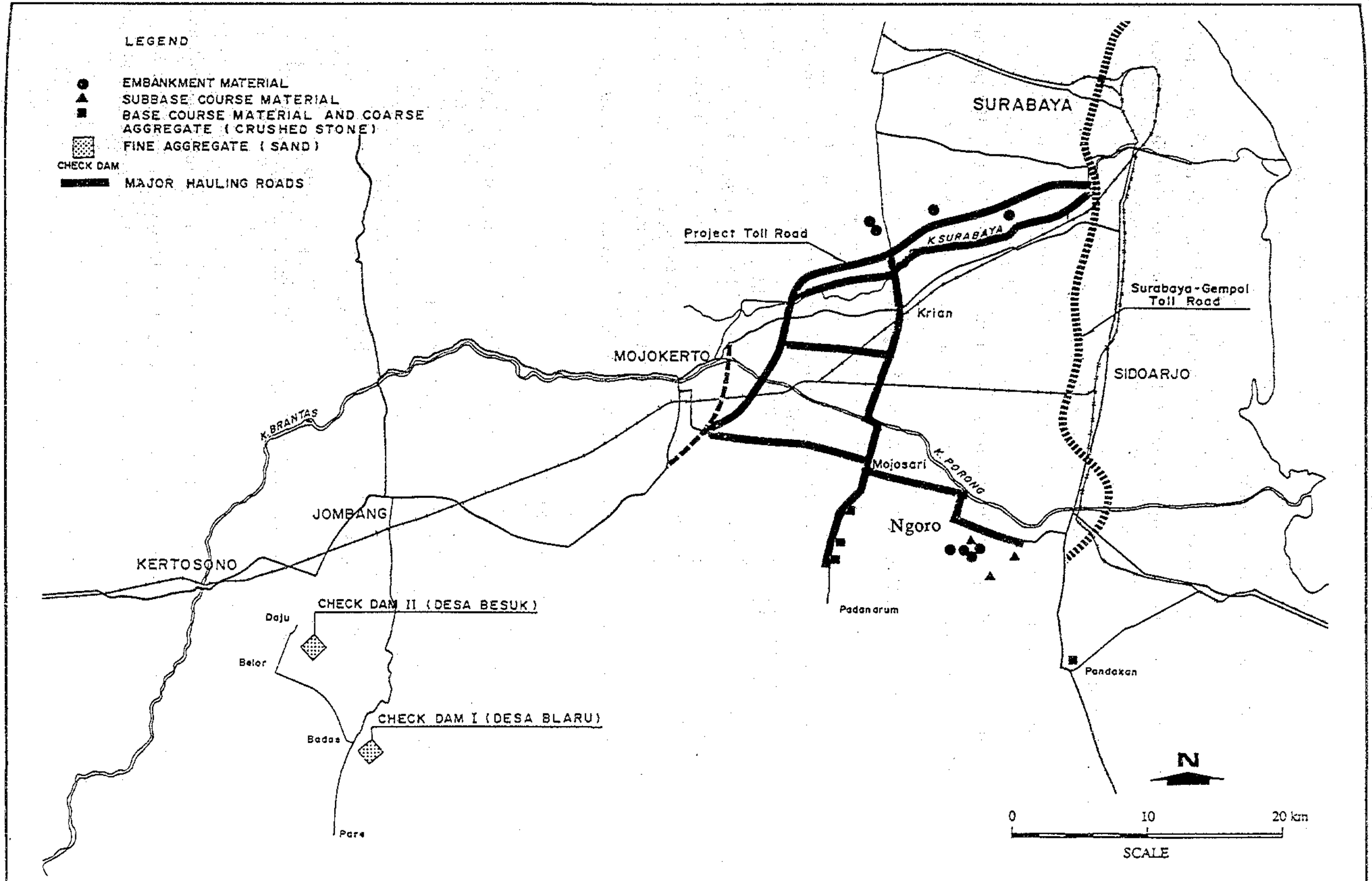
(5) Road Network for Hauling of Materials

The construction involves the hauling of a large quantity of embankment/pavement materials. Basically the Project Area is provided with a sufficiently dense road network (refer to Fig. 10.1). However, the pavement condition of the existing desa roads sometimes lacks enough strength. Pavement strengthening/repair will be necessary but construction of new roads is unlikely.

The largest traffic increase by the hauling of embankment/pavement materials from the southeast area of Mojosari, the major source of materials, to the job site will occur in the provincial road section between Ngoro and Mojosari. The maximum number of dump trucks for hauling of these materials was estimated at about 900 dump trucks in a peak hour in this section, which will be added to the existing traffic of about 350 vehicles per hour. To such traffic level, widening/strengthening of the existing 6 m wide pavement (by additional 1.5 m wide paved shoulders) and asphaltic concrete overlay will be required. Other road links from Mojosari to the job site used for hauling of materials need same type of improvement, more or less.

At the job site, the construction should be executed in a sequence to use the mainline of the Toll Road as a pilot as much as possible to enable the transportation of materials on it, without using the parallel national road in order to avoid disturbance to the existing traffic.

Refer to subsection 12.6.5 in Chapter 12 for further description of traffic matters from the viewpoint of environment.



SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 10.1 Material Sources and Major Hauling Roads

10.3 Construction Method

10.3.1 Equipment Intensive Construction

To attain construction economy and to realize the Toll Road with a shorter construction period, the equipment intensive construction method will be adopted.

10.3.2 Earthwork

(1) Major Equipment

The use of the following major earthwork equipment is considered in the planning (refer to Table 10.1).

Table 10.1 Earthwork Equipment

Main Works	Equipment	
	Hauling distance less than 100 m	Hauling distance more than 100 m
Clearing and Grubbing	Bulldozer	
Excavation Loading Hauling	Bulldozer — Bulldozer	Tractor Shovel Tractor Shovel/Payloader Dump Truck
Spreading Compaction	Bulldozer/Motor grader Tamping Roller/Tire Roller	

(2) Outline of Earthwork Planning

Table 10.2 shows the borrow pits of embankment material available for the Project.

Table 10.2 Borrow Materials

Borrow Pit Location	Soil Type
- Southeast of Mojosari	Laterite
- Southeast of Mojosari	Fine to Coarse Sand
- Hilly area nearby the Toll Road	Silty Soil, Tuffaceous Clay

Section 1 is divided into three (3) earthwork subsections considering the situation of bridge construction over the Porong and the Surabaya rivers. Each earthwork subsection has its own different hauling distance from the borrow pits located near Mojosari.

Section 2 is also divided into three (3) earthwork subsections depending on terrain and soils conditions along the Toll Road. The middle subsection will be constructed with borrow materials available near the site (about 500,000 m^3 in total), but the other subsections require hauling of borrow materials from Mojosari.

Table 10.3 shows the summary of earthwork planning.

Materials obtained from common excavation (i.e. silty soil) will be utilized for the embankment as much as possible. Excavated topsoil will be stockpiled and later utilized for sodding.

(3) Embankment on Soft Ground Area

Embankment on soft ground ares will be constructed by slow banking method increasing the strength of foundation soil. Construction of 7 m high embankment will be executed in 150-200 days. Bridge abutment will be constructed after consolidation of foundation soil by preloading.

10.3.3 Paving Work

(1) Major Equipment

The use of the following major paving equipment is considered (refer to Table 10.4).

Table 10.4 Paving Work Equipment

Main Work	Equipment
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 Plant, Transit Mixer

(2) Material Sources

The summary of material sources is shown in Table 10.5.

Table 10.3 Summary of Earthwork Planning

Section/Subsection		Length (km)	Excavation (1000 m3)			Embankment			Borrow Pit	
			Common	Topsoil	Total	From Common	Borrow	Total	Location	Haulage (km)
Sec.1	Mojokerto IC (Sta. 0+000) - Porong River (Sta. 5+367)	5.37	0.0	42.1	42.1	0.0	1,053.0	1,053.0	Southeast of Mojosari	23.0
	Porong River (Sta. 5+367) - Surabaya River (Sta. 11+870)	6.50	0.0	11.4	11.4	0.0	781.3	781.3	Southeast of Mojosari	26.0
	Surabaya River (Sta. 11+870) - Krian IC (Sta. 21+000)	9.13	110.2	45.3	155.5	99.2	1,048.8	1,148.0	Southeast of Mojosari	27.0
	Sub-total	21.00	110.2	98.8	209.0	99.2	2,883.1	2,982.3		25.0
Sec.2	Krian IC (Sta. 21+000) - Sta. 25+000	4.00	0.0	22.1	22.1	0.0	646.0	646.0	Southeast of Mojosari	29.0
	Sta. 25+000 - Sta. 34+000	9.00	260.5	49.5	310.0	234.5	578.0	812.5	Local Borrow Pit	5.0
	Sta. 34+000 - Surabaya JC (Sta. 38+318)	4.32	0.0	15.5	15.5	0.0	674.6	674.6	Southeast of Mojosari	36.0
	Sub-total	17.32	260.5	87.1	347.6	234.5	1,898.6	2,133.1		25.5
Total		38.32	370.7	185.9	556.6	333.7	4,781.7	5,115.4		25.0

The total volume of borrow (i.e. volume after compaction to required density) from Mojosari is estimated at approximately 4,200,000 m3 and weighted average hauling distance resulted in approximately 28 km.

Table 10.5 Sources of Paving Materials

Item	Quantity	Location of Materials Source
Subbase Course	Fine - Coarse Sand	Southeast of Mojosari
Base Course	Crushed Stone (Andesite)	South of Mojosari
Coarse Aggregate	Crushed Stone (Andesite)	South of Mojosari
Fine Aggregate	Coarse - Fine Sand	Desa Blaru, Desa Besuk
Asphalt Mixture		Surabaya

(3) General Descriptions of Materials

a) Subbase Course Materials

Subbase course materials from southeast of Mojosari will not require processing for gradation control considering the nature of deposit.

b) Base Course Materials and Coarse and Fine Aggregate

A number of aggregate producers are in operation in the south of Mojosari. Raw materials are obtained from gravel pits. The contractor will be able to establish his own pit and to operate his own crushing/screening plant.

c) Asphalt Mixture

Procurement or production of hot-mix asphaltic concrete is possible for the construction of binder/surface course.

10.3.4 Bridge and Viaduct Construction

(1) Major Equipment

The major equipment for bridge construction is shown in Table 10.6.

Table 10.6 Bridge Construction Equipment

Main Work	Equipment
Foundation	Diesel Pile Hammer, Pile driver, Truck crane
Structure Excavation	Clamshell, Power Shovel, Dump Truck
Substructure	Transit Mixer, Concrete pump truck
Superstructure	Truck crane, Erection Girder

(2) Construction of Porong River Bridge and Surabaya River Bridge

Open caisson is adopted for bridge foundations which will be constructed in the dry season. Temporary bridges are required for the hauling of construction materials. The adoption of cantilever construction is recommended.

(3) Construction of Mas River Bridge

The construction of foundations and substructures are limited to the dry season. Cofferdam with steel sheet piling in the water and temporary bridge will be required for the substructure construction. Erection girder or fixed staging method will be applied for the erection of PC I-girders.

(4) Other Bridges and Viaduct

No major problems are anticipated in the construction of bridge foundations and substructures. PC I-girders will be erected by means of conventional crane erection method. It is recommended to construct a parallel temporary road when the bridge or viaduct length becomes long.

10.4 Construction Time Schedule

10.4.1 Conditions for Scheduling

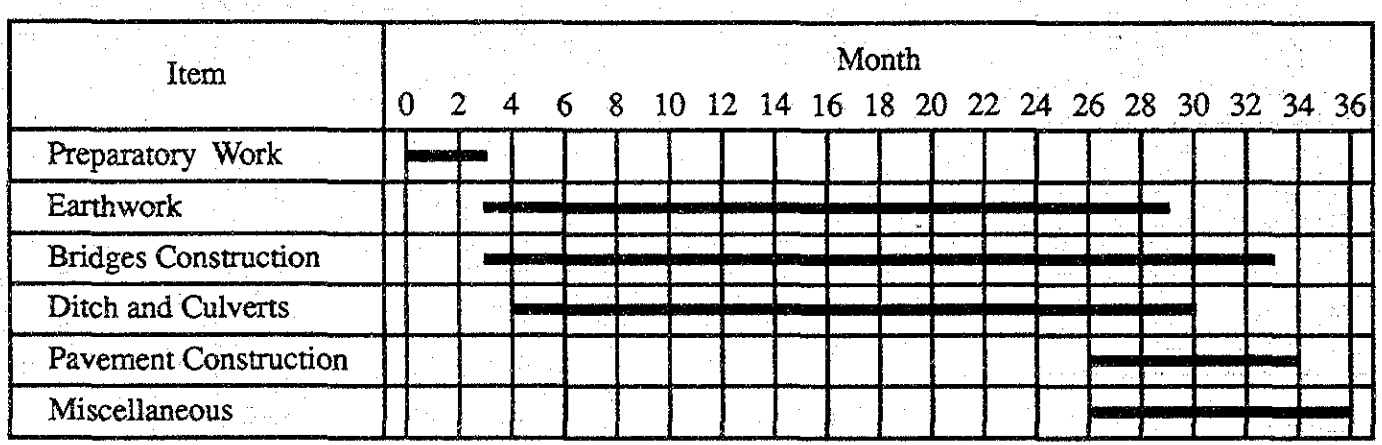
(1) Maximum Construction Period

Taking into account the scale of the construction and the number of major equipment and plant required, the maximum possible construction period was set at 3 years.

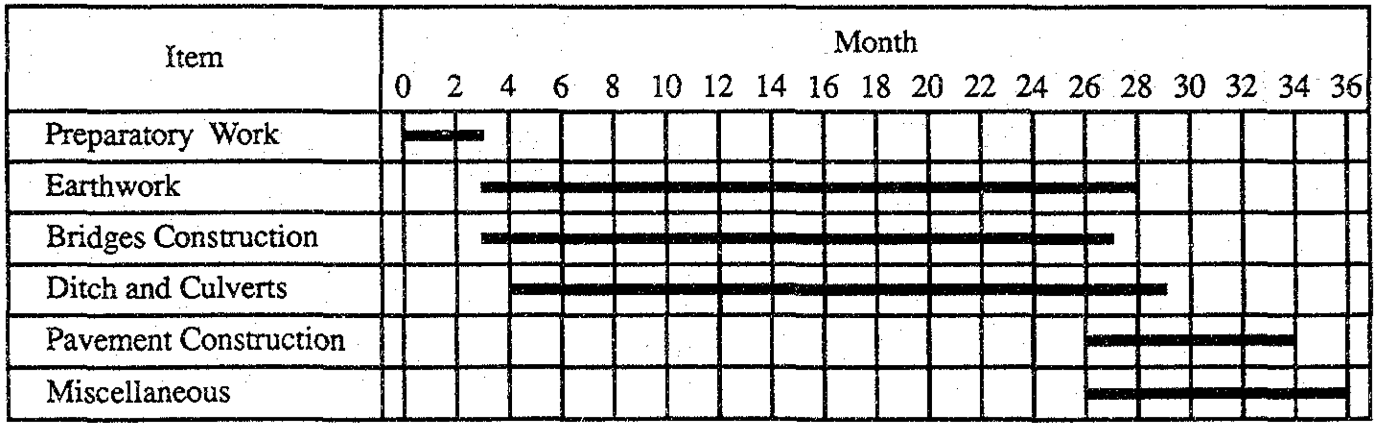
(2) Weather Conditions

According to the rainfall data shown in Appendix A-6.6, the number working days for earthwork and the construction of pavement was estimated as shown in Table 10.7.

Section 1 (Mojokerto IC - Krian IC : 21.00 km)



Section 2 (Krian IC - Surabaya JC : 17.32 km)



SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 10.2 Construction Time Schedule

Table 10.7 Number of Working Days

Item	Dry Season May - Oct. (6 months)	Rainy Season Nov. - Apr. (6 months)	Annual
Number of rainy days	2.9 days/month	13.6 days/month	98.0 days
Working efficiency on a rainy day	65%	35%	50%
Number of holidays	5.0 days/month	5.0 days/month	60.0 days
Number of working days	24.0 days/month	16.2 days/month	241.2 days
Working efficiency	80%	54%	67%

10.4.2 Time Schedule

The construction time schedule for each construction section was prepared based on the conditions described in Subsection 10.4.1 above, as shown in Fig. 10.2.

10.5 Implementation Schedule

Based on the fact that the interested private investors have been already invited to submit investment proposals for the implementation of the Project, it is assumed that the final engineering design for the Project will be started by late 1991 for a one year period, and that construction will be executed in 3 years from the beginning of 1993. The opening of the Toll Road to traffic will be at the beginning of 1996 (refer to Fig. 10.3).

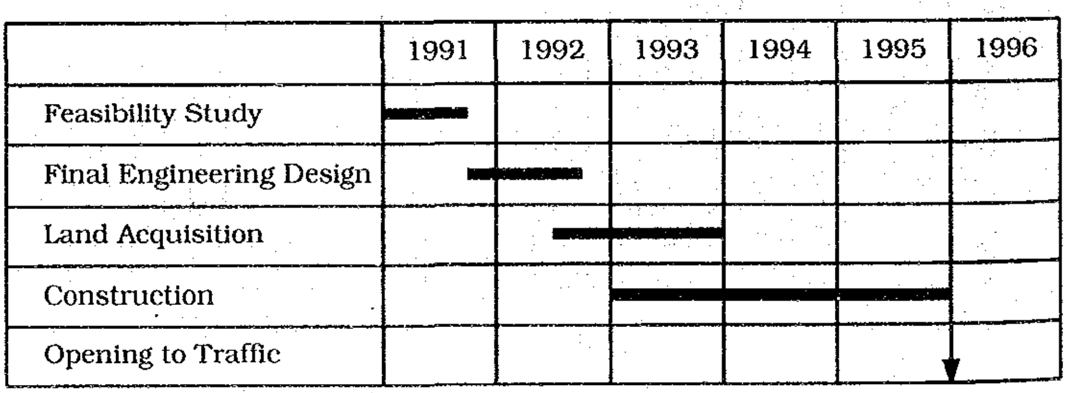


Fig. 10.3 Implementation Schedule

Chapter 11

OPERATION AND MAINTENANCE OF THE TOLL ROAD

CHAPTER 11

OPERATION AND MAINTENANCE OF THE TOLL ROAD

11.1 Tollway Operator

The Government is actively pursuing private sector participation (including foreign investors) in the construction and operation of selected toll roads in order to promote the implementation of the tollway development under the limited appropriation of the Government budget. Such facilities as duty free importation and delay of certain tax payments on capital goods used by tollway projects are provided to encourage the private sector participation. The Surabaya-Mojokerto Toll Road (the Toll Road) is one of the tollways in which the Government intends to utilize private sector participation.

The participation of P.T. Jasa Marga (Persero, Indonesian Highway Corporation) is an essential requirement in all tollway development and private investor participation should be implemented in the form of a joint venture (JV) or joint operation (JO) with P.T. Jasa Marga.

At present, there are 5 tollway links operated or to be operated with participation of private investors, as follows.

	Name of Tollway	Length (km)	Status	Form of Investment
1.	N-S Link	14.0	Under Operation	Joint Venture
2.	Cibitung-Cikampek (Add. 2-lane)	47.5	Under Construction	Joint Operation
3.	Tangerang-Merak (Phase-1)	34.0	Under Construction	Joint Venture
4.	Surabaya-Gresik	20.0	Review of Detailed Design	Joint Venture
5.	Jakarta Outer Ring Road (W2 Section)	10.4	Detailed Design being started	Joint Venture

The concession period is generally 30 years, and thereafter the tollway properties will be transferred to the Government.

The Toll Road will be connected with the Surabaya-Gempol Toll Road operated by P.T. Jasa Marga therefore these tollways will be operated by two (2) different operators.

11.2 Scope of Operation and Maintenance Works

The scope of operation and maintenance works for tollway is broadly divided into the following three major components:

- Tollway Maintenance
- Traffic Management
- Toll Collection

(1) Tollway Maintenance

Tollway maintenance together with traffic management has the three basic goals of providing traffic safety, smooth traffic flow and users comfort.

The maintenance function can be divided into routine maintenance, periodic maintenance and incidental maintenance.

Routine maintenance is based on routine (daily) inspection of the condition of pavement, cut and fill slopes, drainage, bridges and other structures and facilities to monitor any defects and damages to them. The results of routine inspection will be promptly reported to the regionanl operation office for follow-up maintenance works as required.

Periodic maintenance is based on detailed inspection to be performed at certain time intervals such as weekly, monthly or yearly depending on the type and kind of facilities, including checking and testing the conditions of various structures and facilities. Defects and damages will be reported for repairs or remedies. Periodic maintenance also covers such works as cleaning of pavement, guardrail and sign boards, mowing and maintenance of landscape plantation areas, and road marking and painting.

Incidental maintenance is basically the work to be carried out to restore the tollway and the related facilities to their normal operating conditions after they are damaged by road accident or natural causes.

Maintenance works except for inspections will be executed basically by contractors under the supervision of a regional operation office, which will include:

- Cleaning of pavement
- Mowing and maintenance of plantation areas
- Cleaning of ditches and culverts
- Pavement repair such as patching and resurfacing
- Repair of expansion joints of bridges and viaducts
- Repair of fill and cutting slopes
- Repair of damage to road facilities caused by traffic accident
- Betterment work including pavement overlay, widening, construction of additional rest facilities, etc.

(2) Traffic Management

Traffic management means traffic control, removal of disabled cars which have been involved in accidents, and furnishing users with expressway and traffic information.

Highway patrols will be conducted to find damage to road facilities, traffic accidents, illegal parking, disabled cars and other extraordinary conditions which disturb traffic safety. Information and reports will be dispatched to the regional operation office through radio communication equipped on the patrol cars.

Such services as rescue, ambulance and emergency treatment to those injured due to traffic accidents, and towing of disabled cars will be executed.

Traffic control includes general control for speed, overloading and emergency lane use (under unusual conditions such as traffic accident, adverse weather and operation of maintenance works). Control and prohibition of illegally overloaded trucks will be conducted in cooperation with traffic police. Axle load meters will be installed at entries of interchanges for weighing.

Traffic surveillance including information collection and dissemination is also an important part of traffic management especially when the traffic volume is approaching the tollway capacity. Installation of facilities such as CCTV, radio broadcasts, variable message signs and emergency telephones will be programmed in future.

(3) Toll Collection

As stated in Subsection 9.6.2, the Toll Road will be operated under a distance-proportional toll levy system as a regional toll road. A magnetic card system will be used. Users pick up a magnetic card on entry and pay a toll on exit at toll gates at interchanges and at the mainline toll barrier. Totalling and audit of collected toll and recording of traffic data will also be executed at toll gate offices.

In the initial stage construction, toll gates will be provided at Mojokerto IC, Krian IC and at a toll barrier 1.6 km west of Lakarsantri IC which is planned for connection with the planned Inner Ring Road. For these toll gates, stage-wise construction of toll booths is recommended with a target year in 2005, 10 years after the presumed opening. Necessity for extension of toll booths will be reviewed based on traffic data collected after the opening.

11.3 Organization for Operation and Maintenance

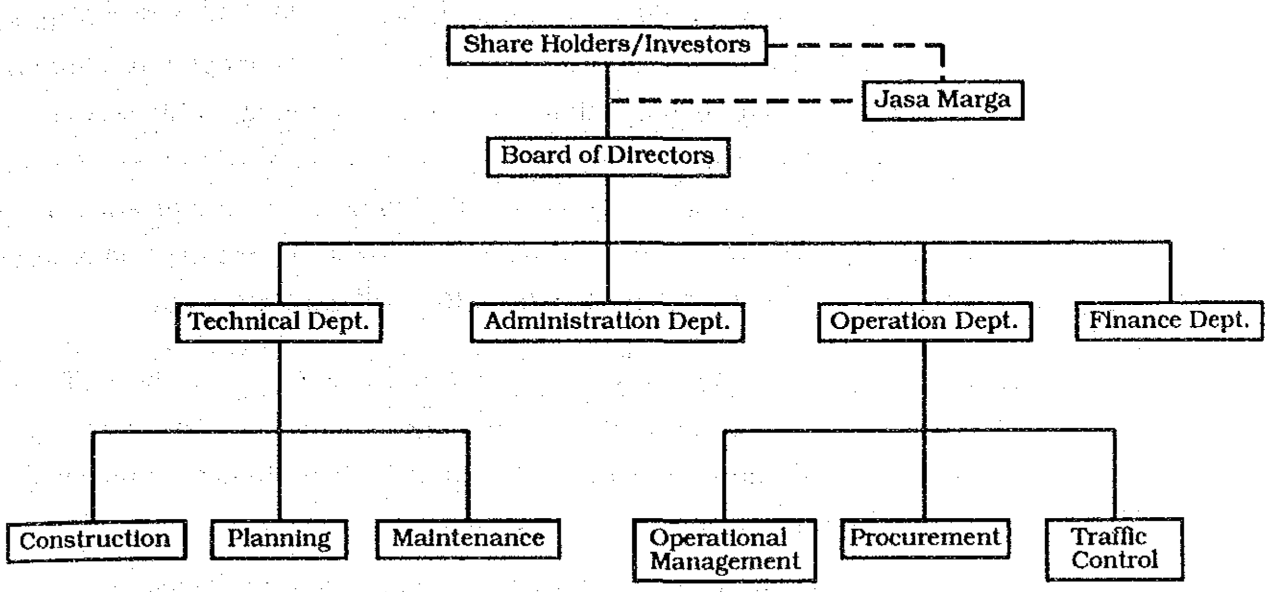
For the assumed private investor participation in the Toll Road, the organization for operation and maintenance should be self-sufficient, separated from that of the Surabaya-Gempol Toll Road. Its basic organization will be composed of a Head Office, a Regional Operation Office and Toll Gate Offices.

1) Head Office

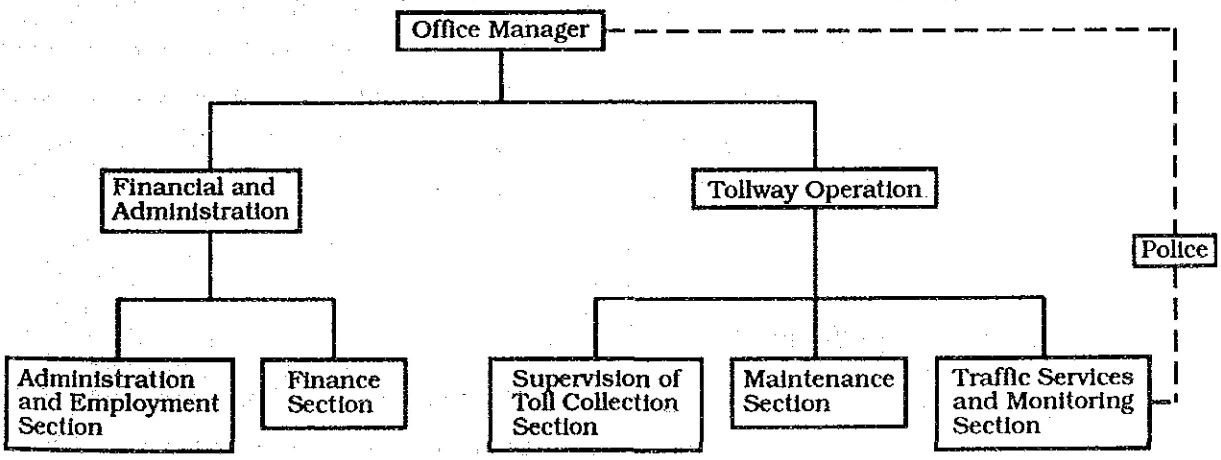
The Head Office will be directed by a board of directors of the joint venture company. It will be responsible for overall management of the organization including decision making related to the activities of operation and maintenance of the Toll Road, budgetary control, etc., generally having four major departments; technical, administration, operation and finance, as shown in Fig.11.1. The director of the operation department shall be the representative from P.T. Jasa Marga in the Head Office organization. The Head Office will be best located in Jakarta to ensure smooth and easy access to the related governmental agencies, financial institutions and business opportunities.

2) Regional Operation Office

A Regional Operation Office will be responsible for execution of operation and maintenance works for the Toll Road. Since the total length of the Toll Road is only 38 km, the establishment of one office is sufficient, as the farthest point from the office can be reached within 30 minutes. It is recommended that the office will be located near the mainline barrier gate, 1.6 km west of Lakarsantri IC.



Organization of Head Office



Organization of Regional Operation Office

SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 11.1 Organization of Head Office and Regional Operation Office

The organization of the Regional Operation Office headed by an Office Manager will generally have 5 sections; administration/employment, finance, supervision of toll collection, maintenance and monitoring/traffic services, as shown in Fig.11.1. Policemen from the provincial police will be stationed in the office to cooperate as traffic police. Referring to the organization of the operation office for the Surabaya-Gempol Toll Road, the required office space is estimated at around 1,500 m2 for about 100 staff members.

As stated in Section 11.2 above, the maintenance works will be performed mostly by contractors under the supervision of the Regional Operation Office. The office will be equipped with the following limited kinds of equipment for operation and maintenance works under such a system:

- Communication cars, patrol cars and maintenance vehicles for highway patrol, inspection and supervision of maintenance works being carried out by the contractors
- Trucks, dump trucks, small crane vehicles, small rollers and tampers, air compressors, breakers, asphalt cutters, etc. for emergency repair works on occasions of accident and disaster.
- Water tankers, grass cutters, etc.
- Ambulance vehicles

3) Toll Gate Offices

A toll gate office will be provided at every interchange (Mojokerto IC and Krian IC in the initial stage construction) and at the mainline toll barrier (Sta. 30+900) to administer toll transactions, issuance of magnetic cards at entry and collection of toll at exit. Toll collectors will work in 3 shifts. The office space will be about 300 - 500 m2 depending on the required number of toll booths.

11.4 Operation and Maintenance Cost

The operation and maintenance costs (O & M costs) of the Toll Road were estimated based on the data from the administrative office of the Surabaya-Gempol Toll Road.

The O & M costs of the Surabaya-Gempol Toll Road, 4-lane 2-way, 43 km long, were Rp. 2,612 mil. in 1987, Rp. 3,087 mil. in 1988 and Rp. 3,531 mil. in 1989, showing an average annual growth rate of 16.3%. Applying this rate to 1989 costs, the 1991 O & M costs were estimated at Rp. 4,773 mil. for the entire length of the Surabaya-Gempol Toll Road, or Rp. 111.0 mil. per km. Assuming 10% overhead, the O & M costs including overhead were estimated at Rp. 122.1 mil. per km for a 4-lane 2-way toll road.

The O & M costs for a 6-lane 2-way toll road were estimated to be Rp. 134.3 mil. per km assuming that the O & M costs of 6-lane toll road is 1.1 times those of 4-lane toll road.

The annual O & M costs of the Surabaya-Mojokerto Toll Road in 1991 price were estimated at Rp. 4,676 mil. for 4-lane and Rp. 5,144 mil. for 6-lane, adopting the above per km costs to the length of the Toll Road (38.3 km).

Chapter 12

ENVIRONMENTAL STUDY

CHAPTER 12

ENVIRONMENTAL STUDY

12.1 General

The Technical Guidelines on the Environmental Impact Analysis for Highway and Bridge Projects (hereinafter called the "EIA Guidelines") was published by the Ministry of Public Works in 1990 (No. 779/KPTS/1990). The EIA Guidelines require the environmental impact analysis (Analisis Dampak Linkungan, hereinafter called the "ANDAL") for all proposed toll read projects at the feasibility study stage.

While, in the discussion of the scope of works of the Study between Bina Marga and the JICA Preliminary Study Team in November 1989, it was agreed to suspend the preparation of ANDAL in the Study since EIA Guidelines was still in preparation stage at that time, but to carry out preliminary identification of environmental impacts in the Study to provide various environmental information for the preparation of an ANDAL report.

A full scale environmental impact analysis would involve numerous variables which require thorough and lengthy studies, which is considered to be beyond the scope of work. The Study Team understands that the execution body of the Project must prepare an ANDAL report in line with the EIA Guidelines and based on the research data which are to be utilized for the detailed examination. Therefore, the conclusions which are derived from the Study would still be of a tentative nature. The Study Team is leaving room for the discussion of future investigations in the establishment of more complete assessment policies. It is hoped that the appropriate agencies will pick up and continue with this endeavor.

The following components, regulations and guidelines were considered as the basis for the environmental study.

(1) Project Toll Road

The Surabaya-Mojokerto Toll Road (hereinafter called the "Toll Road") starts from Mojokerto Bypass. It runs in a northeast to north direction to cross the Porong and the Surabaya rivers, then turns to the east, runs in the north of the Surabaya river and reaches Surabaya JC, the junction with the Surabaya-Gempol Toll Road. The total length of the Toll Road is measured at 38.32 km and is divided into the following two sections:

Section 1	:	Sta. 0 + 000 - Sta. 21 + 000 (Mojokerto IC - Krian IC, L = 21.00 km); and
Section 2	:	Sta. 21 + 000 - Sta. 38 + 318 (Krian IC - Surabaya JC, L = 17.32 km).

The Toll Road development is planned in two stages in order to optimize the investment schedule:

Stage 1	:	Construction of 4-lane Toll Road for the both sections
Stage 2	:	Widening of pavement, from 4-lane to 6-lane, for the both sections.

(2) Time Period for Consideration of Environmental Impact

- Pre-construction phase;
- Construction phase; and
- Operation and maintenance phase.

(3) Affected Areas

- GKS region; and
- Corridors of the Surabaya - Mojokerto Toll Road (Direct Influence Zone).

(4) Government Regulations and Guidelines

The following Government regulations and guidelines were referred to in the environmental study:

- Government Regulation of the Republic of Indonesia Number 29 Year 1986 pertaining to Analysis of Impacts upon the Environment;
- Elucidation of the Government Regulation of the Republic of Indonesia Number 29 Year 1986 pertaining to Analysis of Impacts upon the Environment; and