4.2 TRAFFIC DEMAND FOR TRAIN OPERATION

The maximum link traffic of the Merak Line was estimated at 160,000 and 318,000 passengers per day in 1995 and 2005 respectively as shown in Fig. 2.19. Taking account of the peak hour ratio for the Study of "Feasibility Study on Track Elevation of Central Line", approximately 40% per 2-hr·direction, which has been discussed in (4) of section 2.4.4, the passenger traffic in peak 2-hours was estimated to be 33,000 and 66,000 passengers per direction in 1995 and 2005 respectively.

The summary of the assigned traffic on Merak Line, Table 4.1 gives the characteristics of the passenger flows and the Fig. 4.4 presents the relationship between peak hour link traffic and the transport capacity with various railcar formation and headway.

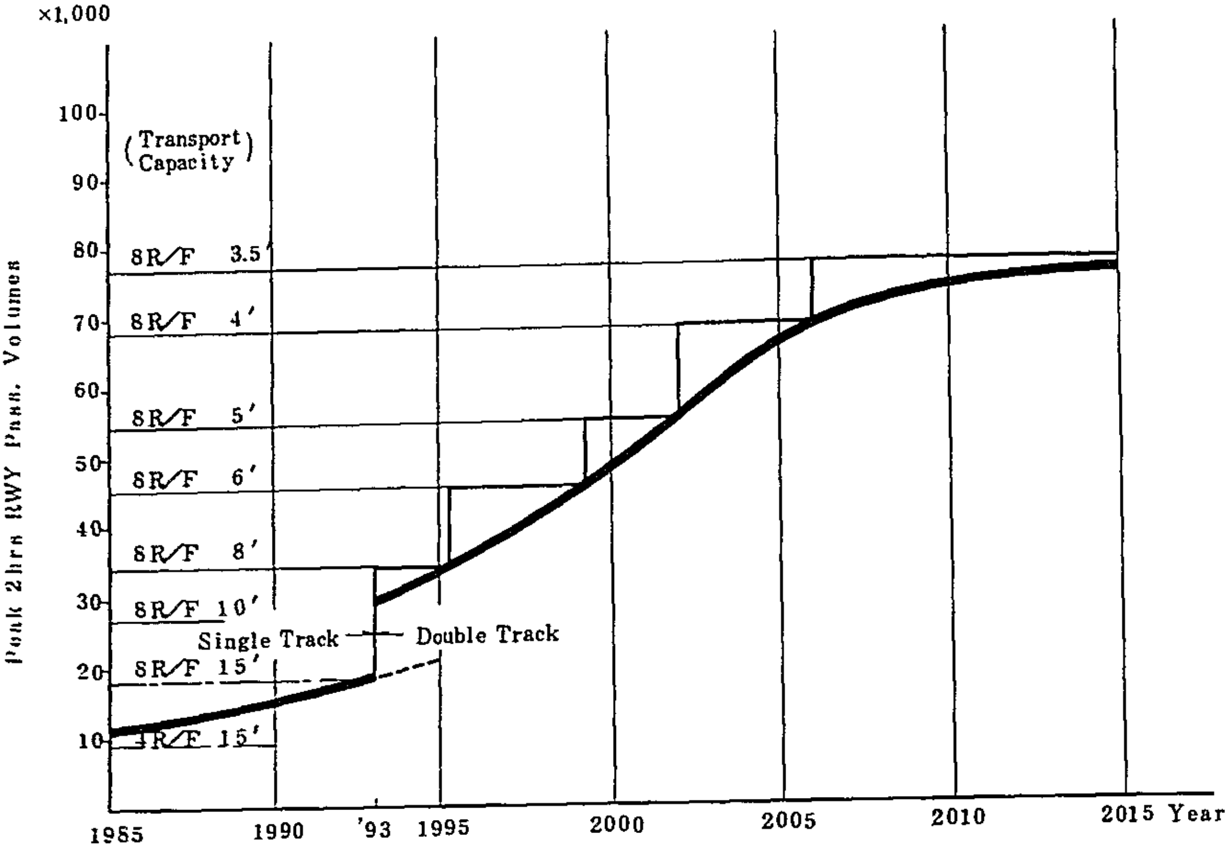
According to this diagram, Merak Line should be double-tracked by 1993 and the operation headway be improved towards 3.5 minutes in the peak hours in and around the year 2015.

Table 4.1 Characteristics of Passenger Flows on Merak Line

(Operating distance: 23.2 km between Tanah Abang and Serpong)

	Year:	1995	2005
1)	Maximum Link Traffic: (pass./day)	160,000	318,000
	(pass./direction.peak 2-hr)	33,000	66,000
2)	Passenger-hour/day	73,412	134,284
3)	Passenger-km/day	2,723,587	4,981,922
4)	Average travel speed (km/hr)	37.1	37.1
5)	Average cross-sectional traffic (pass./km)	117,396	214,738

In addition, the railway passenger volumes on Merak Line was estimated for the years 1985, 1995, 2005 and 2015 as shown in Fig. 4.5.



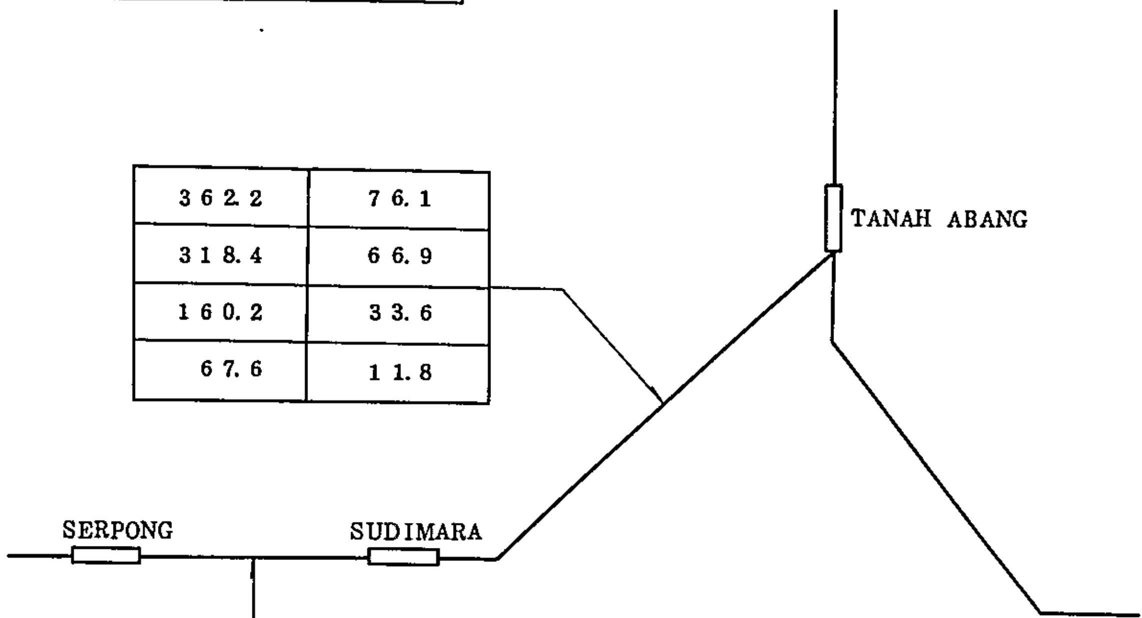
Notes 1) R/F=Railcar Formation 15'=15'Headway

2) —·— Transport Capacity of Single Track — Transport Capacity of Double Track

Fig. 4.4 Transport Capacity and Peak Hour Traffic

LEGEND :

ALL DAY(2-WAY)	PEAK 2 – hr. (1–DIRECTION)	→ YEAR 2015 (×1,000 Pass.)
ALL DAY(2-WAY)	PEAK 2 – hr. (1–DIRECTION)	→ YEAR 2005 (×1,000 Pass.)
ALL DAY(2-WAY)	PEAK 2 – hr. (1–DIRECTION)	→ YEAR 1995 (×1,000 Pass.)
ALL DAY(2-WAY)	PEAK 2 – hr. (1–DIRECTION)	→ YEAR 1985 (×1,000 Pass.)



362.2	76.1
318.4	66.9
160.2	33.6
67.6	11.8

121.6	25.5
106.9	22.5
53.5	11.2
22.5	3.9

Fig. 4.5 Estimated Railway Volumes on Merak Line

4.3 TRAIN OPERATION

4.3.1 Present Status

The present status of train operations on the Merak Line between Tanah Abang and Serpong (Cisauk) is as follows: (Table 4.2)

Table 4.2 Present Train Operation Status

Kind of Train		Tanah Abang ∿ Kebayoran	Kebayoran ∿ Cisauk
Passenger train	Fast	4	4
	Local	8	8
	Diesel Railcar	4	4
Freight train	Fast	2	2
	Local	8	12
Mixed train		2	2
Total		28	32

During the peak hour, 6:00 ∿ 8:00, there are only two trains arriving at Tanah Abang, train numbers 601 and 331. Therefore, the transportation system of the Merak Line does not cater to commuting passengers. Travelling time, between Tanah Abang and Serpong, by locomotive hauled trains (600 train numbers) averages 50.3 minutes and diesel railcar trains (300 train numbers), 47.8 minutes. Stopping time between Tanah Abang and Serpong is 6.1 minutes and 7.8 minutes respectively. These trains are medium and long distance trains operating beyond Serpong from Tanah Abang to Rankasbitung and Merak, and express trains do not stop at Serpong.

4.3.2 Train Operation Plan after Single Line Electrification

(1) Train operation time

The train operation time of each section based on the train operating curve of the electric railcar is indicated in Table 4.3.

Table 4.3 Train Operation Time (Single Track)

(min. : sec.)

Station	Kilometerage		Station Distance (km)	For Serpong		For Tanah Abang		Station Stop
	From Thb	Train dia.		Calculated	Adjusted	Calculated	Adjusted	
Tanah Abang	0	6.295						
			3.821	5:51	6:00	5:36	6:00	
Palmerah	3.821	10.116						1:00
			3.737	6:48	7:00	6:50	7:00	
Kebayoran	7.558	13.853						1:00
			2.930	3:36	3:30	3:32	3:30	
Pondok-bitung	10.488	16.783						1:00
			1.417	2:12	2:30	2:18	2:30	
Signal Station	11.905	18.200						1:00
			4.055	4:42	5:00	4:36	5:00	
Jurang-manggu	15.960	22.255						1:00
			1.989	3:00	3:00	2:54	3:00	
Sudimara	17.949	24.244						1:00
			2.456	3:18	3:30	3:12	3:30	
Signal Station	20.405	26.700						1:00
			2.090	3:00	3:00	2:54	3:00	
Rawabuntu	22.495	28.790						1:00
			1.413	2:18	2:30	2:15	2:30	
Serpong	23.908	30.203						
Total			23.908	34:27	36:00	34:07	36:00	8:00
Travel Time					44:00		44:00	

Train stopping time at station and signal station is supposed to be one minute, thus the total travelling time between Tanah Abang and Serpong and vice-versa is 44 minutes.

In calculating the train operating time, between Tanah Abang and Kebayoran the train speed is restricted to not more than 40 km/h due to the danger presented by dwellers along the railway track.

(2) Train operation plan and train diagram

In order to attract passengers to the railway and to offer good service to commuting passengers, at least 4 trains per hour during peak hour, that is a 15 minute train headway, are required. Frequent service to commuters after all is one of the main roles of railways.

The train operation diagram for electric railcar trains during the peak hour is as shown in Fig. 4.6. This train diagram is planned to employ the minimum number of signal stations in addition to the present stations for train crossing. Signal station, located at 26 km 700 m, will become a passenger station at a time of track doubling.

During the peak hour, additional trains can be operated between Tanah Abang and Serpong only if additional signal stations are installed. During off-peak hour, train headway may be extended to between 30 minutes and one hour depending upon transportation demand. Thus extra trains can be accommodated with either 15 minute or 30 minute headway between electric railcar trains.

To insert an extra train between electric railcar trains, the performance of the extra train to be inserted should be checked. But generally, performance (acceleration, retardation and maximum speed) of electric railcar train is the best compared with a locomotive hauled train or diesel railcar train. So, it is preferable to make the extra train a non-stop train in the section between Tanah Abang and Serpong so as to have the same travelling time as an electric railcar train. The new travelling time of a non-stop train should be less than 44 minutes. To confirm the new travelling time, the loss-time for stopping (total of retardation time and acceleration time) should be taken into account.

Table 4.4 Confirmation of New Travelling Time (min.)

Train	Present travel time	Time for station stop	Loss time	New travelling time
600's	50.3	6.1	2.2	42.0
300's	47.8	7.8	1.9	38.1

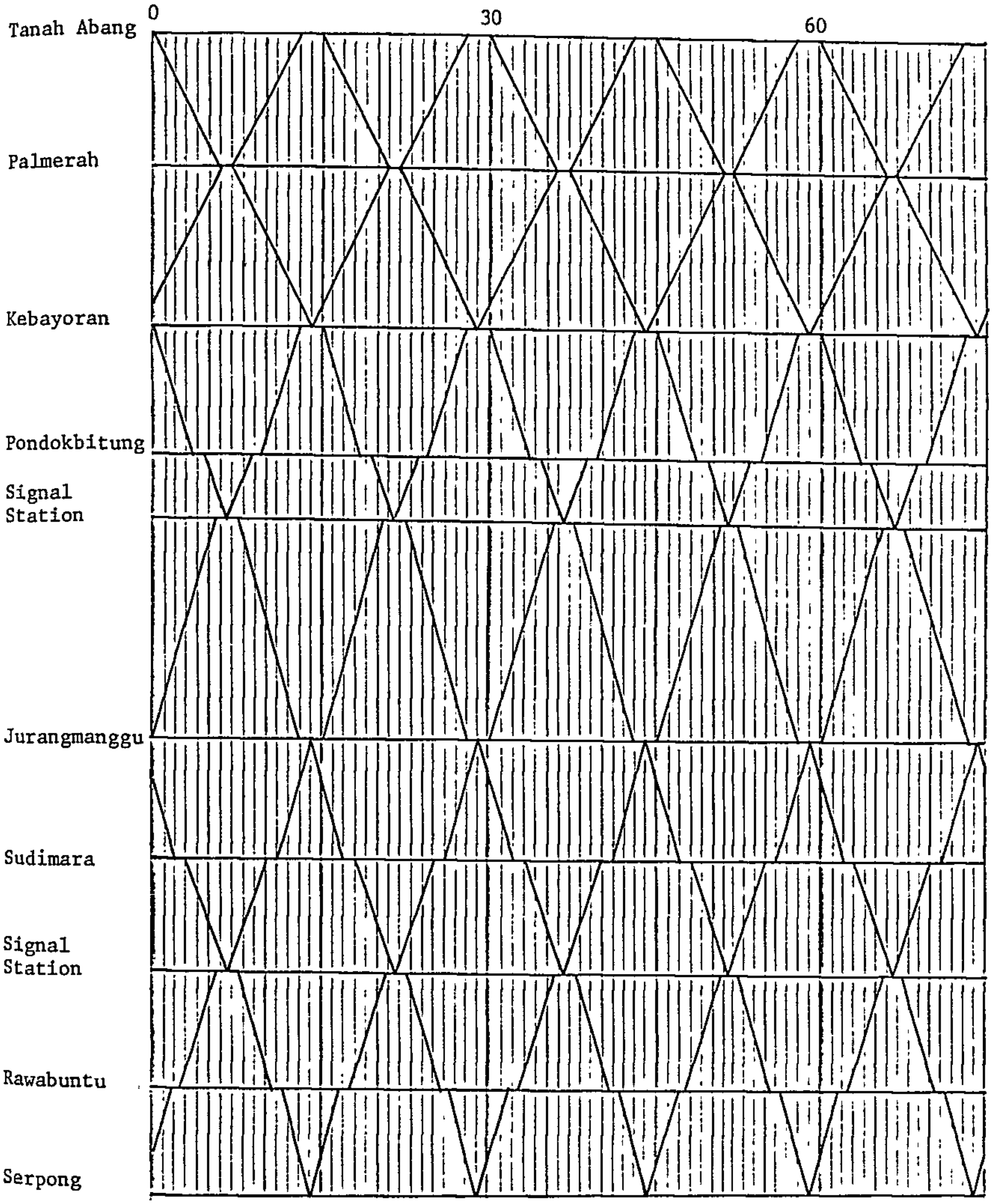


Fig. 4.6 Train Operation Diagram, Single Track with Speed Restriction due to Squatter

In the case of a freight train, acceleration and retardation is comparatively low, thus the loss time is bigger than that of passenger trains, 47 sec. to 53 sec. for one stop. Therefore, the gained time of a non-stop freight train changed from a stopping train is larger than that of a passenger train.

Finally, there are no problems inserting extra non-stop trains between electric railcar trains.

4.3.3 Train Operation after Completion of Track Doubling

(1) Train operation time

Train operation time is indicated in Table 4.5. On train operation on the double track, since speed limit, 40 km/h, between Tanah Abang and Kebayoran, and speed restrictions at entrances of stations are eliminated, travelling time will be reduced to 38.5 minutes for a train to Tanah Abang and 39 minutes to Serpong even with opening three new passenger stations and with one minute station stops.

The signal station at 18 km 200 m will be closed but the one at 26 km 700 m will be changed to a passenger station.

(2) Train operation plan and train diagram

Based on the transportation demand, train operating headways can be decided. Factors to be considered on assembling a train operation plan for a double track are far less than that for a single track. But the same concept with single line stage, i.e. trains operating beyond Serpong are to be non-stop between Tanah Abang and Serpong, still applies.

Even on a double track, a train operating beyond Serpong cannot be inserted between electric railcar trains if the train headway of electric railcar trains during peak hour is below 6 minutes since the train headways become below 3 minutes.

Table 4.5 Train Operation Time (Double track)

(min. : sec.)

Station	Kilometerage		Station Distance (km)	For Serpong		For Tanah Abang		Station Stop
	From Thb	Train dia.		Calcu-lated	Adjust-ed	Calcu-lated	Adjust-ed	
Tanah Abang	0	6.295	3.821	3:38	4:00	3:36	4:00	
Palmerah	3.821	10.116	2.034	2:33	2:30	2:42	2:30	1:00
New Station	5.855	12.150	1.703	2:24	2:30	2:15	2:30	1:00
Kebayoran	7.558	13.853	2.930	3:24	3:30	3:06	3:00	1:00
Pondok-bitung	10.488	16.783	2.367	2:48	3:00	2:48	3:00	1:00
New Station	12.855	19.150	3.105	3:36	3:30	3:30	3:30	1:00
Jurang-manggu	15.960	22.255	1.989	2:40	2:30	2:42	3:00	1:00
Sudimara	17.949	24.244	2.456	3:00	3:00	2:57	3:00	1:00
New Station	20.405	26.700	2.090	2:42	3:00	2:36	2:30	1:00
Rawabuntu	22.495	28.790	1.413	2:04	2:30	2:06	2:30	1:00
Serpong	23.908	30.203						
Total			23.908	28:49	30:00	28:36	29:30	9:00
Travel Time					39:00		38:30	

4.3.4 Train Headway, Train Formation and Number of Railcars Required

During the single track stage, train headways will be 15 minutes in the peak hour period. Accordingly, transportation capacity with 4 car trains during peak 2 hours will be 9,000 passengers and with 8 car trains, 18,000 during the same period. When modification of signalling system and electrification is completed in 1989, transportation demand is expected to exceed 9,000 passengers, so the train formation should be 8 cars. Transportation demand is considered to exceed 18,000 passengers in 1993, therefore, construction of a double track should be completed not later than 1993.

By demand forecast, a 10 minute train headway is so attractive for commuters that a 10 minute headway with 8 car trains will not be enough for commuter transportation. Thus, on completion of the double track, the train headway should be no longer than 10 minutes, preferably 8 minutes.

Table 4.6 indicates the necessary train headway to accommodate transportation demand, train formation and number of railcars required. Number of railcars in the same table includes 8% reserves for maintenance. However, since a train unit is 4 railcars, the total was adjusted to be a multiple of four after caluculation of reserve railcars.

Table 4.6 Train Headway, Transportation Capacity and Number of Railcars Required

Year	Track Condition	Train Headway	Make up of Train	Capacity (×1,000)	Number of Train set	Number of Railcar rqd.
89-92	Single	15 min.	8 railcar	18.1	8	72
93-95	Double	8 min.	8 railcar	34.0	11	96
96-99	Double	6 min.	8 railcar	45.3	15	132
00-01	Double	5 min.	8 railcar	54.3	18	156
02-05	Double	4 min.	8 railcar	67.9	22	192
06-	Double	3.5min.	8 railcar	108.7	25	216

Remarks: Load factor during peak 2 hours is 200%.
Train headway is for during peak 2 hours.

4.3.5 Railcar Operation Schedule

On making a railcar operation schedule, the following items should be taken into account:

1) Daily inspection must be carried out at the depot once in two days.

2) Three storage tracks are provided at Serpong.

3) Time for changing over operating cabs at terminal stations of Tanah Abang and Serpong should be not less than five minutes (i.e. turnround time).

4) Since train operation density on the Western Line is very heavy due to the strong transportation demand, all the electric railcar trains of the Merak Line are terminated at Tanah Abang.

As seen in Fig. 4.7, all train sets required for peak-hour operation are not needed during the off-peak hours, so some train sets should be stored at Tanah Abang or Manggarai (1 set), and Serpong (3 sets).

Five train sets are based in a depot (Bukit Duri or Depok) leaving in the morning and returning at night. Three train sets are stored at Serpong over-night. Note that these sets must be rotated to permit daily inspections to be carried out at the depot.

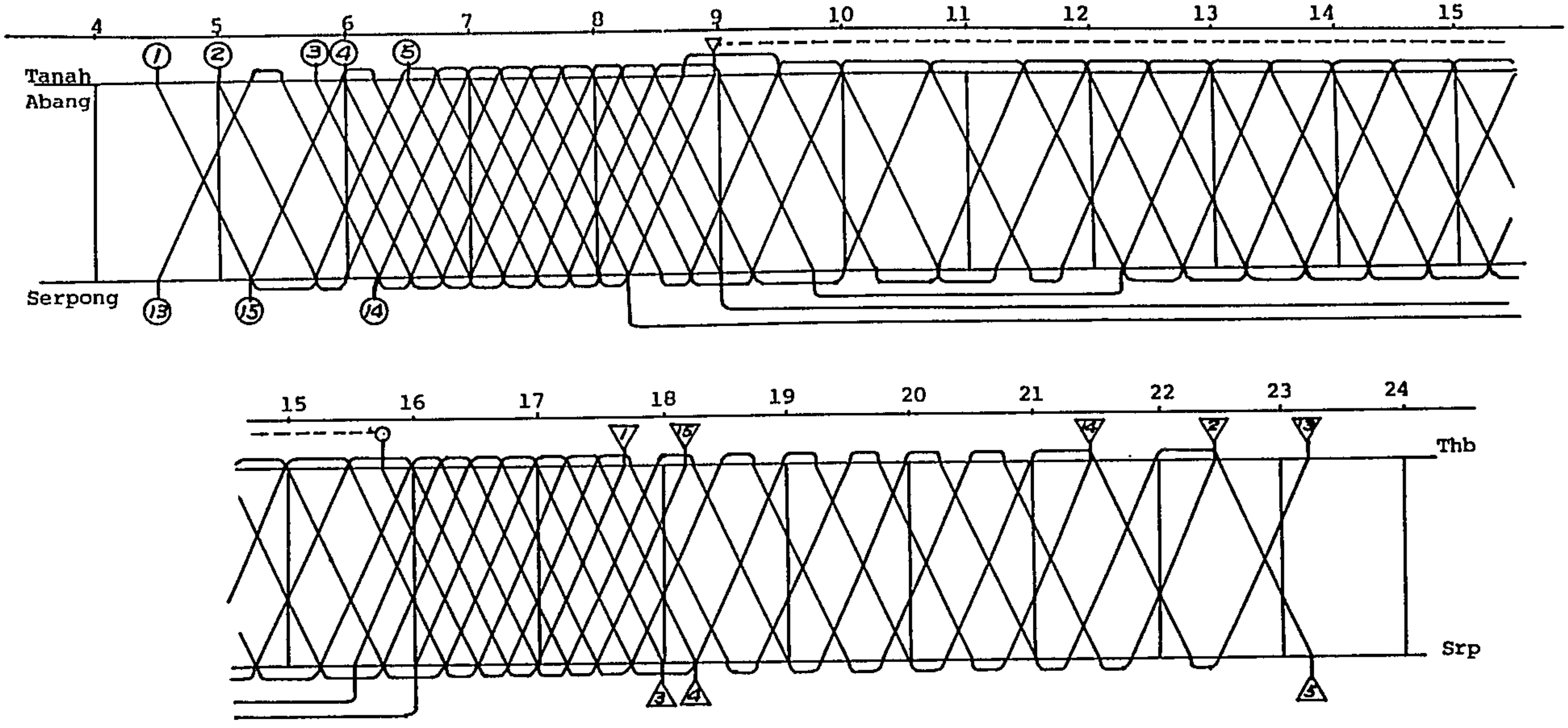


Fig. 4.7 Railcar Operation Schedule
(Single Track)

4.4 IMPROVEMENT PLAN

4.1.1 Existing State of Railway Facilities

(1) Track and structure

The project section is between Tanah Abang and Serpong of the Merak Line, and is 23.3 km in length. The line was opened to traffic in 1916.

(a) Roadbed

The line lies in a hilly district, and consists of embankments, cuts and bridges across valleys. Therefore, the gradient changes frequently, and Serpong Station is 40 m higher than Tanah Abang Station. Most of the gradients are 10‰ which are the steepest grades of this section.

There are many horizontal curves sharper than 600 m radius, and the minimum radius is 300 m except for the curve of 250 m radius between Palmerah and Kebayoran (10 km 800 m).

The standard cross section of the roadbed is "2nd class I degrees III" of the old standard, the maximum design speed of which is 59 km/h. (Refer to Fig. 4.8)

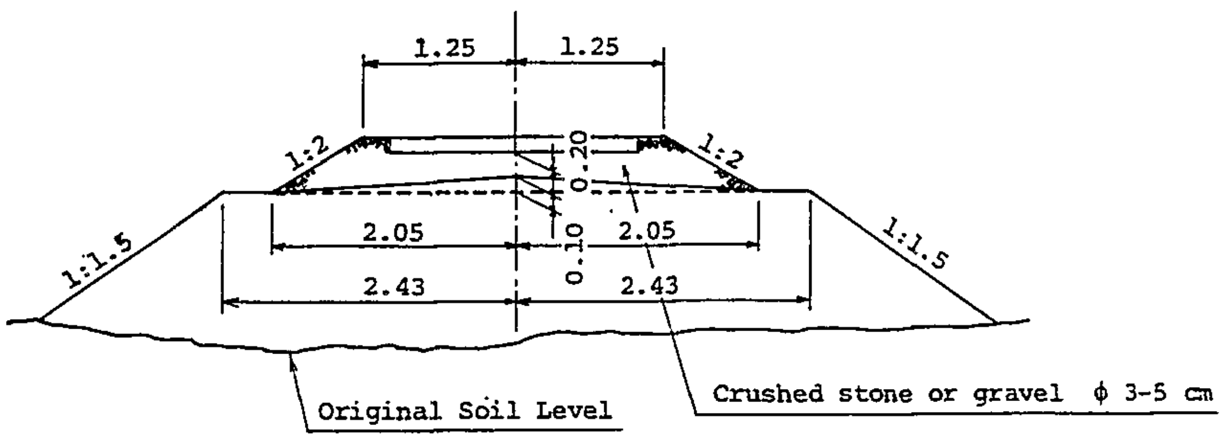


Fig. 4.8 Standard Cross Section of the Roadbed

As shown in the figure, the width of the formation level from the track center is 2.43 m which is less than 2.75 m of the present standard.

The existing state of the roadbed is not so bad, but in many places the shoulders are used as roads for pedestrians, bicycles and motorcycles, and consequently are reduced and scraped out.

(b) Bridge

The bridges are mainly reinforced concrete structures for short spans (less than 6 m) and steel girders or trusses for longer spans (more than 8 m). There is little corrosion of the steel.

The substructures are almost all made of plain concrete including cobblestones.

The bridges appear to be in good state for present train operation but not to have enough bearing capacity for desirable future train operation. The soundness and actual bearing capacity of the substructures must be confirmed by vibration test, etc.

(c) Track

The rails of this section are R3 (33.4 kg/m) relaid in 1976, and partially R14A. The sleepers are steel and the fastenings are Pandrol for R14A with adjusting pads to R3. The rails and sleepers except fastenings are all made in 1910 $\sim$ 1930 and reused in this section. The project of replacing the rails to R14A is presently in progress. The ballast is adequate but in some sections there is mud pumping.

The existing condition is regarded as sufficient for the existing operation speed (maximum 60 km/h) and frequency, but for a higher level service, track rehabilitation and a higher level maintenance work are necessary.

(2) Station

Between Tanah Abang and Serpong there are 8 stations (including both stations) and the average distance between each station is 3.3 km.

The crossing stations are Tanah Abang, Palmerah, Kebayoran, Sudimara and Serpong, and a freight service is provided at Tanah Abang, Palmerah, Kebayoran and Serpong.

Platform height is 0.18 m and length is 60 ∿ 110 m. The island platform between the 2 main tracks of 4.0 ∿ 4.5 m track center to center distance at the crossing station cannot be used for frequent commuter service because of danger to passengers due to lack of space.

Station buildings of various sizes are installed at each station but some of them are now used for dwellings or stores without regard to the railway operation and service. (Refer to Table 4.7.)

(3) Road level crossing

Between Tanah Abang and Serpong there are 18 road level crossings and their average distance apart is about 1.3 km. The warning system is not sufficient and the condition of track and road surface is not good.

(4) Illegal housing

Along the line between Tanah Abang and Kebayoran and in the yard of Tanah Abang Station, there are many illegal houses close to the track. Their residents are using the roadbed as roads and living spaces. The state of the track in these sections is not good in comparison with other sections.

(5) Signalling

The stations with sidings have the equipment for the signalling system including mechanical interlocking devices, home and distant semaphore signals and mechanical switch devices with indicators. These devices are controlled by signal levers and switch levers centralized in a signal cabin through signal wires.

The condition of these devices is such that they will not effectively function in the near future and spare parts for these devices are becoming difficult to obtain.

Table 4.7 Existing Station Facilities

Name of Station	Facilities	Quantity	Remarks
Tanah Abang	Platform	110 m × 2 H = 0.18 m W = 1.9 ∿ 5.6 m	* Including Western Line
	Platform Roof	O	
	Main Track	2	
	Side Track	3	
Palmerah	Platform	90 m × 2 H = 0.18 m W = 1.8 ∿ 2.8 m	*
	Platform Roof	-	
	Main Track	2	
	Side Track	3	
Kebayoran	Platform	90 m × 2 H = 0.18 m W = 1.9 ∿ 2.8 m	*
	Platform Roof	-	
	Main of Track	2	
	Side Track	4	
Pondokbitung	Platform	90 m × 1 H = 0.18 m W = 3.7 m	
	Platform Roof	O	
	Main Track	1	
Jurangmangu	Platform	-	
	Main Track	1	
Sudimara	Platform	90 m × 2 H = 0.18 m W = 1.6 ∿ 2.8 m	*
	Platform Roof	-	
	Main Track	2	
	Side Track	1	
Rawabuntu	Platform	60 m × 1 H = 0.18 m W = 4.5 m	
	Platform Roof	-	
	Main Track	1	
Palmerah	Platform	90 m × 2 H = 0.18 m W = 1.5 ∿ 1.8 m	*
	Platform Roof	-	
	Main Track	2	
	Side Track	3	

* Platform between two main tracks cannot be used for frequent commuter service.

(6) Road level crossing protection

The existing level crossing protection secures against accidents using a manual barrier operated by a watchman. The watchman receives information of the train starting from the adjacent station by an alarm bell. Thereafter, the barrier is closed after hearing the train horn.

At level crossings with heavy road traffic, many vehicles continue to cross over even as the barriers are closing. Therefore, trains are obliged to slow down or even stop at level crossings.

(7) Telecommunication

The stations with sidings have dedicated telecommunication equipment including magneto telephone with neighbouring stations with sidings. Magneto telephone is used for train operation messages, and Morse telegraph (T type) is used for block message and train dispatching. Morse telegraph (B type) is used for exchange of information of train operation. Spare parts for Morse telegraph equipment are becoming difficult to obtain.

(8) Background for electrification work

In the land of PJKA between Tanah Abang and Kebayoran, there are many private houses close to the track.

Pondokbitung Station is in the middle between Tanah Abang and Serpong and Serpong Station is the terminal for electrification. They are suitable sites for substations and there are few private houses in the yard.

The roadbeds between Kebayoran and Serpong are in comparatively good condition for pole erection.

There are 3 overbridges between Tanah Abang and Palmerah. The headrooms are 4.75 m (7 km 235 m), 5.10 m (7 km 250 m) and 4.35 m

(9 km 500 m). The overbridge of Jl. Jend. Gatot Subroto (9 km 500 m) has insufficient headroom of 4.35 m, and so the track must be lowered about 0.5 m, which is possible while maintaining natural drainage.

There are many distribution lines and telephone wires crossing over the track. Especially there are more than 20 in the section between Tanah Abang and Kebayoran.

There is no lighting at any of the stations.

4.4.2 Basic Improvement Plan (Stage Dividing)

(1) Characteristics of the line

The Merak Line is the trunk line running through Java Island, and links Sumatra Island by the ferry across the strait and Central and Eastern Java via Jakarta City. This project is to provide a commuter service for the Jakarta Metropolitan Area by electric cars in addition to the trunk line transportation in the 23.3 km section between Tanah Abang and Serpong.

(2) Project stage dividing

This project is ultimately to provide a frequent service by electric trains running on a double track. It is divided into the following 3 stages in consideration of the rise in demand, the effective use of capital and the schedule for the execution of works.

(a) 1st stage

This stage which is presently in progress and not included in this study involves rehabilitation of the existing track and road level crossings. The major work is replacement of the R3 rail by R14A rail between stations.

Diesel cars presently owned or to be procured are to be used to reinforce the commuter service to the greatest extent possible in conjunction with the rehabilitation work.

(b) 2nd stage (Electrification on single track)

Step-by-step investment will occur with rising demand and therefore electrification and related improvements are to be performed in this stage on the single track. This stage is to achieve a commuter service of 15 minute headways (30 minutes headways when off-peak) with train formation increased within the stage from 4 to 8 cars to give the best transportation facilities. (The smallest pratical headways of 15 minutes are used because modification of determined headways is impossible unless new crossing facilities corresponding to the new headways are built.)

The present medium and long distance passenger and freight services are also to operate.

The improvement works to be carried out in the 2nd stage will be as follows:

1) Electrification
2) Improvement and new construction of crossing stations (including replacement of turnouts)
3) Improvement of Tanah Abang Station (including track layout modification)
4) Improvements of signalling system, road level crossing protection system and telecommunication system.
5) Improvement of station facilities

(c) 3rd stage (Track doubling)

Provision of a double track is to be performed in this stage in accordance with the traffic demand which cannot be met by the performance given by the service of 15 minute headways with 8 car trains.

Improvement and reinforcement of station facilities including Tanah Abang Station and the raising of platforms to 0.95 m will also be performed.

Operation by single line working on the additional new track is to precede the operation on the double track, so that complete rehabilitation of the existing track can be carried out. These works will include widening the existing formation in accordance with the present standard, replacement of rails and sleepers, replacement and supplementation of ballast, replacement and reinforcement of bridge superstructures, and improvement and reinforcement of bridge substructures.

The service for this stage is to be a frequent commuter service of 10 ∿ 3 minute headways in peak times with 8 car trains. The reinforcement of the medium and long distance passanger and freight services will be also possible, even though it is outside the scope of this project.

The train formation for the commuter service in this stage is to be 8 cars, but increasing to 12 cars in some future stage is taken into consideration.

4.4.3 Design Standard

This project is to improve the section of the line which is in operation by conducting improvements in 3 stages. In addition to the standard for the final stage, temporary standards are provided taking into consideration the work method, procedure and present condition.

The design standard is applied to the whole railway system. However, only the standard required for the feasibility study is detailed in this report.

1) Maximum train operation speed

a) Final (3rd) stage

100 km/h	The additional track and the existing track after the complete rehabilitation.

b) 1st and 2nd stages

80 km/h	The existing track after the rehabilitation of the 1st stage.
40 km/h	On the section where there are too many houses close to the track (Tannah Abang ∿ Kebayoran)

2) Minimum radius of curvature of main track

As the existing track (The existing track 250 m, the additional track actually 300 m)

3) Maximum gradient of main track

10‰

4) Track center to center distance

4.0 m

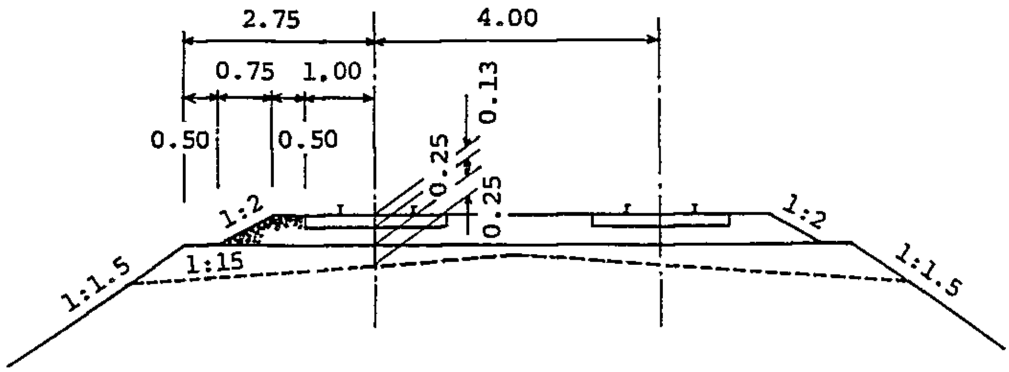
5) Width of formation level

a) Final (3rd) stage

2.75 m (from the track center) (Refer to Fig. 4.9.)

b) 1st and 2nd stage

As the existing state



Note: 1st class, 2nd degree
Speed: 100 km/h
Straight track

Fig. 4.9 Standard Cross Section of Roadbed

6) Track

a) Final (3rd) stage

Rail	UIC54 (or equivalent)
Sleeper (except turnouts)	PC (1,666/km)
Ballast thickness	25 cm
Axle loads	18 t

b) 1st stage

Rail (except turnouts)	R14A
Sleeper (except turnouts)	Steel (120/85 m)
Tournout	As the existing
Ballast	As the existing state

c) 2nd stage

Rail of turnout	UIC54 (or equivalent)
Sleeper of turnout	Wood
Sleeper of section which need insulation for signalling system	PC (1,666/km)
Others	Same as the 1st stage

7) Bridge bearing capacity

a) Final (3rd) stage

KS - 16

b) 1st and 2nd stages

As the existing state

8) Strength of roadbed (newly constructed part)

K30 $\geq$ 7 kg/cm^3 (or equivalent complying with the condition of geological features or nature of soil)

9) Platform

a) Final (3rd) stage

Height	0.95 m	
Length	190 m	(Extension to 270 m in future is taken into consideration.)

b) 1st and 2nd stages

Height	0.18 m	(Before decision of raising the platform height to 0.95 m a temporary platform of 0.18 m height will be used.)
Length	190 m	

10) Electrification

Current and voltage DC 1,500 V

Overhead contact wire catenary system

Simple catenary (St 90 mm^2/Cu 110mm^2) with PC pole and cantilever or V-truss beam

Height of contact wire

Normal 5.3 m

Minimum 4.25 m (Refer to 4.4.4 (5)(b).)

Minimum on road level crossing 5.5 m

Clearance of pole 2.7 m (pole center to track center)

11) Signalling system

a) Final (3rd) stage

Automatic block system

Relay interlocking system

b) 2nd stage

Tokenless system which can be installed on the track with steel sleepers and can be easily converted into automatic block system

Relay interlocking system

4.4.4 Improvement Plan of 2nd Stage (Electrification on Single Track)

(1) Roadbed and structure

In the 2nd stage the existing roadbeds and structures between the stations will be used. This is considered sufficient for the operation and service within the limited period of the 2nd stage.

The width from track center of the existing formation is 2.43 m, which is 0.32 m narrower than the present standard of 2.75 m. However, this will not be widened in the 2nd stage, because it is difficult to obtain adequate strength by placing a thin earth layer onto the existing embankment, and it is uneconomical to extend both sides whether the construction of the roadbed is on an embankment, in a cutting or on a level. This can be widened to the double track in the 3rd stage.

For the design of the structure gauge for erecting electric poles and the height of the contact wire, the re-alignment and raising of the track in the 3rd stage must be considered.

In the section between Tanah Abang and Kebayoran where there are too many houses close to the track, it is very difficult to remove them in a short period. Therefore the removal will be performed together with the land acquisition for the track doubling, and so in the 1st and 2nd stages the operation speed will be reduced to 40 km/h.

The superstructures and substructures of the Merak Line bridges are considered to be adequate for the service in the 2nd stage, so that they can be used as they are.

(2) Track

The tracks of the Merak Line have steel sleepers with R3 rails. Steel sleepers and ballast are generally kept in good condition. Originally the sleepers were provided to be used for R14A rails, and the baseplates for the Pandrol clips were welded to them. The R3 rails are accomodated by using adjusting pads. Now the rehabilitation of the track (1st stage) is in progress and according to the plan the R3 rails will be replaced by R14A except at the station yards.

After the rehabilitation the track is considered to be adequate for the service in the 2nd stage. In the 2nd stage some crossing loops will be newly installed and some will be improved. The remaining turn-outs will be changed, and the tracks in the station yards will be improved. With regard to the improvement of the signalling system, the insulation resistance of the rail circuits must be improved, so that sleepers within station limits will be changed to PC sleepers or wooden turnout sleepers at that time.

(3) Station

The stations and signal stations will have to be improved or newly built to suit the 15 minute headways with 8 car trains. The facilities related to the services of long and medium distance passenger and freight trains at the present level will be left in place or removed. Rough sketches of the track layouts of the Merak Line in the 2nd stage are shown in Fig. 4.10 and Fig. 4.11.

(a) Tanah Abang Station

At Tanah Abang Station the Western Line portion will be left as it is, and only the Merak Line portion which occupies half in the west side of the station will be improved in this project. In relation to the arrangement of crossing stations, 2 tracks will be provided for the Merak Line for the 15 minute headway operation.

There is a locomotive depot in this station. And this station is the starting and terminating station of some of the long and medium distance passenger trains, and also handles freight. Hence the facilities which are concerned with the above mentioned activities, such as routes for locomotives to go in and out when changing locomotives and storage tracks for passenger cars and freight cars, will remain or be removed.

The commuter trains on the Merak Line turn round at this station. It is planned that the passengers connecting to the Western Line shall change trains here, but it is possible that the trains of the Merak Line will go onto the Western Line by way of a flat junction providing

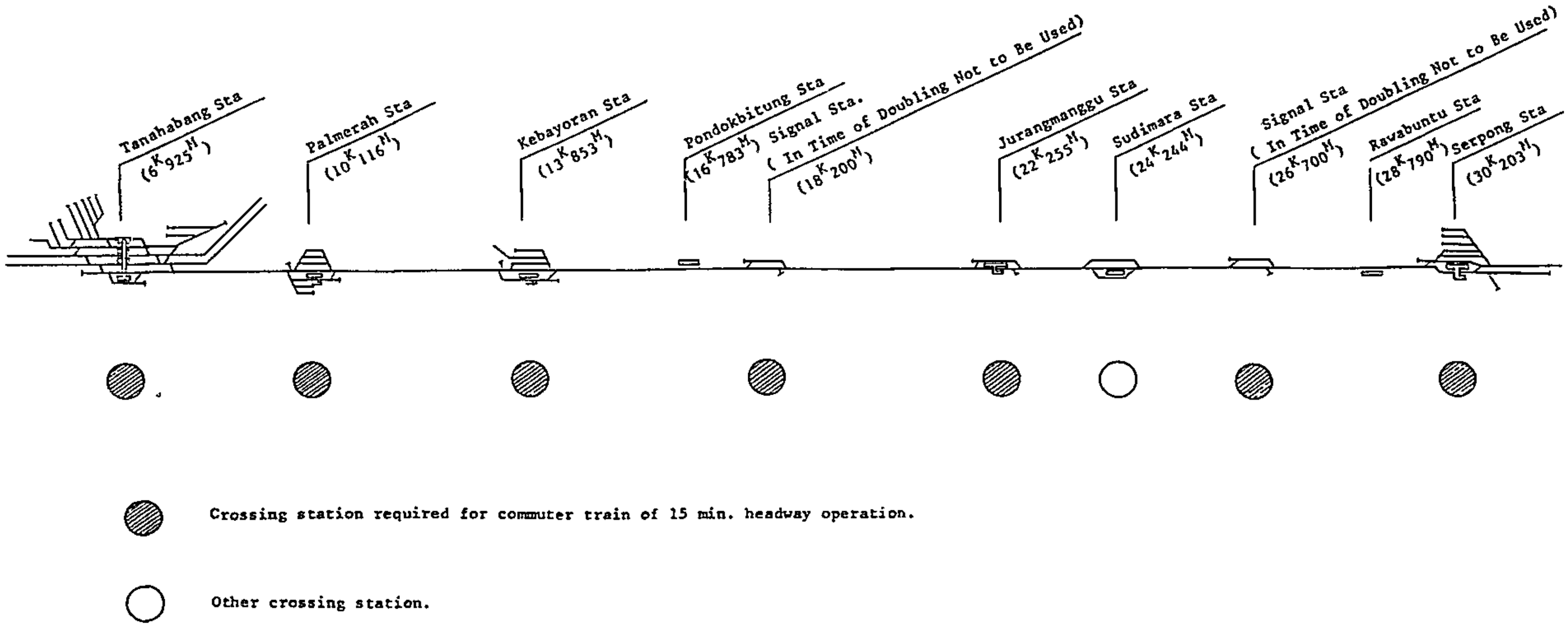


Fig. 4.10 Track Layout on 2nd Stage

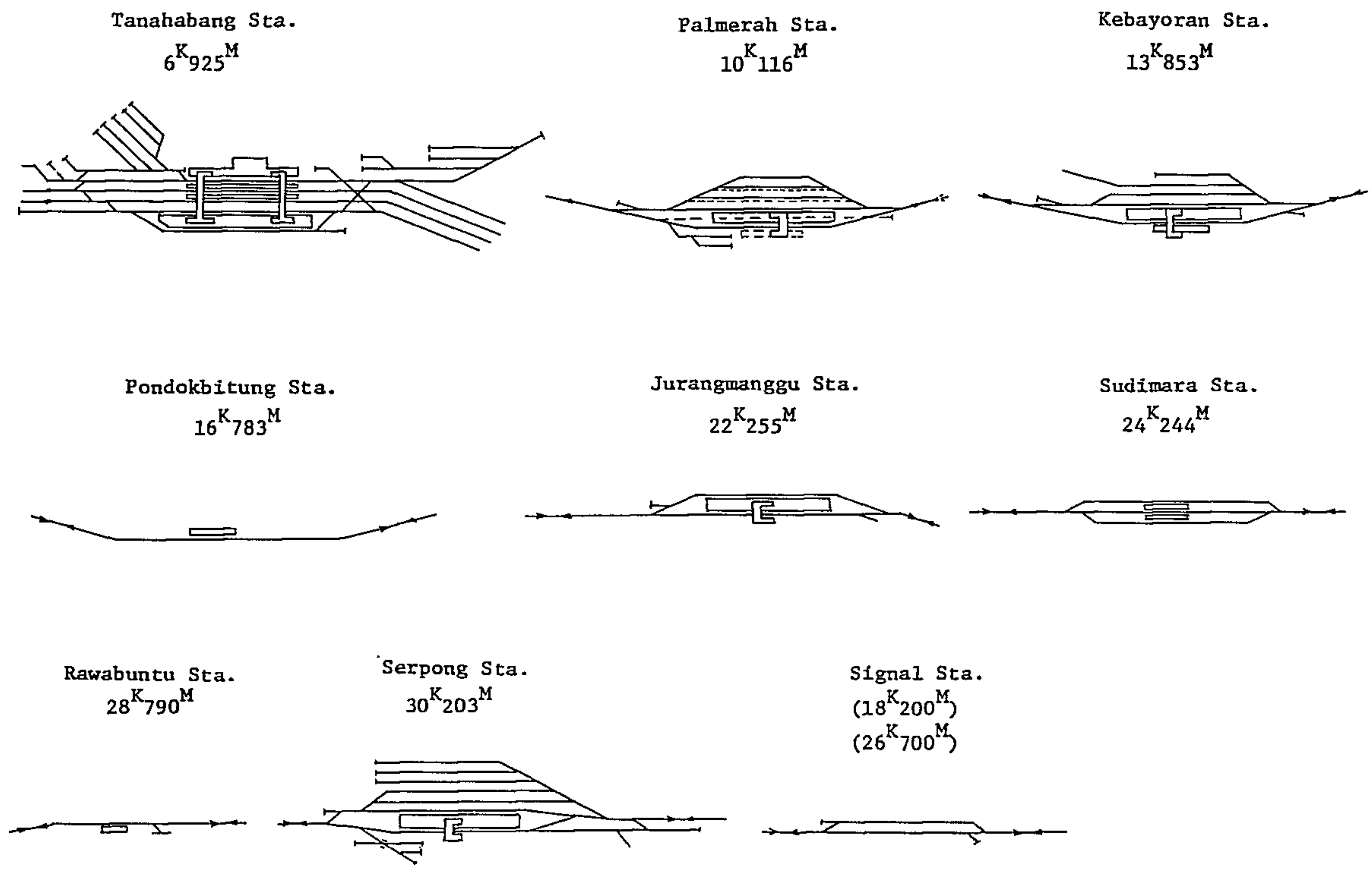


Fig. 4.11 Track Layout of Stations on 2nd Stage

the train diagram for the Western Line will not be unfavorable. It is of course necessary for trains to have access to the electric car depots such as Bukit Duri.

(b) Improvement and establishment of crossing stations

The crossing stations necessary for the 15 minute headway train operation will be Tanah Abang, Palmerah, Kebayoran, Signal Station (18 km 200 m), Jurangmanggu, Signal Station (26 km 700 m) and Serpong.

Palmerah, Kebayoran, Serpong stations are at present operated as crossing stations, so that their facilities will be improved. At Jurangmanggu Station and the signal stations new crossing loops will be installed.

As Sudimara Station is at present operated as a crossing station, its facilities will be improved to be used as a spare crossing station when the diagram is out of order, and also it will be a crossing station for long and medium distance passenger and freight trains when traffic is light and the 15 minute headways are not in operation.

(c) Handling of freight at intermediate stations

The handling of freight such as ballast and sand at Palmerah, Kebayoran and Serpong stations will continue.

(d) Storage track

3 storage tracks will be installed utilizing the vacant space on the south side of Serpong Station in order to store electric cars for the night and off-peak times.

In addition 1 of the 2 main tracks at Tanah Abang Station will also be used so that in-all 4 storage tracks are available for night storage.

For further storage and car inspection Bukit Duri and Depok depots are to be used. These depot facilities are considered under other projects, but the cost of them is to be shared by the Merak Line project.

(e) Platform and platform roof

Considering 8 car trains the length of platforms is to be 190 m.

The height of platforms is recommended to be 0.95 m for smooth and speedy boarding and detraining. This has already been recommended, but as it is a general problem in the JABOTABEK Area and will take time before the final decision, temporary platforms of 0.18 m height will be prepared as tentative measures in the 2nd stage. (Refer to Fig. 4.12.)

Should the height of platforms of 0.95 m be decided earlier than anticipated, the construction of new platforms can be implemented in advance of the 3rd stage. (Refer to Fig. 4.13.)

If the structure will permit construction of the bases on the present foundation, there will be no problem to start the construction of the platform roofs in advance of the 3rd stage.

(f) Station footbridge

With the improved train frequency and length of trains, in order to provide safety for the passengers and to improve the service for them, station footbridges will be built at stations where passengers will be required to cross the track of their trains or that of the trains approaching from the opposite direction. (Refer to Fig. 4.14.)

This construction will be accomplished at the Tanah Abang, Palmelah, Kebayoran, Jurangmanggu and Serpong stations.

At Tanah Abang Station which is the terminal station, 2 foot bridges will be necessary because all passengers detrain.

(g) Points to be observed about crossing stations

a) Simultaneous entry

When a net diagram of 15 minute headways is implemented, the train density is high and it is advantageous to allow both trains to enter the station simultaneously because the trains from both directions will be scheduled to stop at the station. The layout of stations is designed to permit simultaneous entry of both trains by installing

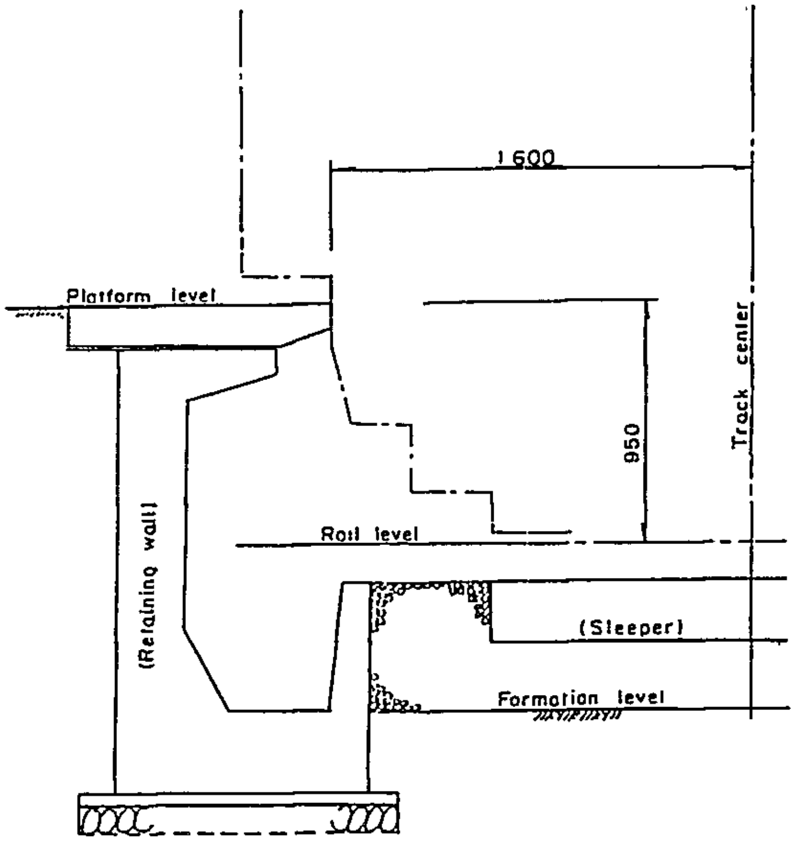
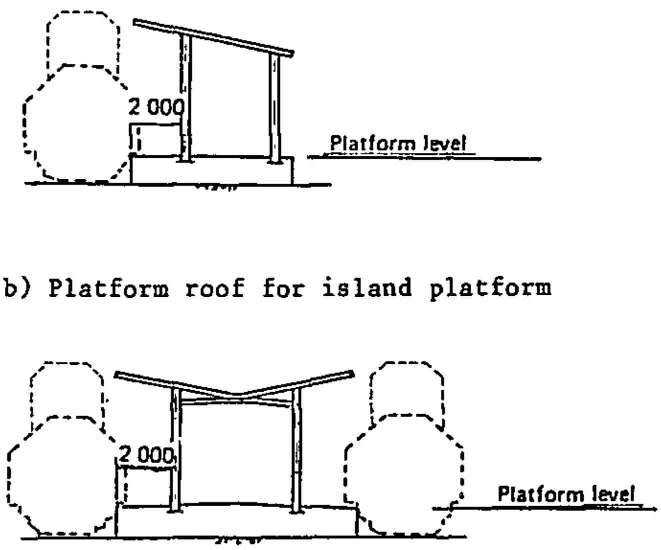


Fig. 4.12 Side Elevation of Platform

(a) Platform roof for side platform



(b) Platform roof for island platform

Fig. 4.13 Standard Design of Platform Roof

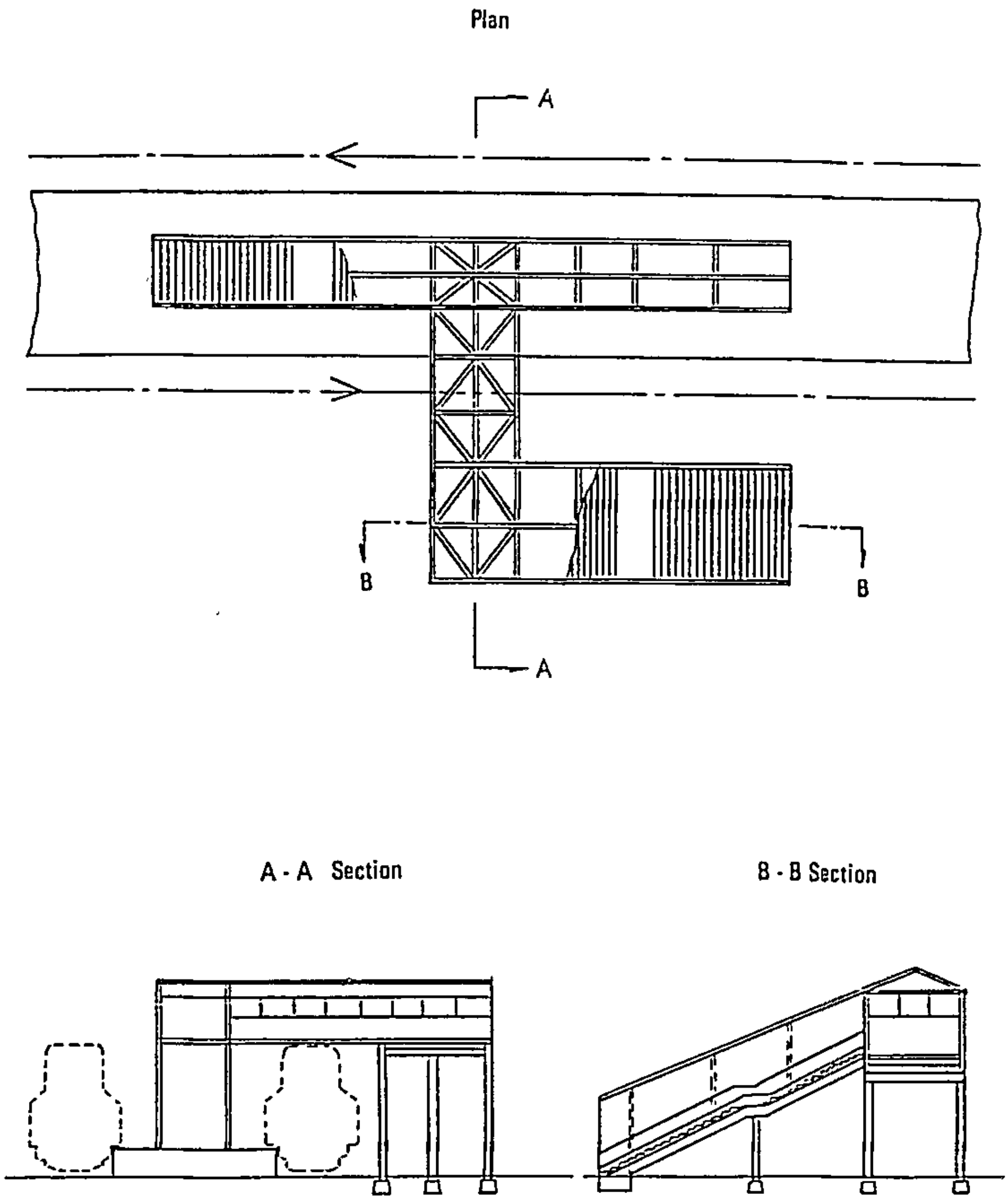
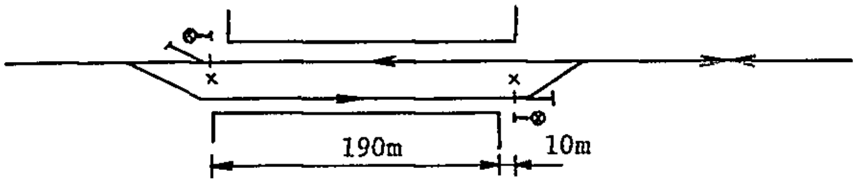


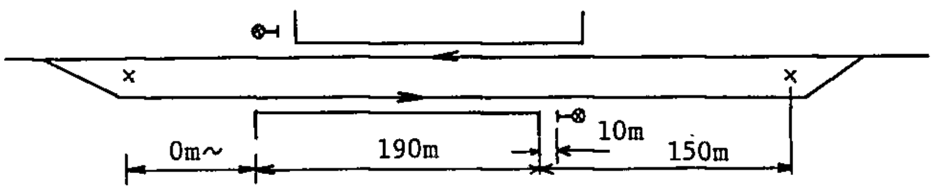
Fig. 4.14 Standard Design of Footbridge

safety sidings. This system has a long history and experience on JNR and other major railway systems, but it has not been used on PJKA, therefore its adoption could be considered controversial.

There is a similar method in which the position of the turnouts is moved to extend the double track to provide an overrun margin of 150 m. If the additional land can be timely acquired, this method could be adopted. Since there is not much difference between the costs of both methods, the economic evaluations for these 2 methods will be the same. (Refer to Fig. 4.15.)



Crossing loop with safety siding



Crossing loop with overrun margin

Fig. 4.15 Crossing Loop

b) Location of crossing loop

If the diagram is closely inspected when the plan for rehabilitation and improvement of the sections between stations is determined and an accurate operation curve is obtained, the probability exists that the position of a crossing loop will not be suitable for 15 minute headway operation and the position of the crossing point will have to be moved. If it will not be possible to move the stopping point of trains at an existing station or if it will not be possible to move the location due to the grade or the curve at a newly-established signal station, it will be necessary to cope with the problem by staggering the crossing point by making a section of a double track longer. The expenses for such a case is calculated in as an unspecified cost. (Refer to Fig. 4.16.)

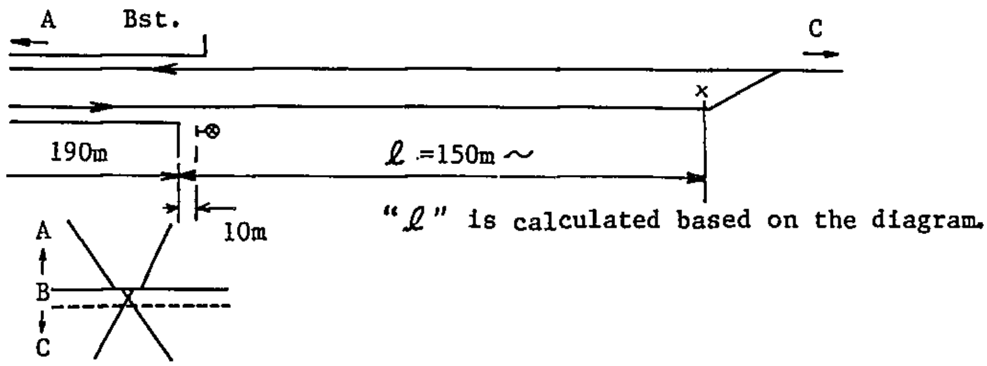


Fig. 4.16 Extended Crossing Loop

(4) Road level crossing

In the 2nd Stage the improvement of the road level crossings will be necessary for frequent train operation, and automatic crossing warnings and gates will have to be installed. The track and road structures will also have to be strengthened. An example of a road level crossing structure is shown in Fig. 4.17, and the warning system is described in 4.4.4 (6) (g).

The existing main road level crossings are listed in Table 4.8.

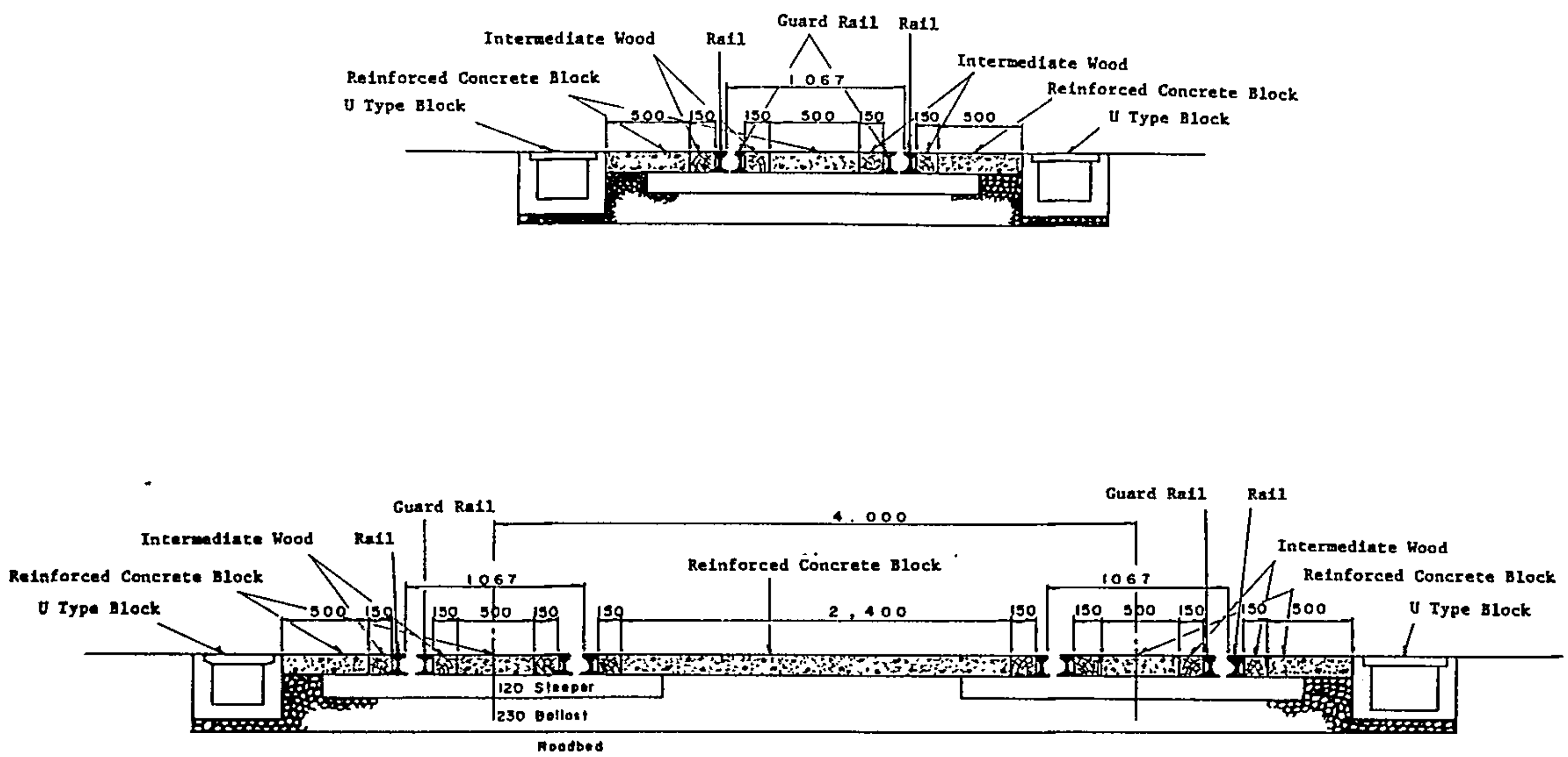


Fig. 4.17 Standard Cross Section of Road Level Crossing

Table 4.8 Main Road Level Crossings

Kilometerage	Name	Width(m)
8.875	Jl. Lan	5.0
10.360	JI. Parmerah	9.5
11.837	Jl. Juraganan	4.5
12.050	Jl. Termatahijal	17.2
13.660	Jl. Pasar Kebayoran	7.0
14.040	Jl. Kereta	8.4
14.292	Jl. Kebayoran Rama	9.3
15.450	Jl. Tanahkusik	5.0
16.943	Jl. Bintaro	6.0
18.180	Jl. Sudala	5.0
19.900	Jl. Ponorekrange	4.0
22.143	Jl. Kampung	4.0
24.433	Ji. Sudimara	4.5
27.572	————	4.0
28.660	Jl. Rawabuntu	3.5
30.383	Jl. Serpong	4.0

(5) Electrification

The electrification of the single track line is the main improvement work to be accomplished in the 2nd stage. A frequent commuter ser vice of 15 minute headways with 4 to 8 electric car trains will also be provided.

The electrification system will be a DC 1,500 V system the same as other electrified lines in the JABOTABEK Area.

(a) Power supply

a) Power source

It is desirable that a 20 kV or 70 kV exclusive power source is used for the electric railway. There are 150 kV and 70 kV transmission lines near the Merak Line as far as Serpong, and the Serpong PLN Substation will be constructed in the Java Island Power Network Improvement Project of PLN. Therefore, there will be no particular problem regarding the incoming power supply for the PJKA electric railway substations.

b) Substation location

Substations for DC electrification will be located at approximately 10 km intervals based on consideration of voltage drop. The planned locations for the substations are Karet, Pondokbitung and Serpong, and the intervals between them are 11.2 km and 13.4 km, based on consideration of basic intervals, geographic conditions, existing conditions related to power supply and future maintenance potential within the district. Karet is located adjacent to Tanah Abang Station at 1.4 km north along the Western Line and is the site for a substation for the Western Line electrification. It is also appropriate to install the substation for the both lines for both economic and maintenance reasons. The substation interval becomes a little too great, but the location of Serpong is convenient for maintenance work.

The substation sites are within PJKA's area, however, it will be necessary to remove private houses on the sites. This removal will entail compensation costs.

c) Substation capacity

The 15 minute headways with 8 car trains are considered to be the maximum for single track operation.

Considering the rapid increase of the traffic demand, the capacity of each substation is initially planned to be 3,000 kW. It is also planned to increase the capacity by another 3,000 kW facilities in accordance with the increased demand after the completion of the double track, when the headways become less than 8 minutes.

(b) Overhead contact wire system

a) Description of facilities

a. Catenary system

Simple catenary system

b. Wire types

Feeder	Hard-drawn copper stranded wire	300 ∿ 400 mm^2
Messenger wire	Galvanized steel wire	90 mm^2
Contact wire	Hard-drawn groove trolley wire	110 mm^2
Ground wire	Galvanized steel wire	55 mm^2

c. Height of contact wire

Normal	5.3 m
Minimum	4.25 m*
Maximum	5.9 m
Minimum on road level crossing	5.5 m

* The minimum height of 4.25 m will have to be provided for the future AC-DC dual purpose electric car on the line for Cikanpek, though on the existing standard a minimum height of 4.1 m is adopted.

d. Maximum gradient of contact wire

Main track	5/1,000
Siding	15/1,000

e. Supporting structure

Prestressed concrete pole
V-truss beam (inside station)
Cantilever beam (between stations)

f. Clearance of pole

2.7 m (pole center to track center)

The standard mounting for the overhead contact wire system is as shown in Fig. 4.18 and Fig. 4.19.

b) Overbridge

There are 3 overbridges in the section to be electrified. These are listed in Table 4.9.

Table 4.9 Overbridges

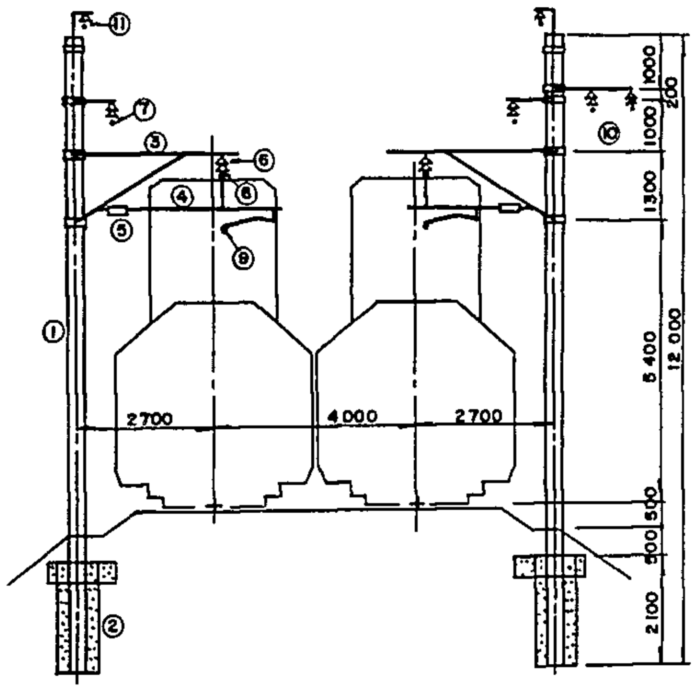
Place	Kilometrage	Name of Road	Hight of Headroom (m)
Tanah Abang St.	7.235	Jl. Jembatan Tinggi	4.75
Tanah Abang St.	7.250	Jl. Jembatan Tinggi	5.10
Tanah Abang ∿ Palmerah	9.500	Jl. Jend. Gatot Subroto	4.35

The headroom of the Jl. Jend. Gatot Subroto Bridge is not sufficient, and it will be necessary to lower the roadbed by about 0.5 m, which is possible while maintaining natural drainage.

c) Special structure gauge taking into consideration complete rehabilitation in the future

It is considered advisable to strengthen the track structure by increasing the embankment shoulder and ballast by shifting the track center line towards the widening work and raising the rail level.

Prior consideration of the length of the cantilever and the structure gauge (clearance of pole and height of contact wire) at the time of single track electrification is therefore necessary.



① Prestressed Concrete Pole
② Concrete Foundation
③ Cantilever Beam
④ Steadying Equipment
⑤ Stem Insulator
⑥ Suspension Insulator
⑦ Feeder Wire Cu 300~400 mm^2
⑧ Messenger Wire St 90 mm^2
⑨ Trolley Wire Cu 110 mm^2
⑩ High Voltage Distribution Wire Cu 38 mm^2
⑪ Ground Wire St 55 mm^2

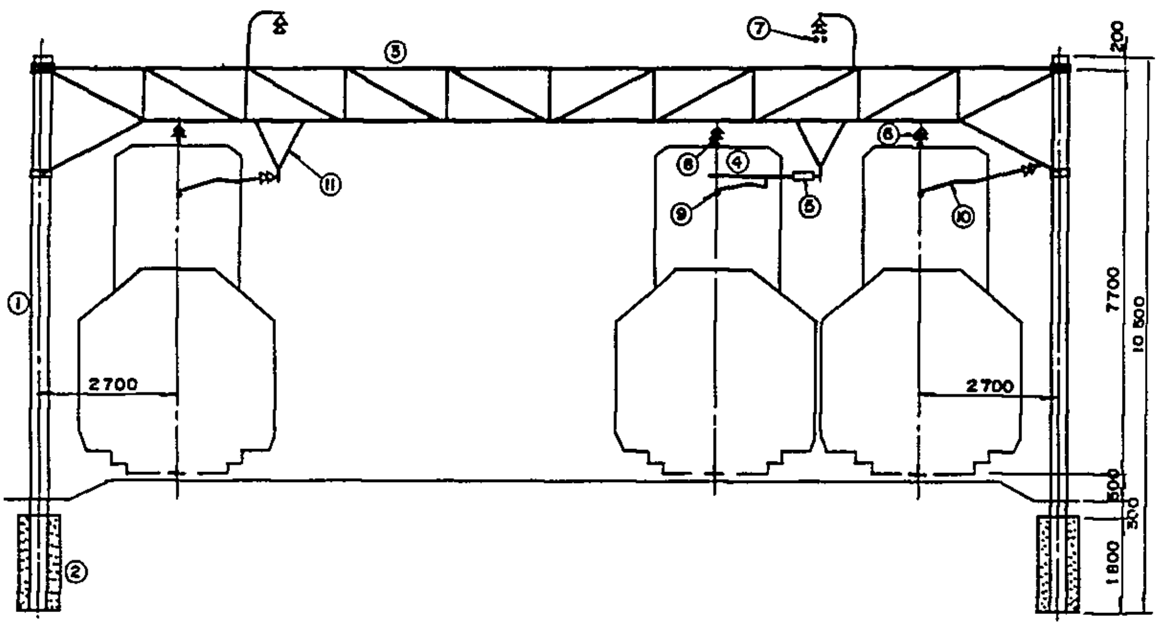
Fig. 4.18 Standard Mounting (between Stations)

d) Overcrossing wires

There are many distribution lines and telephone wires crossing over the track, particularly between Tanah Abang and Kebayoran more than 20 lines cross. And they will have to be dealt with before electrification.

e) Houses obstructing electrification

There are many houses along the line close to the track between Tanah Abang and Kebayoran, and these will become obstruction to pole election prior to the track doubling. At that time, only a minimum number of houses will have to be removed and compensation for them will be necessary.



① Prestressed Concrete Pole
② Concrete Foundation
③ V- Truss Beam
④ Steadying Equipment
⑤ Stem Insulator
⑥ Suspension Insulator
⑦ Feeder Wire Cu 300∿400 mm^2
⑧ Messenger Wire St 90 mm^2
⑨ Trolley Wire Cu 110 mm^2
⑩ Pull-off Equipment
⑪ Drop Arm

Fig. 4.19 Standard Mounting (in Station)

(c) Power facilities

a) High-voltage distribution line for signalling system.

Each PJKA substation will have an exclusive-use transformer for signalling and road level crossing protection system. It will be a 6.6 kV single-phase one-circuit distribution line, and the voltage will be dropped where necessary. It will not be used as the power source for electric lighting facilities at stations. (There are PLN distribution lines along the Merak Line, so the power sources for electric lighting facilities can be provided by them. Accordingly, the exclusive line will be only for the signalling system and it may be single-phase.)

b) Lighting facilities

There are practically no lighting facilities at any of the existing stations, so it will be necessary to provide lighting facilities for the main parts of each yard, platform and station building. The power sources for these facilities will be provided from PLN distribution lines.

(6) Signalling

As described in the preceding paragraphs, the existing signalling system is old and inadequate to function well and to meet increasing traffic demand. In order to deal with further increase in traffic demand, it is essential to modernize the existing system. In this modernization the signalling system is planned on the basis of a train operation of 15 minute headways on the single track (2nd stage), 5 minute headways on the double track (3rd stage) and 3 minute headways on the double track (3rd stage in future).

The outline of the signalling system in the 2nd stage is shown in Fig. 4.20.

(a) Block system

When a train is proceeding on a main-track route, no other trains or cars may be allowed on the same section of the route at the same time. In order to secure this, a block system which make up a route of blocking sections and allow only 1 train to operate in each section is to be provided.

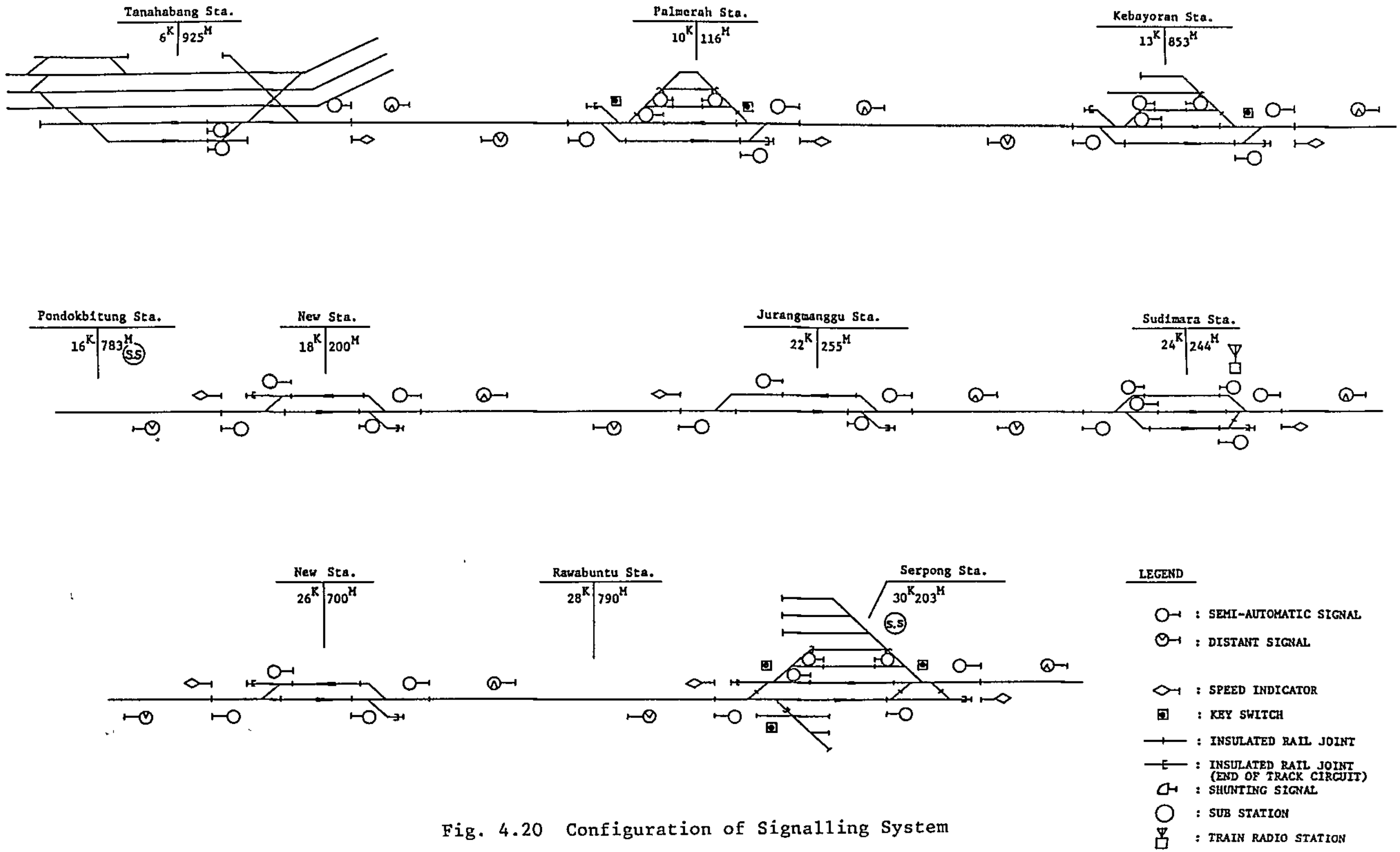


Fig. 4.20 Configuration of Signalling System

For the single track operation in the 2nd stage, between stations the section is to be blocked by the train itself and train direction is to be decided by the operators of both stations, and within a station yard sections are blocked by the train itself or the signal operator.

(b) Signal system

The signal system is to be such that a speed condition for the proceeding train is indicated by a signal aspect. A signal is to be provided at a boundary of blocking sections and automatically controlled by the train itself. Home and starting signals are also to be manually controlled by the signal operator. The signal aspects are basically to be 3 colors of green, yellow and red, and if necessary green-yellow and/or yellow-yellow are to be used.

For shunting a train or cars, a shunting signal of position lights is to be provided, which is designed to indicate the clearance of the route. A shunting signal is not, however, to be provided for a simple station yard with small shunting movements. Instead, a locking switche at the site is to be provided to enable the shunter to lock the route controlled by a relay interlocking device.

(c) Interlocking system

The interlocking system is to be a relay type designed to operate a route under remote control by levers for signals, shunting signals and related electric switch machines in order to increase the operator's efficiency and ensure safety. The interlocking device is to be provided a lock between these controlled units on the fail-safe principle.

(d) Train detection system

Automatic signals and relay interlocking devices require train detection for which a commercial frequency AC track circuit system is to be adopted as the simplest and both highly reliable and economical system. Between track circuits, insulated rail joints are to be inserted and in order to make traction current return impedance bonds are to be provided.

In a blocking section between stations a continuous track circuit cannot be adopted because of the steel sleepers remaining in this stage. For train detection in such section, therefore, short track circuits are to be installed at the edges of stations for checkin - checkout method in the 2nd stage.

(e) Switch system

The switch system is to be a motor type to provide reduced switching time for a increased train speed and a traffic density. Electric switch machines controlled remotely on the control panel of the relay interlocking device are to be provided.

(f) Automatic train stop system (ATS)

The train route is to be ensured by the relay interlocking device and the safety of the train is secured as long as the train enters at a speed in accordance with the signal aspect. Should the signal aspect be ignored due to sudden illness or negligence of the operator, a serious accident could occur.

In order to prevent such an accident, an automatic train stop system (ATS) is to be installed as a backup system to the operator.

(g) Level crossing protection system

In order to prevent a traffic accident under growing road traffic volume and increasing train operation speed and dencity, a system with level-crossing signals and automatic barriers is to be installed. This is controlled automatically by the level-crossing controller. It would be necessary to arrange for a watchman to ensure smooth traffic flows.

(h) Signal cable

Signal cable in station yards and at specified areas are to be housed in reinforced concrete troughs, while the others installed along railways are just to be buried.

(7) Telecommunication

Under increasing train operation speed and density, the telecommunication system must be modernized to ensure safety and efficient of operation, to improve services for users and to make railway management more efficient. The system is necessary to be optimal, and it will have to be compatible with the system proposed in the Intermediate Program for the JABOTABEK Area.

(a) Telecommunication cable

The telecommunication cable is to be the unit cable housing communication circuits between various divisions, command circuits for train operation, circuits to control substations, block circuits for signals and maintenance circuits.

(b) PCM cable carrier system

The PCM cable carrier system, which is less sensitive to the induced noise distortion and suitable for a high-speed data circuit, is to be used to ensure much higher-quality transmission to provide multiplication of data transmission channels.

(c) Dispatch telephone equipment

In order to ensure the best train operation by recognizing operational conditions such as delay of a train, dispatch telephone equipment designed to convey information from the center directly to the outstations is to be provided.

(d) Talk-back equipment

At a station where there are shunting works, talk-back equipment is to be provided for communication between the signal cabin (signal operator) and the field man.

At every station talk-back broadcast equipment is to be provided for a passenger guide service.

(e) Subscriber telephone

Subscriber telephones are to be provided at each station for communication between stations, signal stations, substations, and administration and other sections in PJKA. They are to be connected to the automatic exchange device (Philips UH-200) installed in Tanah Abang Station.

(f) Wayside telephone terminal box

Wayside telephone terminal boxes are to be installed every 500 m along the railway tracks, so that a portable telephone can be connected to communicate information in case of a train accident, track failure or maintenance from the site to the nearest station or operation center.

(g) Facsimile telegraphy

Facsimile telegraphies are to be provided at each station, which allow transmission of important commands (in diagrams or characters) from the operation dispatcher to each station or all stations and enable the recording of information between both sender and receivers.

(h) Electric clock equipment

To ensure the correctness of train schedule for the operational personnel and passengers, electric clocks are to be provided at station offices, signal cabins and platforms. These are to be controlled from the master clock installed at Tanah Abang Station.

4.4.5 Improvement Plan of 3rd Stage (Track Doubling)

(1) Outline of this stage

The initial aim of this stage is track doubling in order to achieve a frequent commuter service of less than 15 minute headways, when more than 18,000 peak 2 hour commuters use the service, which is the limit of the 15 minute headway commuter service with 8 car trains. And by increasing the number of cars and enlarging the maintenance and storage facilities such as the workshop, depots and storage tracks in addition to the track doubling, the additional transportation capability up to 3 minute headways can be obtained. The workshop, depots and storage tracks are considered under other projects, but the costs of them are to be shared by this project.

This project is based on the assumption that the commuting demand would not exceed the transportation capability of 3 minute headways with 8 car trains during the project life. The modification to 12 car trains in future, however, should the demand increase, is taken into consideration in this project.

The complete rehabilitation of the existing track is also suggested, so the improvement of the line has been minimized in the 1st and 2nd stages. The complete rehabilitation of the existing roadbeds, bridges, tracks, etc. is estimated to require a construction period of 1.5 years using the new track for a single track operation during that time.

(2) Overview of the geographical and geological features

(a) Geographical features

The alluvial plain extends to the sea in the northern part around Jakarta, and the rolling volcanic hills are located to the south. The Merak Line runs through these hills in a south westerly direction on embankments, cuttings and bridges over the valleys which run northwards cutting into the uplands. The profile of the line therefore generally climbs to Serpong Station, which is 40 m higher, and repeats up and down.

(b) Geological features

The Merak Line passes through the diluvial uplands in which volcanic ash covers the bedrock of the Neogene formation made of clay rock or sandstone. The volcanic ash has become laterite to a great depth.

On the valley bottom which has been eroded from the upland there are sediments from the upper strata not yet consolidated, and the bedrock is located at about 10 to 20 m depth. (Refer to Fig. 4.21.)

(c) Geology and construction

a) Cutting

The diluvial upland soil can be cut and is of sufficient strength, so that the existing line has earth slopes at 1:1 ∿ 1:1.2 without retaining walls. The widened line can also use the same slopes.

b) Embankment

The soil excavated in the uplands or from nearby uplands can be used for constructing the embankments except in the deep valleys. Although the lateritic soil might be poor to some extent, embankments have been constructed of this material for the road between Jakarta and Merak and the access road to Cengkareng airport.

c) Bridge

Since most of the bridges are in the erosional valley of the diluvial uplands, piles should be driven for the bridge foundations. The bridges of more than 15 m span and the high bridges over the deep valleys would require piles to be driven to the bedrock which is less than 20 m deep.

(3) Environment

The line runs through the urban district of Jakarta between Tanh Abang and Kebayoram. In this area illegal houses have been built close to the track on both sides and the trackbed is used as a road or a playground. The scale of the illegal housing is so great that there would be a social problem to remove it. Accordingly, in the 2nd stage the

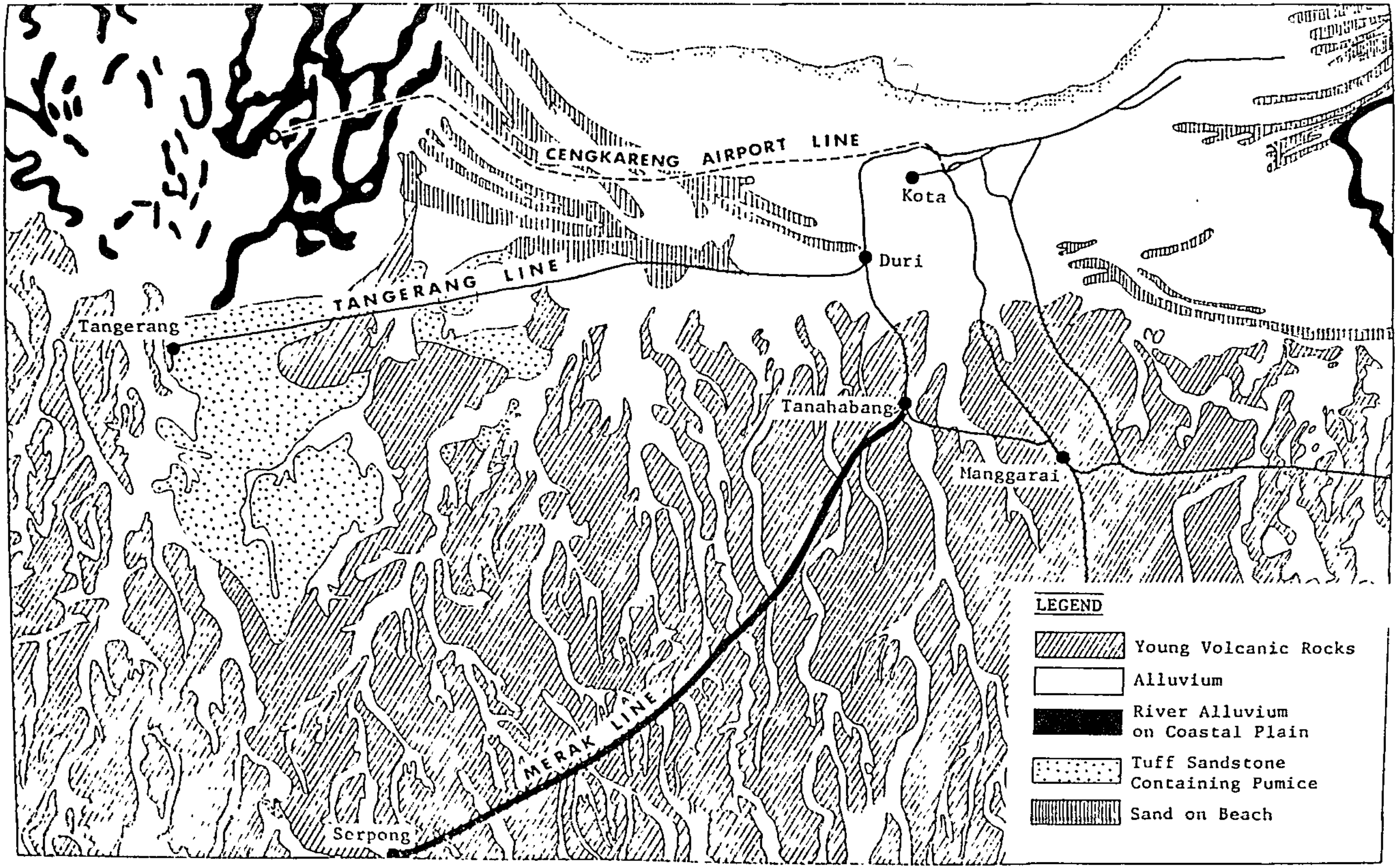


Fig. 4.21 Geological Map

train is planned to run slowly at a speed of less than 40 km/h for safety without removing it. In the 3rd stage the removing of the housing as well as enlarging the right-of-way for the new track is planned as a long term project.

From Kebayoran to Serpong the line runs through the fields, paddies and forests on the hills and valleys. At around 18 km 000 m to 19 km 000 m and around 21 km 000 m large scale housing sites are being prepared on the hills, where the geological and geographical conditions and water supply conditions are so good that these areas would be developed in the future.

(4) Alignment and profile of additional track

The alignment of the additional track is planned to be located near and parallel to the existing track but at bridges the distance between the new track and the existing track should be 8 to 12 m to allow adequate construction space.

The tracks have 250 ∿ 350 m radius curves just after Tanah Abang Station, before and after Palmerah Station and after Pondokbitung Station, but the curve modification is not planned for these places, since higher running speed is not required by local trains stopping at the stations. (The sharpest curve of the additional track will be actually 300 m radius.)

The profile of the additional track is planned to be almost the same as that of the existing track. The alignment and profile of the additional track are shown in Fig. 4.22 and Fig. 4.23. And the standard cross section is shown in Fig. 4.9. The detailed alignment is shown in the Drawings (separate volume).

When doubling the track, the existing track will be improved (complete rehabilitation). Therefore, the condition of the existing track (such as the track center) after the improvement will have to be considered fully, when establishing the alignment and profile of the additional track.

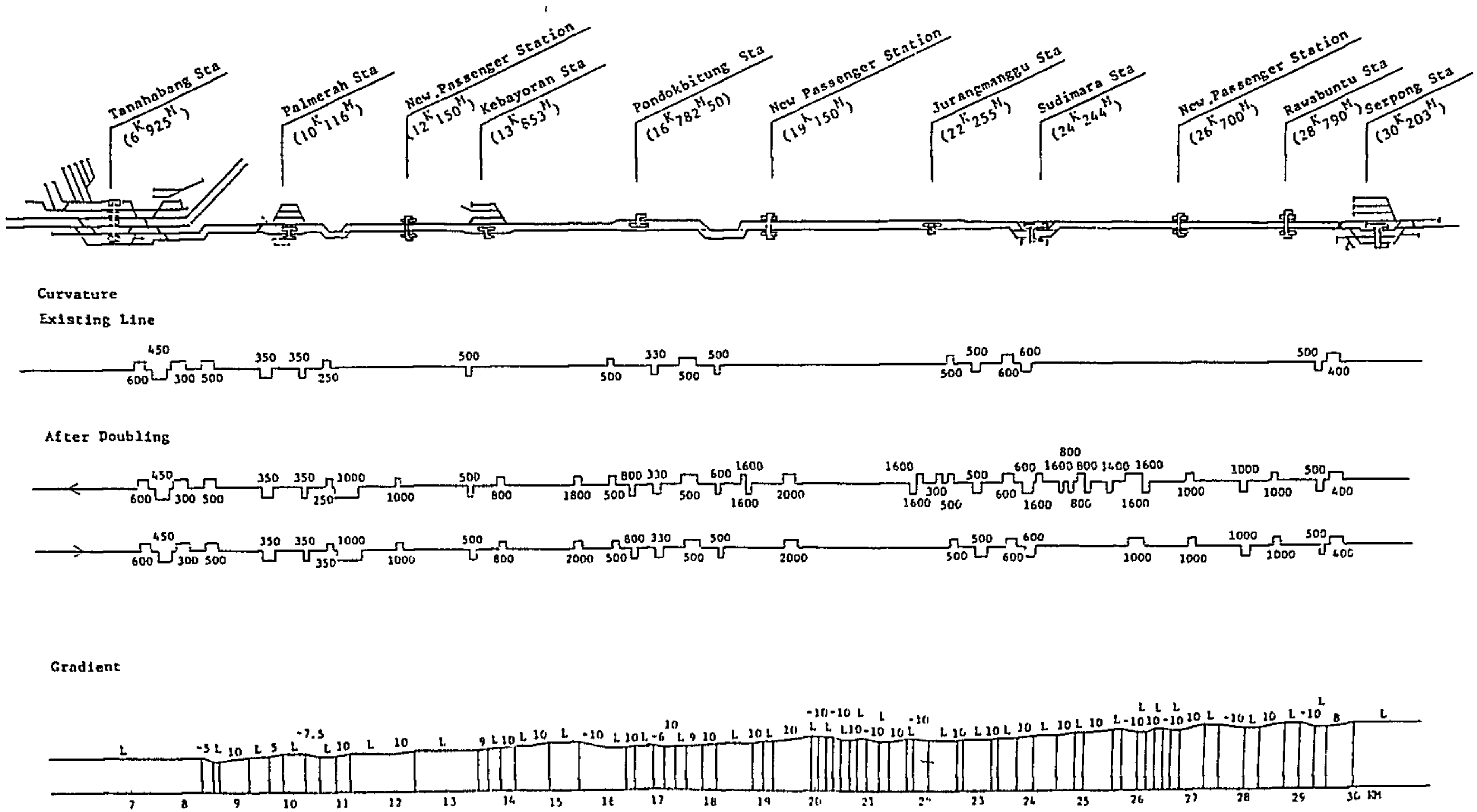
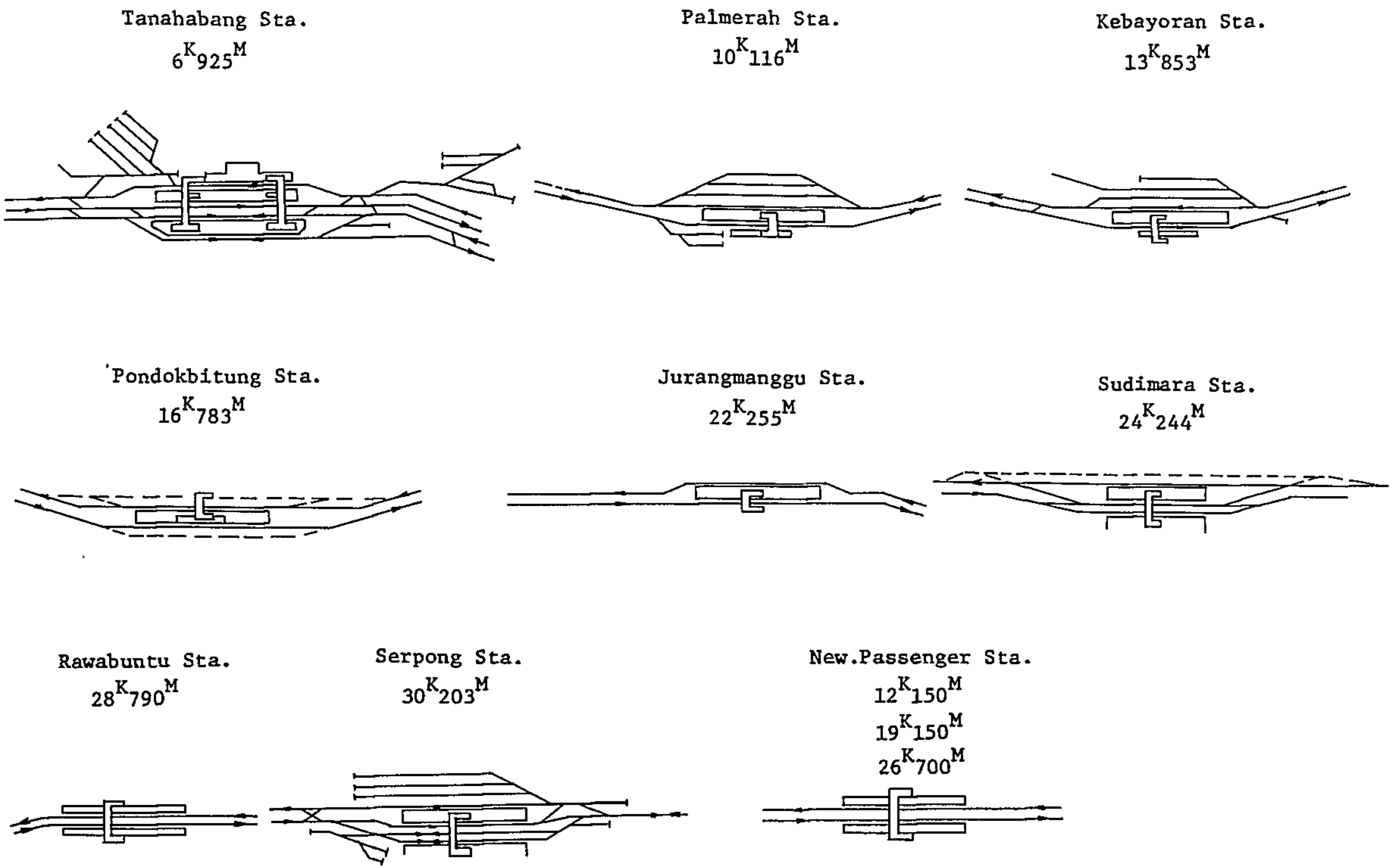


Fig. 4.22 Alignment and Profile of the Tracks on 3rd Stage



----- Relief tracks or through tracks for increase of medium and long distance passenger freight services, which will be executed as another project if necessary.

Fig. 4.23 Track Layout of Stations on 3rd Stage

(5) Roadbed and structure

(a) Additional track

The structures for this project will be almost all embankments and cuttings. Bridges will be only used for the rivers and flood openings.

The types of bridges of the additional track will be steel girders (composite girder) for more than 30m spans, prestressed concrete I-section girders for spans between 15m and 30m and reinforced concrete girders or culverts for less than 15m spans. (Refer to Fig. 4.24.) The substructures will be made of reinforced concrete and if the geological features require, reinforced concrete piles will be driven.

The planned profile which gives rough estimated volume of the earthwork is shown in Fig. 4.24 and the planned main bridges are listed in Table 4. 10.

The line lies in residential (or becoming residential) district and so all the bridges are planned to have ballast in order to reduce noise.

For the design of the river bridges any river improvement plans will have to be taken into consideration. For the design of the embankments sufficient flood openings will have to be considered.

To widen the formation, in earthworks for the additional track, embankments of sufficient width for a double track to the new standard (including the existing embankment) will have to be constructed. In the complete rehabilitation the center of the existing track will be moved towards the new line to increase the shoulder width to the new standard.

There are 3 road over bridges, and they all have the sufficient room for the additional track.

(b) Complete rehabilitation

After the completion of the additional track, by the single track operation on the new track, the complete rehabilitation of the existing track will be carried out. Based on detailed inspections, replacement of bridges, either superstructures only or including substructures, will be implemented at the same time.

Table 4.10 Main Bridge List

Kilometerage	Name	Existing Bridge Type	Existing Bridge Span(m)	Planned Bridge Type	Planned Bridge Span(m)
8.285	Banjir Kanal	RC Girder	4× 5.5	Composite Girder	1×40
10.878	Kari Grogol	Steel Girder (Deck)	1×10	RC Girder	1×10
16.376	Kari Pasang Tahan	RC Girder Steel Girder (Deck)	2× 6 1×15	RC Girder PC Girder	2× 6 1×15
21.914		Steel Girder (Deck) RC Girder	1× 8 2× 6	PC Girder	1×20
22.123		RC Girder	3× 6	PC Girder	1×20
22.497		PC Girder RC Girder	1× 5 2× 4	PC Girder	1×15
24.953		Steel Girder (Deck)	1× 8	RC Girder	1×12
26.016		Steel Girder (Deck) Truss(Deck)	2× 8 1×30	RC Girder PC Girder	2× 8 1×30
28.034		RC Girder	1× 5	RC Girder	1× 8
28.123		RC Girder	1× 5	RC Girder	1× 8
29.366		Truss(Deck) Truss(Deck)	2×15 1×20	RC Girder PC Girder	2×10 1×30

The strength of the existing girders appears to be insufficient for the loads for this project and the girders are planned to be replaced.

(6) Track

(a) Additional track

For the additional new track UIC54 (or equivalent) rails and PC sleepers - 1,666/km with elastic fastenings are used with ballast thickness of 25 cm, for the maximum speed of 100 km/h and a frequent commuter service by electric cars.

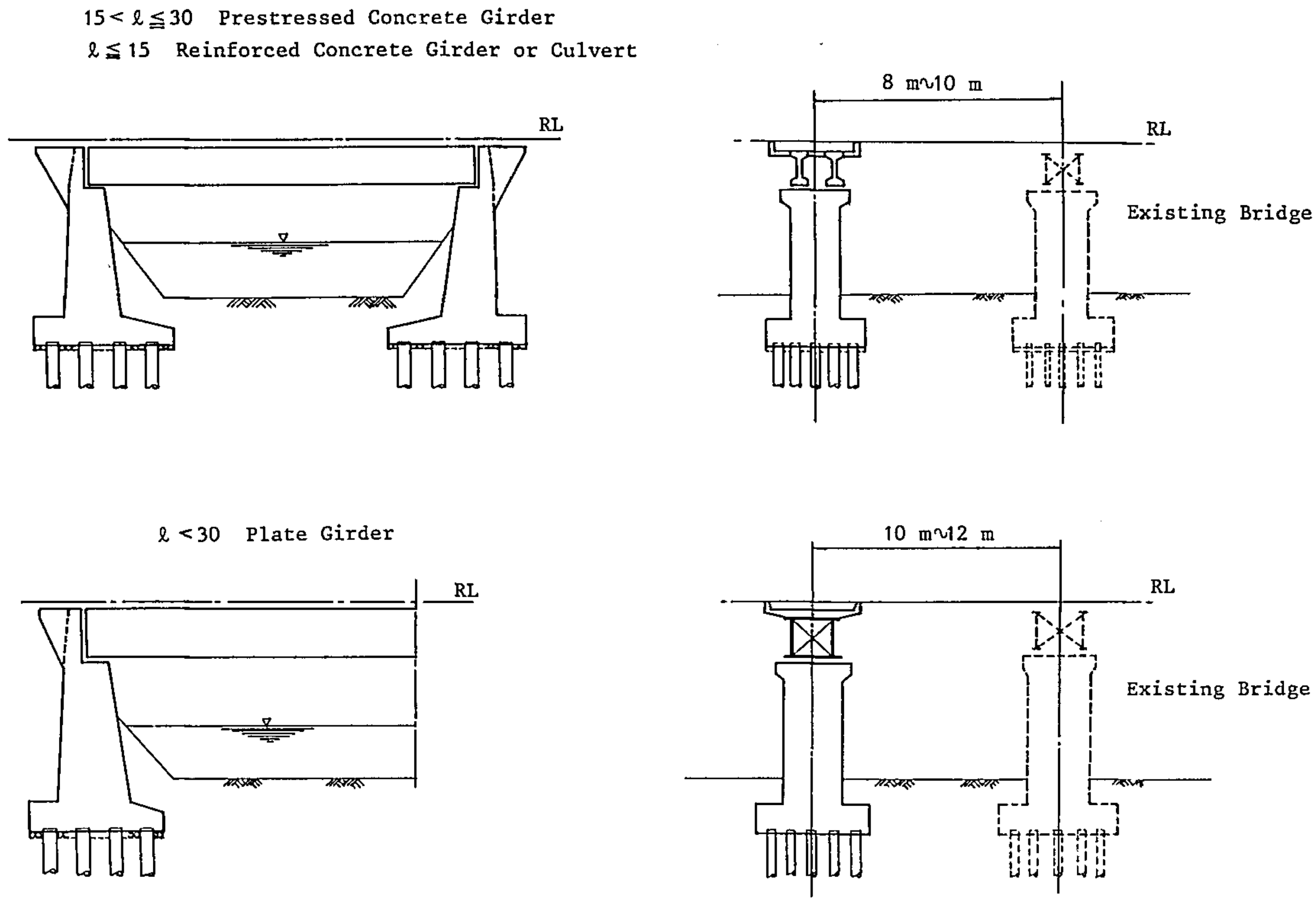


Fig. 4.24 Bridge

Herak Line

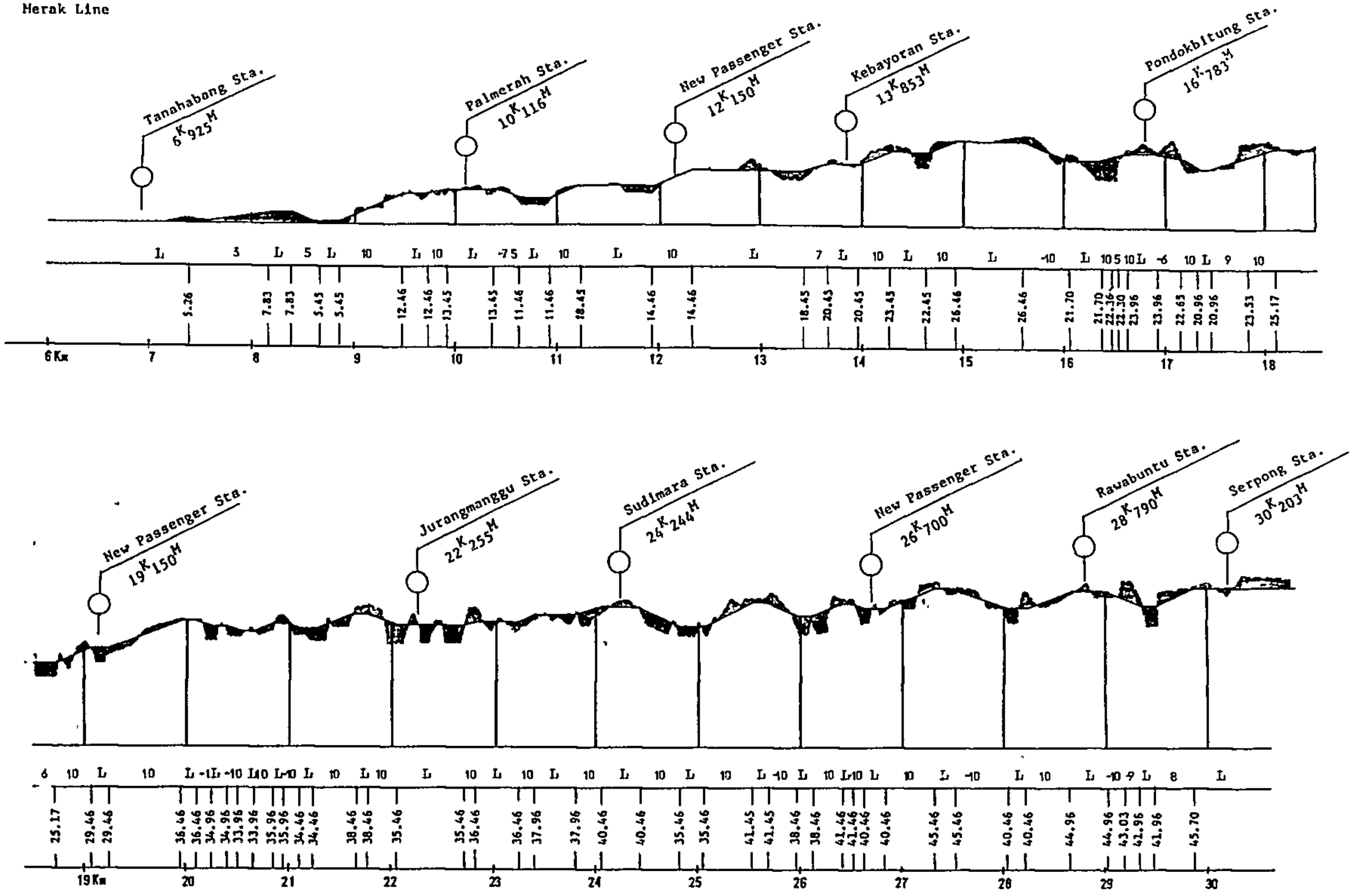
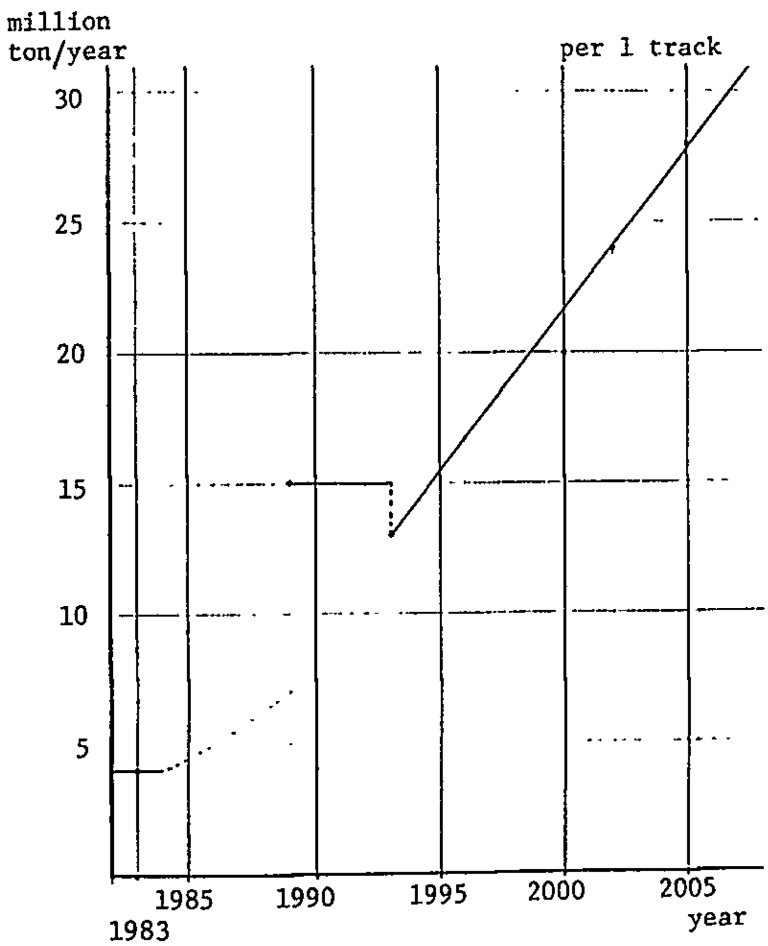


Fig. 4.25 Profile of Track

(b) Existing track

After the rehabilitation of the 1st stage, for the existing track R14A rails and steel sleepers with Pandrol crips are used.

Steel sleeper is considered better than wooden sleeper for stability and durability of the track, but inferior to PC sleeper because of light weight. In addition the existing steel sleeper for the Merak Line cannot be used for automatic block system or with UIC54 (or equivalent) rail (because of the size of the base plate welded to the sleeper). Therefore the sleepers and the R14A rails would be replaced at the time when the passing tonnage becomes near to 10 million t/year or the train frequency needs automatic block working. Estimated passing tonnage is shown in Fig. 4.26. The complete rehabilitation by the single track operation on the additional new track will be a good opportunity to effect these changes.



Remark: Increase of medium and long distance train services is not included

Fig. 4.26 Estimated Passing Tonnage

(7) Stations

The improvement of the stations in this stage will be carried out so that commuter trains can operate more frequently than 15 minute headways on double track. The existing facilities for medium and long distance passenger and freight services are left or removed.

The rough drawings of track layout of the stations are shown in Fig. 4.23.

Increase of medium and long distance passenger and freight services is not included in this project. If it is necessary, moving up the track doubling, establishing relief tracks or through tracks at intermediate stations and additional improvement of Tanah Abang Station will have to be implemented as another project.

(a) Tanah Abang Station

At Tanah Abang Station 2 tracks are prepared for the Merak Line already in the 2nd stage. Basically the plan of this station does not differ from the 2nd stage. And it is planned that the passengers connecting to the Western Line shall change trains here. (Refer to 4.4.4 (3)(a).)

In the future the traffic demand for the Merak Line will increase, and transport capacity of the Western Line and handling capacity of changing passengers at Tanah Abang Station will become inadequate. The Western Line development project to cope with this problem, such as a grade separated crossing for the both lines, a quadrupling of the Western Line and an expansion of Tanah Abang Station, should be carried out. This study is not included in this project. It requires the detail traffic demand forecast, and its timely execution is desirable. Allowances for a grade separated crossing and a quadrupling are taken into consideration in the improvement plans for Tanah Abang Station. Schematic plans of direct access by a grade separated crossing are shown in Fig. 4.27 and Fig. 4.28.

Schematic Plan

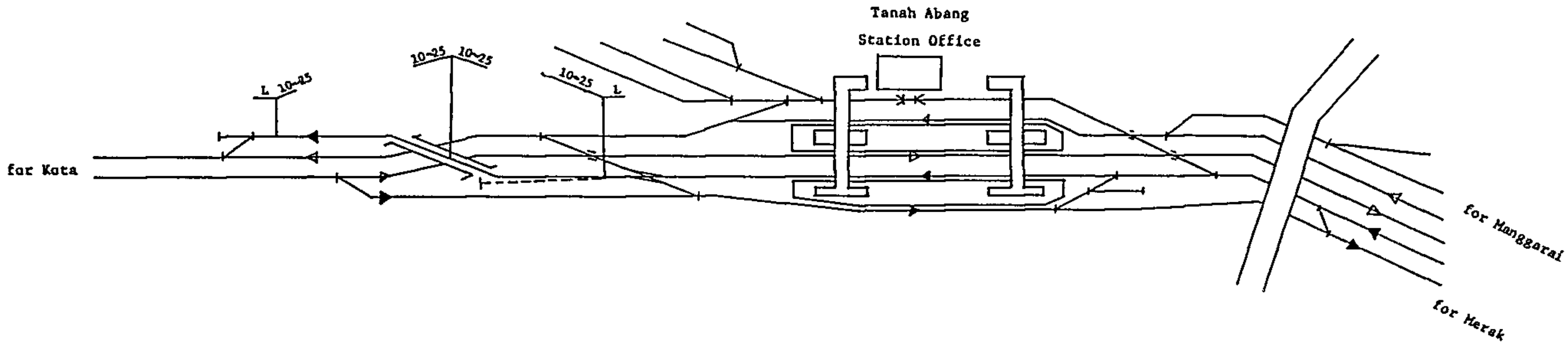


Fig. 4.27 Schematic Plan of Direct Access to Western Line (1)

Schematic Plan

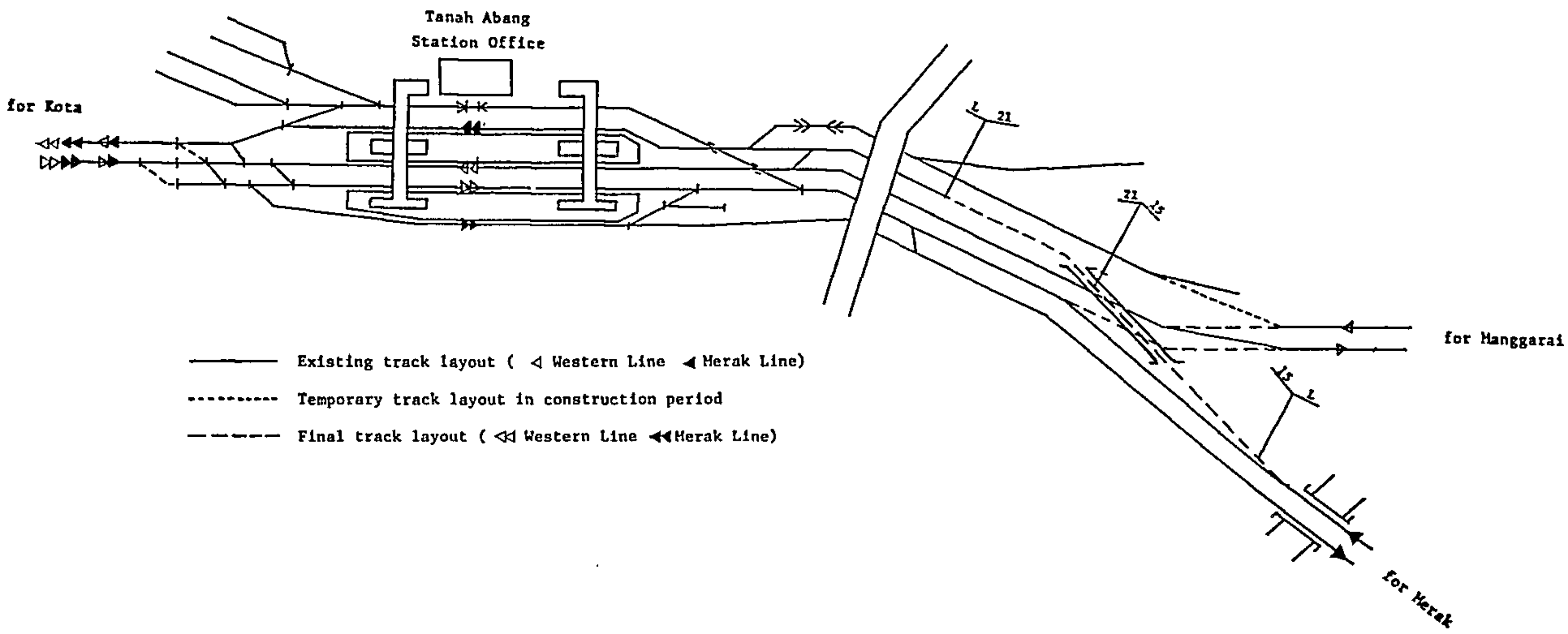


Fig. 4.28 Schematic Plan of Direct Access to Western Line (2)

(b) Other station

The facilities for freight services such as side tracks and handling spaces are to remain at Palmerah, Kebayoran, and Serpong stations, as far as Tanah Abong Station. At the other stations, only 2 main tracks without turnouts are installed for this project except at Sudimara Station, where a siding is installed for emergency use.

(c) Night storage

4 night storage tracks will be prepared with 1 of the main tracks at Tanah Abang Station and 3 storage tracks at Serpong Station as in the 2nd stage.

(d) Platform and platform roof

The length of platforms is planned to be 190 m for 8 car trains.
The height of the platforms is planned to be 0.95 m, and an early decision on raising to this height is desirable.

Half of the platform length should be roofed. (Refer to 4.4.4 (1)(e).)

(e) Passenger footbridge

In this stage at all passenger stations footbridges will be installed. (Refer to 4.4.4 (1)(f).)

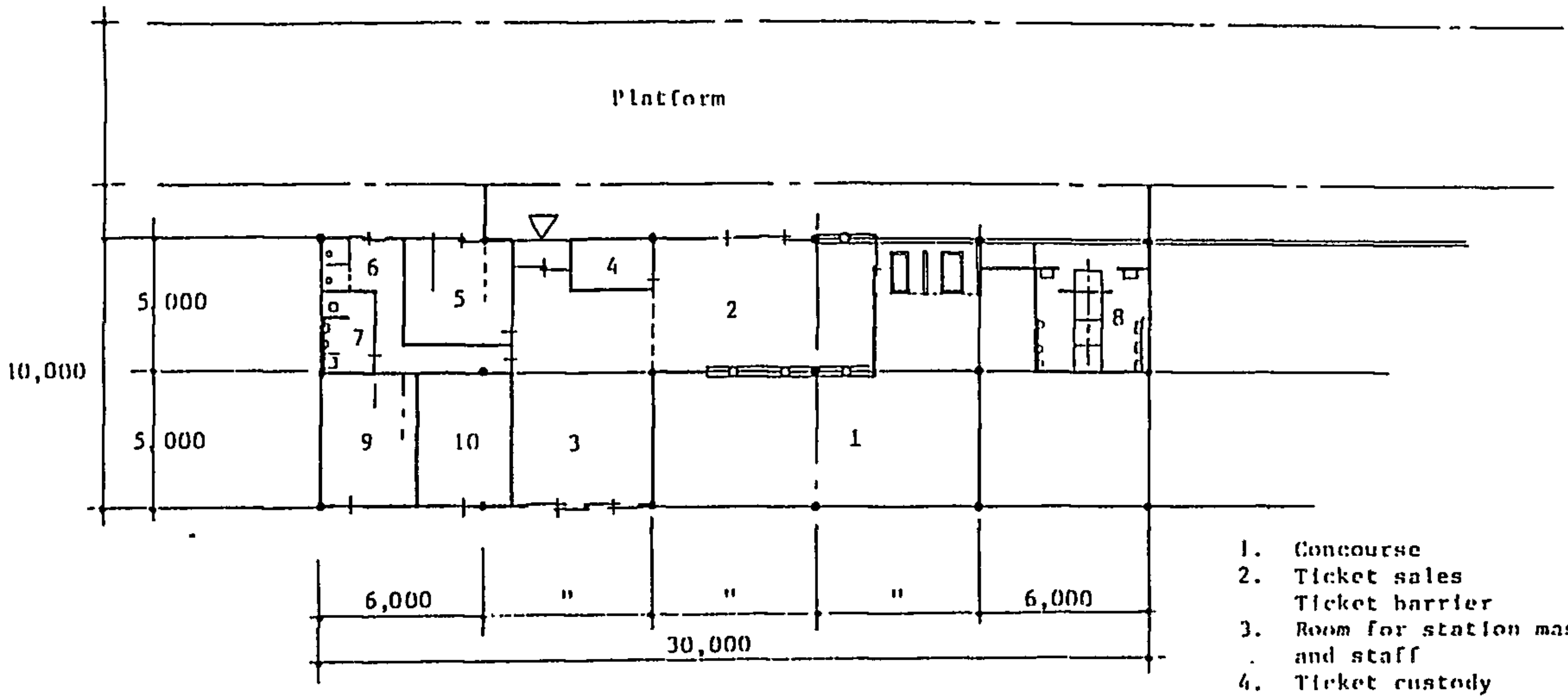
(f) New passenger station

When the operation on the double track begins, 3 new passenger stations will be established at 12 km 150 m, 19 km 150 m and 26 km 700 m.

The new station (26 km 700 m) is located at the same location as the signal station (26 km 700 m) in the 2nd stage, therefore it can begin to offer the service earlier than the track doubling in accordance with the development of the surrounding area.

(g) Station main building

Station main buildings are planned according to the number of passengers and the purpose of the stations. For the plan smooth flow of passengers is a paramount factor in the design. (Refer to Fig. 4.29)



1. Concourse
2. Ticket sales
   Ticket barrier
3. Room for station master and staff
4. Ticket custody
5. Rest room
6. Shower
7. Toilet (for staff)
8. Toilet for passenger
9. Power distribution room
10. Signaling equipment

Floor area: $30.0 \times 10.0 = 300\ M^2$

Fig. 4.29 Example of Station Main Building

(h) Station plaza

The station plaza is necessary for the intermodal transfer to transportation by road. Its area is planned according to the number of passengers and the mode and the terminal arrangement of the access. For the access transportation facilities bus, minibus, microlet, taxi, bajaj, etc. are to be provided.

(8) Electrification

The electrification work for the additional track will be carried out with the same system as the existing track.

The 3,000 kW capacity for the substations is considered sufficient in the initial period of the double track operation.

When the headways with 8 car train will become 8 minutes, one more set of 3,000 kW facilities will be installed at each substation for both increasing demand and spare for the high density train operation.

There will still be one circuit high voltage distribution line for signalling system and it was judged from the section environment that one circuit could maintain the intensity for protective devices as a stable power source.

(9) Signalling

For the initial period of this stage the signalling system for 5 minute headways on the double track is planned. For future the system is planned to be improved for 3 minute headways.

All the automatic block sections with track circuits will be sectionalized to meet high-speed and high-density train operation on the double track. This is to be controlled as automatic block signals (home, starting, and intermediate) by the train.

The outline of the signalling system is shown in Fig. 4.30 and Fig. 4.31.

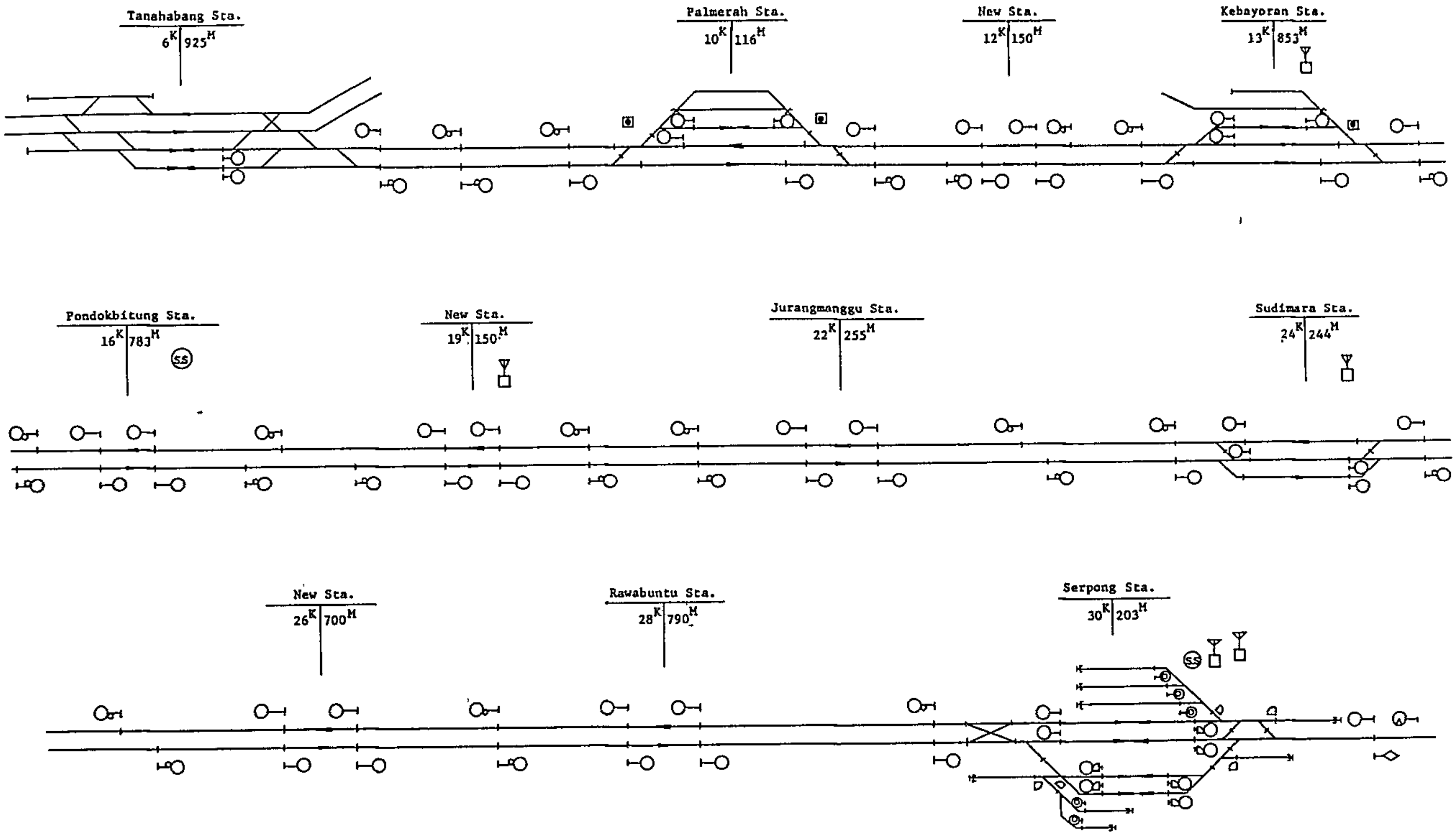


Fig. 4.30 Configuration of Signalling System (5 Minute Headways)

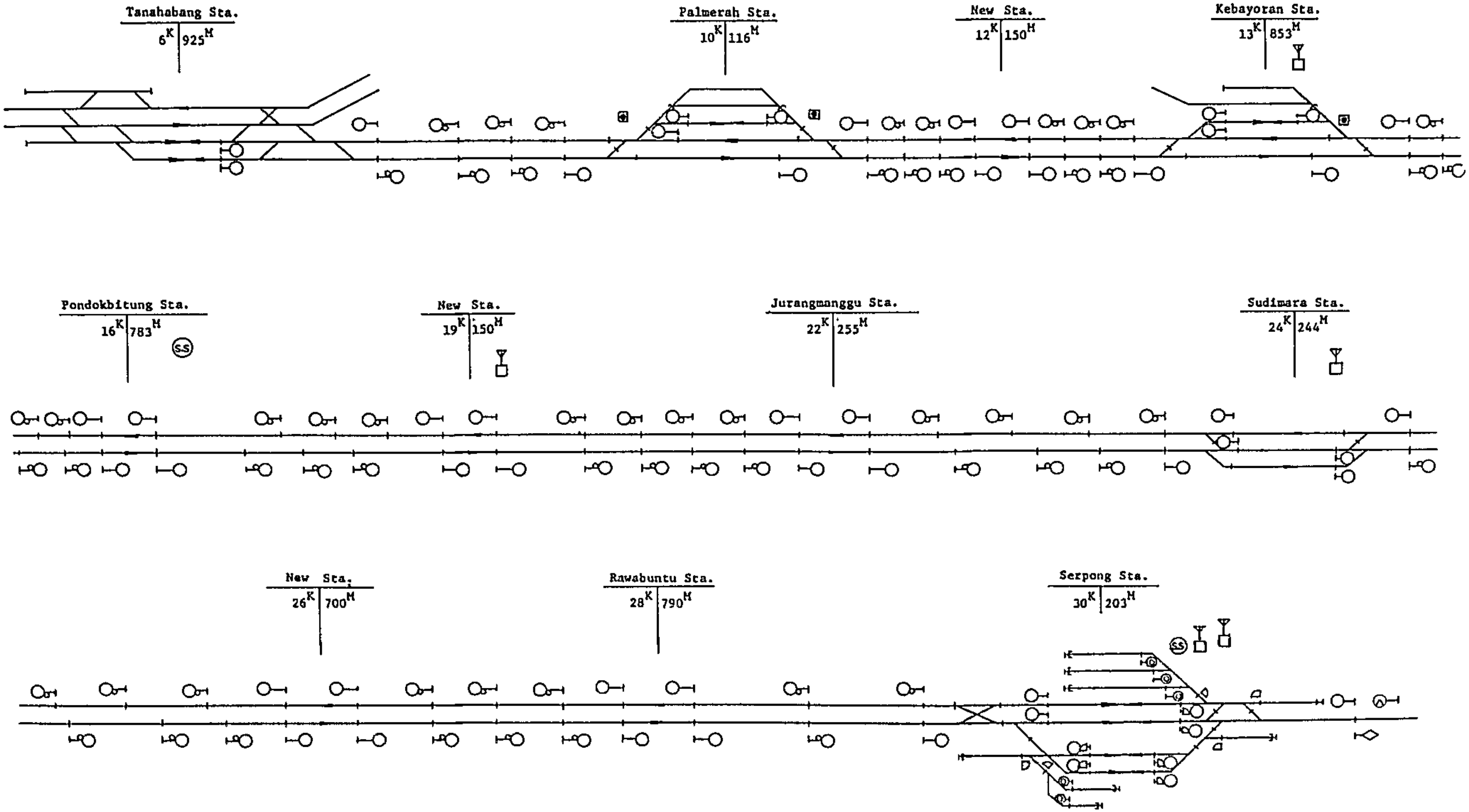


Fig. 4.31 Configuration of Signalling System (3 Minute Headways)

It is necessary to change the steel sleepers of the existing track to PC sleepers in order to provide the track circuit. The complete rehabilitation of the existing track with single track operation on the additional new track will be a good opportunity for changing the sleepers, rails and ballast.

(10) Telecommunication

Train radio equipment is to be provided at the time of track doubling for transmitting operational instructions between the operator of a running train and the instructor, and for emergency communication in the event of an accident. The ground station is to be installed in the station planned in the Intermediate Programme.

4.5 SCHEDULE OF THE PROJECT

The schedule for the execution of the project is as shown in Fig. 4.32. Judging from the demand forcast, the execution of the 2nd stage should be carried out as early as possible.

Expecting the positive impact to be an early improvement of the housing situation in the JABOTABEK Area by active development along the line, the track doubling from Tanah Abang to Serpong is planned to be carried out at once. Since it is commuter service in a radial direction, however, the traffic demand will be greater and will exceed earlier the carrying capacity for 15 minute headways with 8 car trains on Tanah Abang side than on Serpong side. Accordingly, in the actual execution, track doubling step by step in order from Tanah Abang side could be considered based on financing conditions. In this case providing an increased train service in the doubled section will be possible. The crossing stations are located based on a 15 minute headway pattern net diagram, so there is no bottleneck section. Also step by step in order from Tanah Abong side track doubling should be carried out. Track doubling earlier in a intermediate section will be meaningless because of not matching the traffic demand and no reduction of travelling time.

The increase of the medium and long distance passenger and freight service is not included in this project. If it becomes necessary, moving up the execution of track doubling would be carried out as another project.

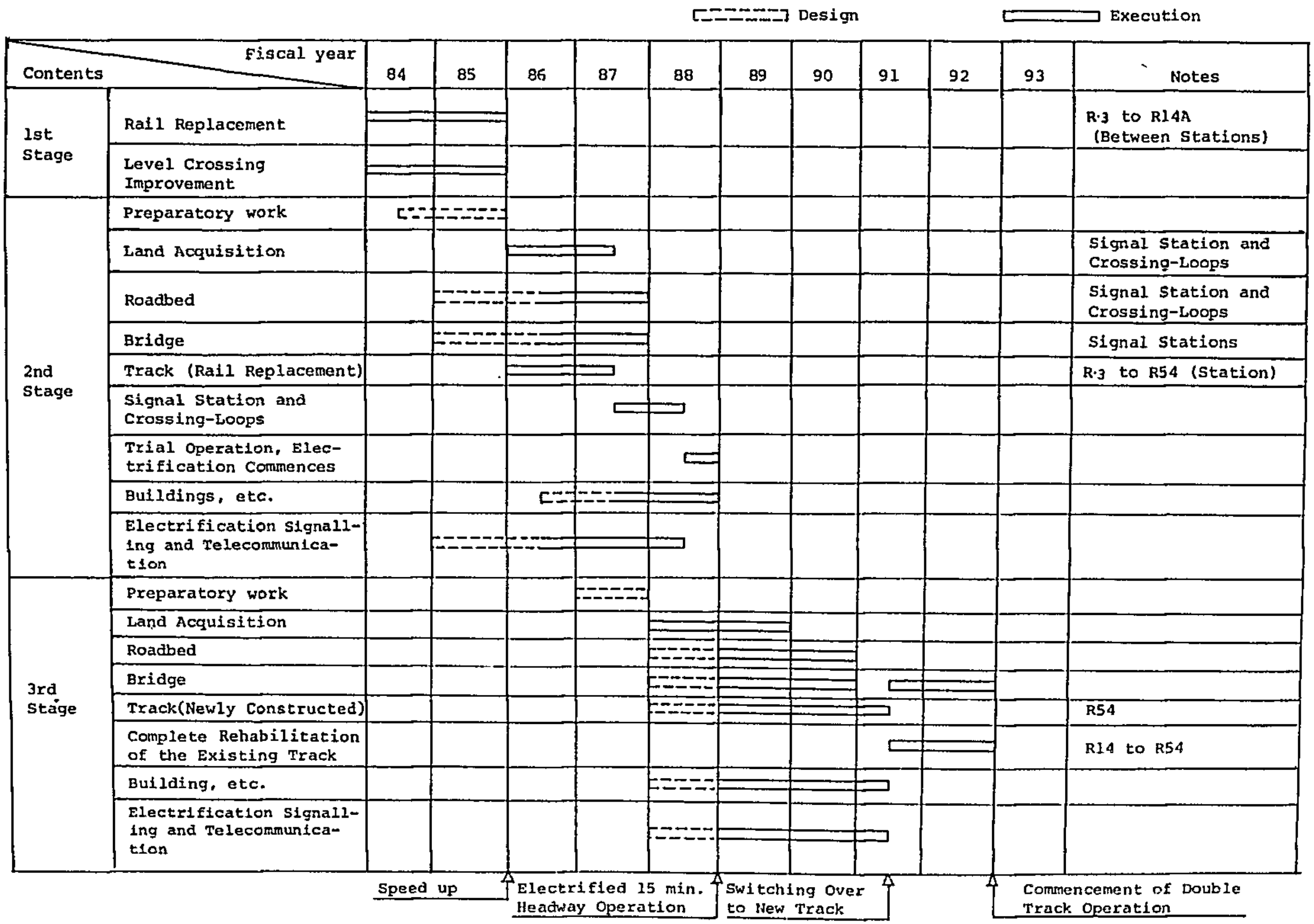


Fig. 4.32 Schedule of the Project

4.6 SQUATTER SURVEY AND STUDY FOR COMPENSATION

It is necessary to remove squatters who live along the Merak line to allow for track addition.

A home interview survey of squatters was carried out in order to get some basic data to decide an appropriate method of compensation and to estimate compensation cost. The squatter area is divided into three sections, Tanah Abang - Malang River, Malang River - Palmerah and Palmerah - Kebayaran. 35 families were sampled from each section thus 105 families were sampled in total. Sampling was taken from the squatters who will be affected by the track addition. Survey date was 24th September, 1983.

(1) The results of the survey

Summary of the survey results along the Merak Line is as follows.

Number of a family members averages 5.4 persons. Religion is Islam 97% and Christianity 3%. Original place of family head is: from Java outside DKI Jakarta 88%, outside Java 7% and DKI Jakarta 5%. Length of stay at present place averages 9.9 years.

Average land area of one house is 36.7 m^2. 88% have no fence, wood fence 8% and brick fence 5%. 89% are without trees, 4% have a fruit tree and 7% have a flowering tree.

The house status is: permanent 4% semi-permanent 54% and temporary 42%. Average floor area is 32.9 m^2 (6.1 m^2 per capita). 32% have one bedroom, 42% have two bedrooms, 19% have 3 bedrooms and 7% have more than 3 bedrooms. Average age of house is 11.5 years.

Potable water is obtained from: a well 69%, a vendor 30% and a river 2%. For lighting, 48% use oil lamp, 47% use electricity. 5% use both oil lamp and electricity. The fuel for cooking is, 99% kerosene and only 1% use gas. Sewerage is, 46% flow to river, 25% use drainage, 21% use septic tank and others is 8%.

Income of one family per month averages 77,262 Rp., expenditure is 68,573 Rp. and saving is 8,689 Rp. Monthly income per capita is 14,281 Rp., monthly expenditure per capita is 12,675 Rp. and monthly saving per capita is 1,606 Rp.

The employment of the family head is; Sector III 84%, Sector II 12% and Sector I 4%. The means of commuting is by: walking 52%, bus 25%, motorcycle 12%, bicycle 4%, others 7%.

The commuting time is average 19 minutes and an average 5,500 Rp. per month is spent on this.

42% of the families have their job in their house. 41% is Sector III and 1% is Sector II. Space for the job averages 11.2 m^2 and they earn an average of 48,235 Rp. per month from the work.

Average distance to primary school is 21 minutes on foot. Average distance for shopping is 18 minutes on foot. The degree of satisfaction with community is: mean 75%, satisfied 15% and not satisfied is only 10%.

When they are forced to move, 46% have alternative places to live and 54% has no expected place. They estimate the present value of their own house to average 53,520 Rp. per m^2.

(2) Study for compensation

(a) House compensation

Even though the residents are squatters, compensation for at least their housing is necessary.

The construction cost of a new house and the assumed depreciation period is as shown in Table 4.11.

Table 4.11 Construction Cost and Depreciation Period of House

(1)	Construction cost of new house (1983 price)	
	Permanent housing	190,000 Rp/m^2 ± α
	Semi-Permanent housing	130,000 Rp/m^2 ± α
	Temporary housing	75,000 to 90,000 Rp/m^2
	Source: DKI AGRARIA	
(2)	Depreciation period (assumed)	
	Permanent	20 years
	Semi-Permanent	15 years
	Temporary	13 years

The floor area of a house averages 33 m^2. The average age of the house is 11 years. Fence and tree are almost negligible for compensation.

As the ratio of housing level is permanent 5%, semi-permanent 55%, and temporary 40%, and using the costs in Table 4.11 depreciated to residual life.

- Permanent 190,000 × 1/2 = 95,000 Rp/m^2
- Semi-permanent 130,000 × 1/3 = 40,000 Rp/m^2
- Temporary 80,000 × 1/4 = 20,000 Rp/m^2

Average: 95 × 0.05 + 40 × 0.55 + 20 × 0.4 = 35,000 Rp/m^2
Average 35,000 Rp per m^2 compensation (Including equipment).
Average compensation per one house
33 m^2 × 35,000 = 1,150,000 Rp

(b) Job compensation

Those who have their job in their house immediately lose their income when they are forced to move. Therefore, compensation for their job for at least one month will be necessary.

40% of family employment is in the house, and as the average space is 11 m^2 and average income is 48,000 Rp/month, compensation is 5,000 Rp per m^2.

(c) Land acquisition cost

For acquiring land outside PJKA Land, land prices along the Merak Line are shown in Table 4.12.

Table 4.12 Land Price around Merak Line (1983)

	Station	Agricultural land (Rp/m^2)	Residential land (Rp/m^2)
DKI Jakarta	Tanah Abang	-	40,000 to 60,000
	Palmerah	-	
	Kebayoran	-	
Tangerang	Pondokbitung	1,000 to 4,000	2,500 to 8,000
	Jurangmanggu	1,000 to 4,000	2,500 to 8,000
	Sudimara	1,000 to 4,000	2,500 to 8,000
	Rawabuntu	1,000 to 3,000	3,000 to 10,000
	Serpong	1,000 to 3,000	3,000 to 10,000

Source: DKI AGRARIA
Tangerang AGRARIA

4.7 ACCESS AND STATION FRONT PLAZA PLANNING

Access roads and station front plaza must be arranged keeping pace with the improvement of the railway.

(1) Access plan

In the access plan, the following two points are important.

1) Smooth and easy access to the station from arterial roads near the station, with the width being at least 8 m so that large city buses can easily pass each other.

2) The road network should be so arranged that people who live within 1 km radius from the station can reach the station easily.

If required by road access, relocation of a station will become necessary. Reorganization of the bus feeder systems is also important.

As an example, Fig. 4.33 shows desirable location of access road and station front plaza of each station in DKI Jakarta.

(2) Station front plaza

(a) Planning concept

The station square is the node between railway and road transport and it also serves as a very important entrance to the district. Accordingly, it must be planned carefully, considering the future number of passengers and vehicles which will use the access road, and also be designed from an aesthetic point of view.

1) Sufficient space should be planned for expansion. In some places staged construction should be adopted; for example, a plaza can be prepared on one side of the station and later another plaza can be added to the other side.

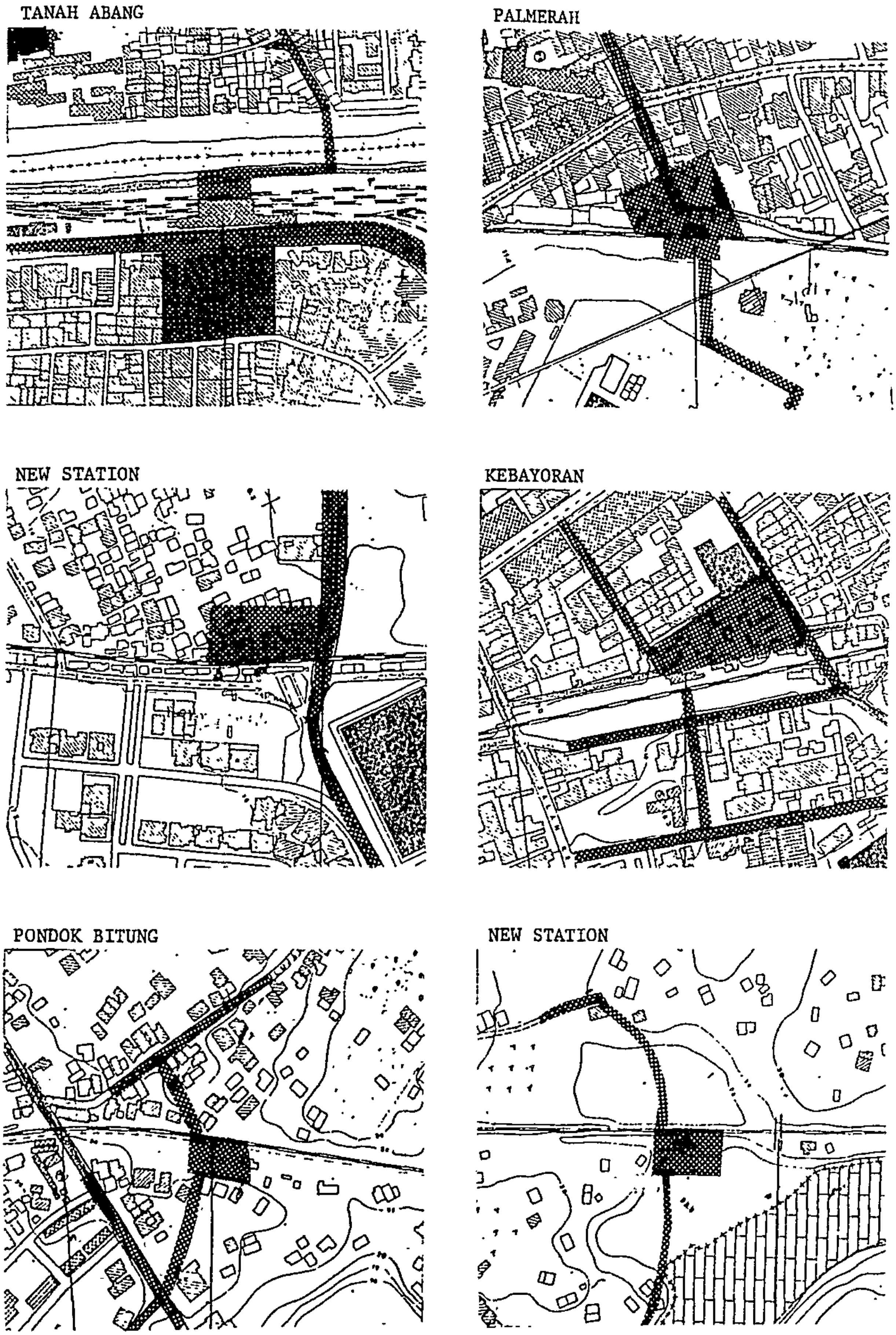


Fig. 4.33 Desirable Location of Access Road and Station Front Plaza

S = 1:5000

2) As the node between railway and road transport, a pedestrian way, carriageway, bus bay, taxi stand, etc., are provided in the station front plaza. Landscaping should also be considered to make the plaza a suitable entrance to the district. It is desirable to install some symbolic features (sculpture, etc.).

3) A city exists for the common use of all people and potentially in a high density area. Public transportation should take priority as a matter of course. The order of vehicle priority is as follows: bus, minibus, taxi, bicycle, motorcycle and finally private cars. Only stopping for private cars should be permitted. Parking facilities for private cars need not be provided by the public sector, but should be provided by private enterprise.

4) For the safety of pedestrians, bus bays and minibus and taxi stands should be zoned separately. In a bus zone, pedestrians and buses should be separated. In a minibus and taxi zone, a minimum crossing between pedestrian and vehicles should be allowed for the effective use of the space.

5) The station front plaza should not be subject to disturbance from passing traffic. Accordingly, in some cases, a change in the access road will become necessary.

6) Since pedestrians do not like to make detours, their line of movement should be as simple as possible. Accessibility to the surrounding stores for shopping on foot is very important.

7) From functional and aesthetic points of view, the desirable layout for the station front plaza is as follows:

   Width : Depth = 1 : 1 $\sim$ 3 : 1

   Standard 2 : 1

   The depth should be more than 40 m in order to be functional.

(b) Determination of the size of the station front plaza.

Approximate total area of the station front plaza can be determined from the following equation which was established by the Station Front Plaza Committee organized by City Planning Association in Japan.

Station inside dense urban area

$$S = 0.0904\ N + 818$$

$$5{,}000 < N \leq 100{,}000$$

$$S = 0.0189\ N + 18{,}316\sqrt{N}$$

$$100{,}000 < N$$

Station in the suburbs

$$S = 0.1421\ N + 417$$

$$5{,}000 < N < 100{,}000$$

In which N: Railway passenger per day (person)

S: Area of Station Front Plaza (m^2)

These equations are adopted in Japan where the peak ratio in the morning is nearly 30%. Peak ratio in JABOTABEK is estimated to be 20% in one hour. Accordingly, it is necessary to adjust the number of passenger per day, that is put 2/3N instead of N in the above equation.

Using the equation, the approximate area required for each station front plaza of Merak Line is calculated as shown in Table 4.13.

Table 4.13 Number of Passengers Getting on and off & Required Area of Station Front Plaza along Merak Line in 2005

Station	Number of passengers getting on and off (1000 persons/day)	Area of Station front plaza (1000 m^2)
Tanahabang	200	9.1
Palmera	100	6.8
New Station	90	6.2
Kebayoran	100	6.8
Pondok Bitung	70	5.0
New Station	60	4.4
Jurang Manggu	40	3.2
Sudimara	30	2.6
New Station	20	2.0
Rawabuntu	20	2.0
Serpong	30	2.6

The number of passengers getting on and off is based on the traffic forecast in 2005.

The modal split of traffic to the station is obtained from Table 4.14.

Table 4.14 Feeder Transportation Means to Railway Station (Access & Egress) (Average of JABOTABEK Area)

	Ratio of Means	
	Result of Traffic Survey 1983 (%)	Estimated Future Ratio (%)
Walking	43.4	45
Bicycle, Motorcycle	4.7	5
Micro Bus, Taxi, Others	37.7	35
Bus	14.2	15
Total	100	100

Necessary number of bus bays, minibus and taxi stands is calculated based on the following conditions.

Bus: Number of passengers boarding and alighting per bus is 60 persons.

Necessary time for board and alighting per bus is 5 minutes.

Minibus: Number of passengers boarding and alighting per minibus is 10 persons.

Necessary time to board and alight per minibus is 2.5 minutes.

Taxi: For alighting

Number of passengers alighting average 1.5 persons

Necessary time for alighting 30 seconds

Time for boarding is one-third the time for alighting.

(The time for boarding 10 seconds.)

Within the approximately calculated area, the necessary number of bus bays and minibus stands etc. are arranged giving adequate consideration to the access road. Finally, the total area of the station front plaza is adjusted.

Fig. 4.34 shows the layout of Palmerah station front plaza as an example.

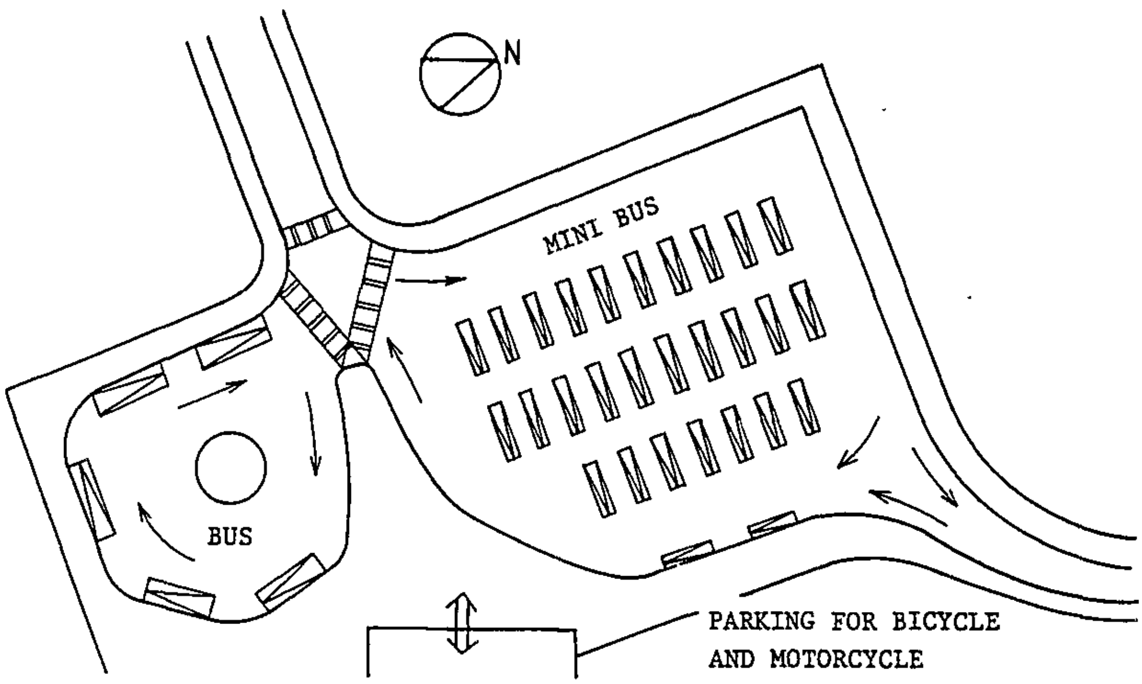


Fig. 4.34 Layout of Station Front Plaza at PALMERA Station S = 1:1000

4.8 IMPACT DUE TO IMPROVEMENT OF MERAK LINE

(1) Positive impact

The service level of the railway will increase so part of the road traffic is transferred to rail. Consequently, noise and pollution will decrease and road congestion will be eased.

The benefit of cost savings in time and operation can be calculated. Moreover, maintenance costs of the road system will be reduced due to the decrease in traffic volume.

Approximately 17300 man-year employment will be created by the construction work.

The placing of station front plazas will provide a better train-bus connection.

As the accessibility of the surrounding area to the station increases, the area near the station will develop as a commercial area and the area within approximately one km radius will become developed as a residential area. It will be effective to release the over crowded area of DKI Jakarta.

(2) Negative impact

Noise and vibration along the railway will increase due to the rise in train speed and reduction in headway. Usually the noise level of a train is between 75 and 85 dB. In some places, for example, near a hospital, a protection wall will be necessary in future. Noise will be reduced by about 7 dB by a protection wall of 1.9 m height.

Interference time to road traffic will increase at the road level crossings on the Merak Line in future.

There is a possibility that accidents at crossings will increase so an improvement to crossing facilities is important.

All sections of the line are at ground level so the line will separate the community.

At present the railway is used as a pedestrian way and as the axis of the community. Where there is no access way except the railway new access roads will be necessary.

Noise and dust during construction will be temporary but should be minimized by careful work methods.

CHAPTER 5

IMPROVEMENT PLAN OF TANGERANG LINE

CHAPTER 5 IMPROVEMENT PLAN OF TANGERANG LINE

5.1 SURROUNDING CONDITION OF THE TANGERANG LINE

(1) Present land use

A high density residential area lies between Duri and Pesing. Westward from Pesing, factories and houses are scattered in the fields. Many factories are distributed along the Tangerang Line (Fig. 5.1).

The industry is labour oriented light industry, with machinery, electric work, drug and process industries predominating.

Squatters live close to both sides of the line between Duri and Pesing and between Tanah Tinggi and Tangerang. In these area, the line is used as a pedestrian route. There are few public facilities near the line. The access to the stations is difficult.

(2) Future land use plan

Future land use plan is as shown in Fig. 5.2 based on DKI Jakarta Master Plan 2005 and JMDP. The north side of the line from Pesing to Poris is planned as an industrial area. Fig. 5.3 shows the road network plan around the line.

There are two on-going housing projects along the Tangerang Line by PERUMNAS, Chengkareng Housing Project (400 ha) and Karawaci Housing Project.

Karawaci housing area is located 6 - 7 km from Tangerang to the southwest and to the north of the Jakarta Merak Highway (Fig. 5.4). 100 thousand people will live there on completion of Phase-1 and Phase-2 projects and it is recommended to extend the Tangerang Line in the future to attract these potential passengers.

Phase-1	160 ha, 7000 houses 50,000 people
Phase-2	165 ha, 7000 houses 50,000 people

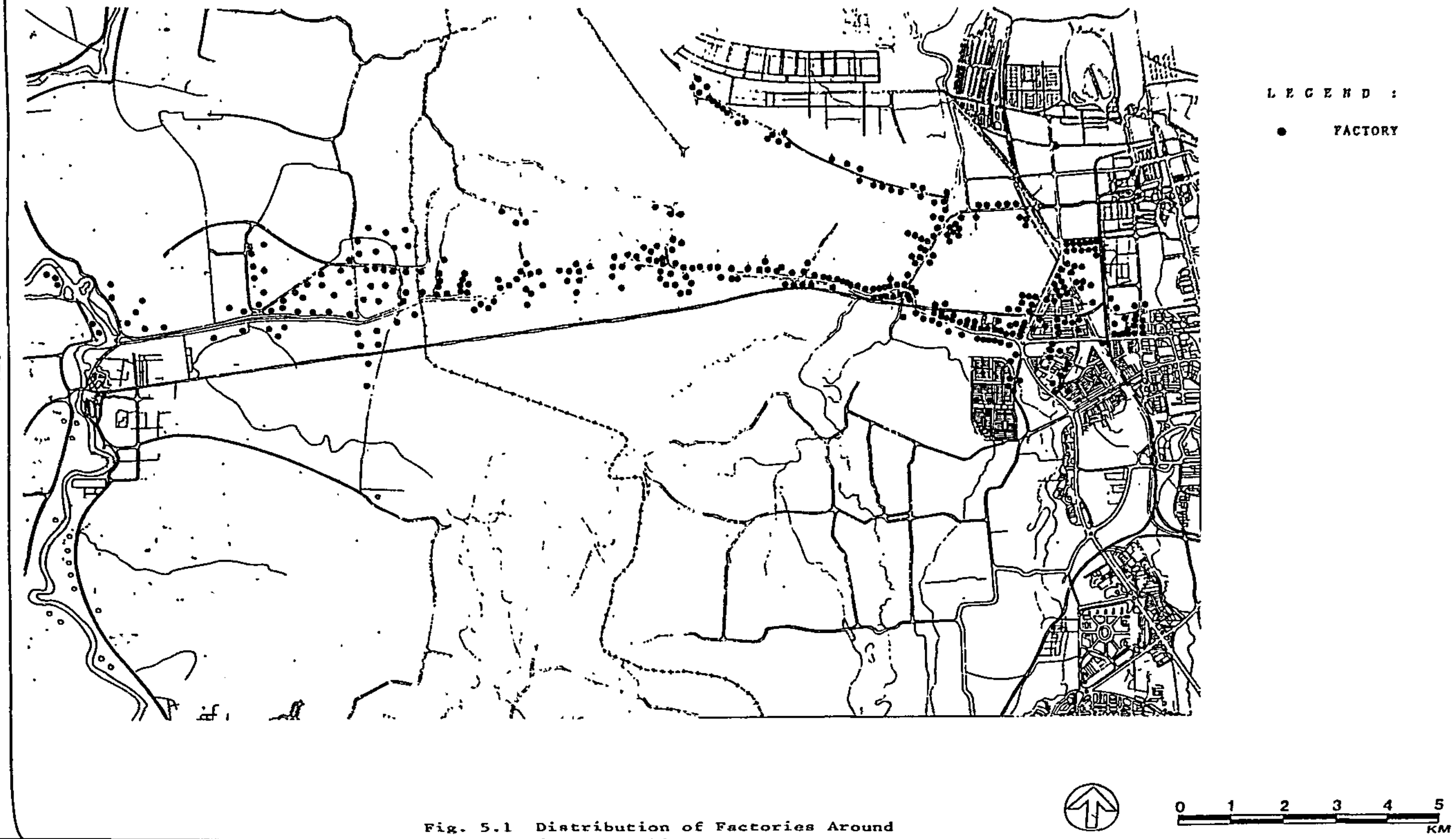


Fig. 5.1 Distribution of Factories Around

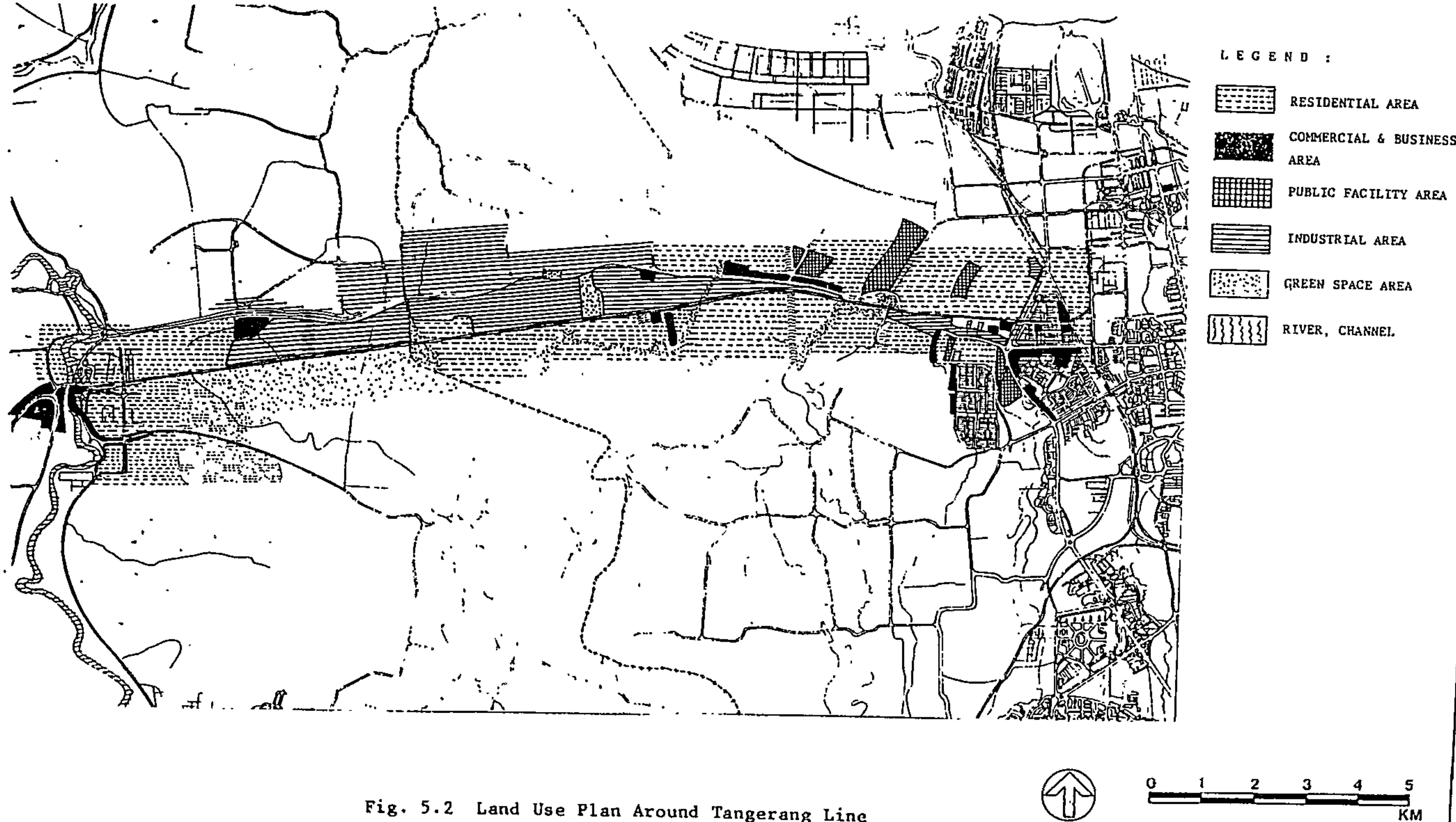


Fig. 5.2 Land Use Plan Around Tangerang Line

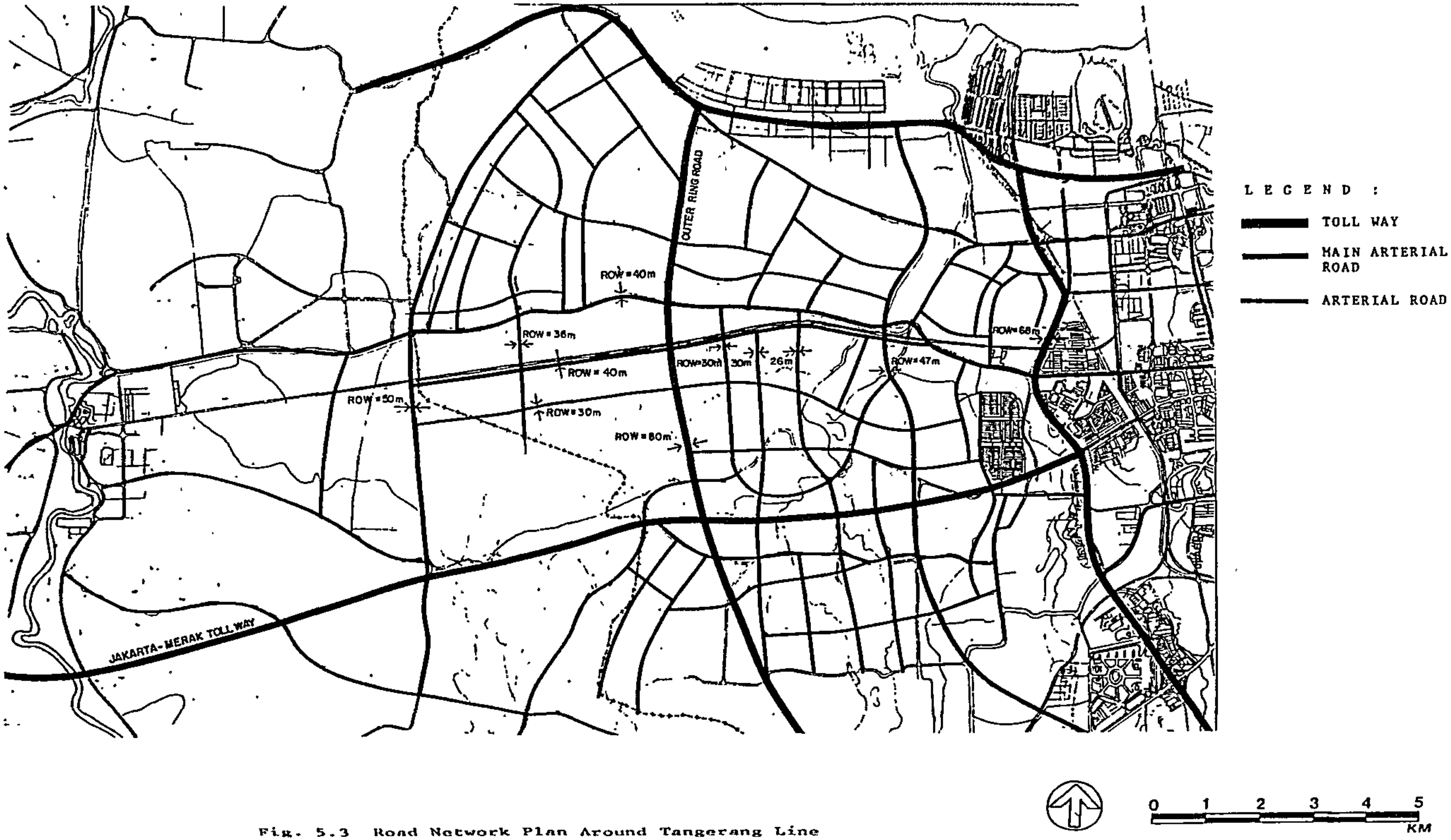


Fig. 5.3 Road Network Plan Around Tangerang Line

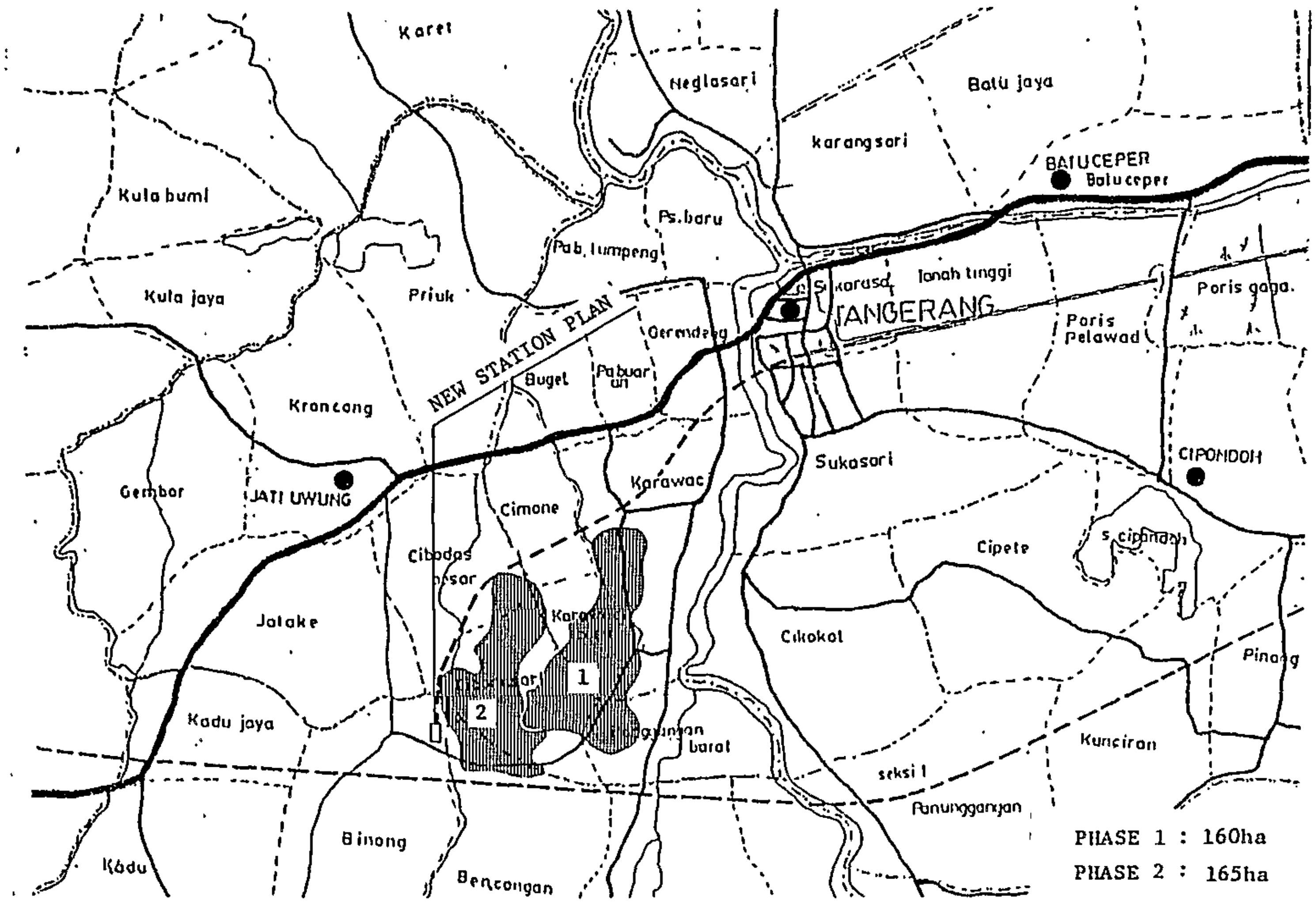


Fig. 5.4 Extension Plan of Tangerang Line

5.2 TRAFFIC DEMAND FOR TRAIN OPERATION

The maximum link traffic on the Tangerang Line was estimated and stated in (3) of section 2.4.4 to be 118,000 and 263,000 passengers per day in 1995 and 2005 respectively as shown in Fig. 2.19. The peak hour ratio in one direction was assumed to be approximately 40% per 2-hour period as discussed in (4) of section 2.4.4. considering this peak hour ratio, the future traffic demand during peak 2 hour period was estimated for the maximum link to be 25,000 and 56,000 passengers for each direction.

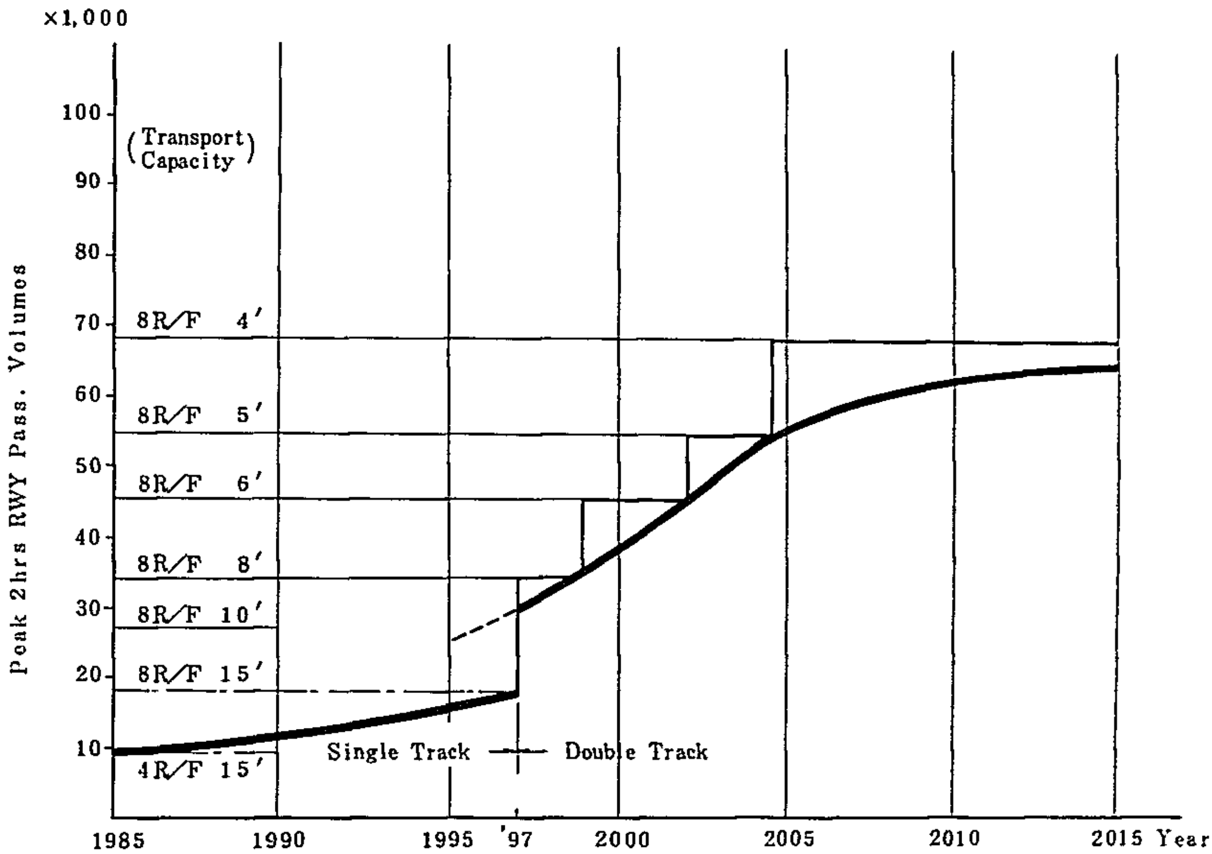
The characteristics of the estimated future traffic on Tangerang Line is summarized in Table 5.1. Fig. 5.5 presents the relationship between peak hour traffic and the transport capacity with various railcar formations and headways.

According to this diagram, the Tangerang Line should be double-tracked by the year 1997 and the operation frequency should be improved toward a 4-minute headway during peak hours before the year 2015.

Table 5.1 Characteristics of Passenger Flows on Tangerang Line
(Operating distance: 19.3 km between Duri and Tangerang)

Year	1995	2005
1) Maximun Link Traffic: (pass./day)	118,000	263,000
(pass./direction•peak-2hr)	25,000	56,000
2) Passenger-hour/day	37,484	67,419
3) Passenger-km/day	1,204,712	2,231,582
4) Average travel speed (km/hr)	33.1	33.1
5) Average cross-sectional traffic (pass./km)	64,286	115,626

In addition, the railway passenger volumes on Tangerang Line were estimated for the years 1985, 1995, 2005 and 2015 as shown in Fig. 5.6.



Notes 1) R/F=Railcar Formation 15′=15′Headway

2) ---- Transport Capacity of Single Track ——— Transport Capacity of Double Track

Fig. 5.5 Transport Capacity and Peak Hour Traffic

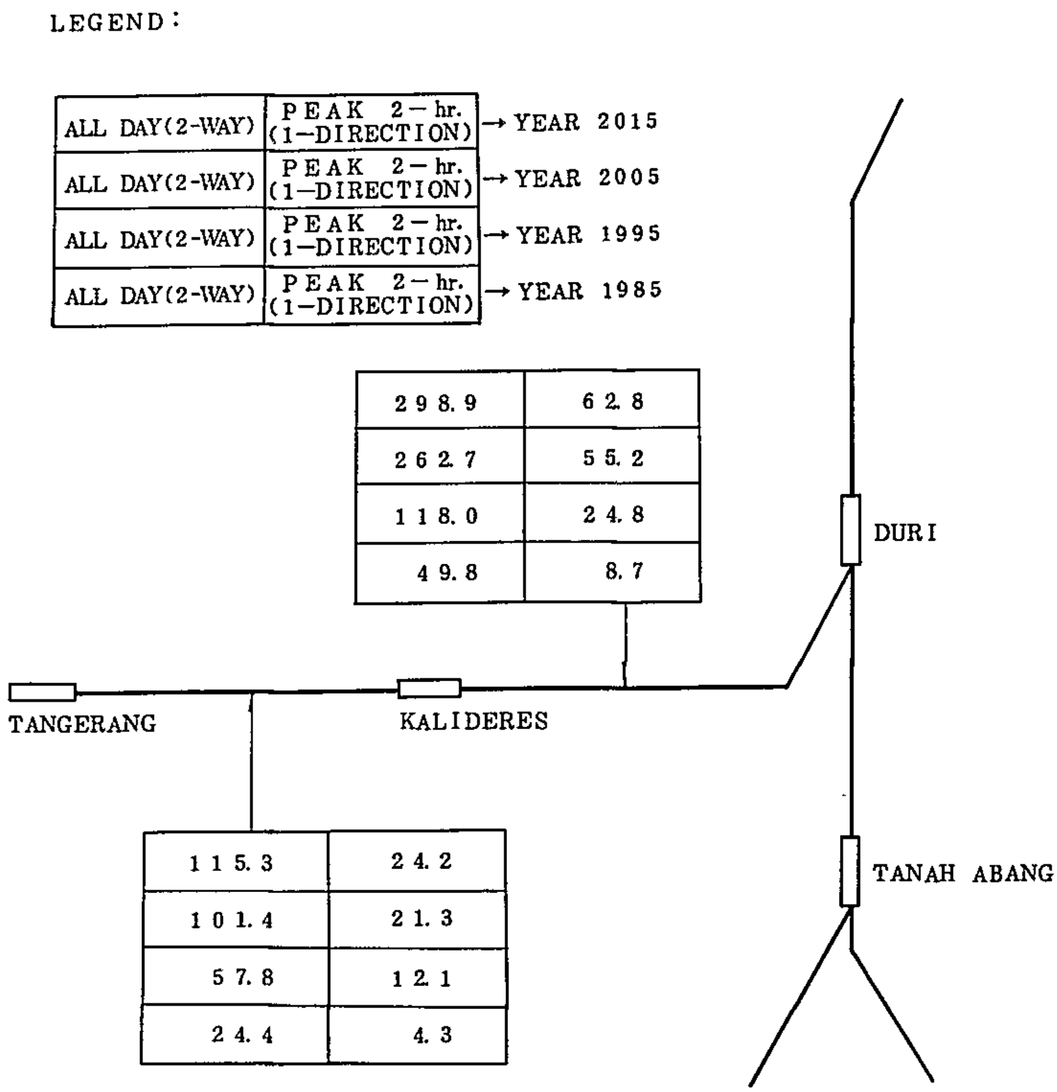


Fig. 5.6 Estimated Railway Passenger Volumes on Tangerang Line

5.3 TRAIN OPERATION

5.3.1 Present Status of Tangerang Line

10 Diesel railcar trains are operated between Duri and Tangerang daily using one train set. Travelling time between Duri and Tangerang is 48 minutes, but actual operation is between Jakarta Kota and Tangerang except for the first and the last trains. No freight trains are operated.

Train crossing facilities provided at stations between Tangerang and Duri are obsolete, thus the number of trains cannot be increased.

To provide good passenger convenience, a complete up-grading of the Tangerang Line including tracks, station facilities, telecommunication and signalling systems is required.

5.3.2 Train Operations after completion of Single Line Electrification

(1) Train operation time

Train operation time for each section based on the train operation curve for an electric railcar is indicated in Table 5.2.

Travelling time between Duri and Tangerang is 41 minutes and 30 seconds for train to Tangerang and 42 minutes for train to Duri. Similar to the Merak Line, between Duri and 5 km 500m and between 18 km 000m and Tangerang the train speed is restricted to not more than 40 km/h due to the danger presented by dwellers along the right-of-way.

(2) Train operation plan and train operation diagram

Similar to the Merak Line, in order to provide a good service for commuting passengers, 4 trains per hour during peak hours are necessary. Thus, passengers can get a train every 15 minutes.

Table 5.2 Train Operation Time (Single Track)

(min. :sec.)

Station	Kilometerage	Station Distance (km)	For Tangerang Calcu-lated	For Tangerang Adjust-ed	For Duri Calcu-lated	For Duri Adjust-ed	Station Stop
Duri	0						
		1.700	3:06	3:30	3:08	3:30	
Grogol	1.700						1:00
		1.050	2:06	2:00	2:00	2:00	
Signal Station	2.750						1:00
		0.986	2:00	2:00	2:06	2:00	
Pesing	3.736						1:00
		1.704	3:06	3:00	3.15	3:00	
New Station	5.440						1:00
		2.208	3:00	3:00	2:56	3:00	
Bojong-indah	7.648						1:00
		1.188	2:08	2:00	2:12	2:30	
Rawabuaya	8.836						1:00
		2.554	3:21	3:30	3:24	3:30	
Kalideres	11.390						1:00
		2.498	3:12	3:30	3:24	3:30	
Poris	13.888						1:00
		1.800	2:40	2:30	2:36	3:00	
Batuceper	15.688						1:00
		2.062	2:58	3:00	2:55	3:00	
New Station	17.750						1:00
		1.547	3:06	3:30	3:03	3:30	
Tangerang	19.297						
Total		19.297	30:37	31:30	30:59	32:00	10:00
Travel Time				41:30		42:00	

The train operation diagram for the peak hours is indicated in Fig. 5.7 which is made so as to require a minimum number of signal stations. A signal station between Grogol and Pesing (2 km 750 m) should be installed for train crossings, and 2 new stations between Pesing and Bojongindah (5 km 440 m) and between Batuceper and Tangerang (17 km 750 m) are required for potential passengers.

Tangerang Line

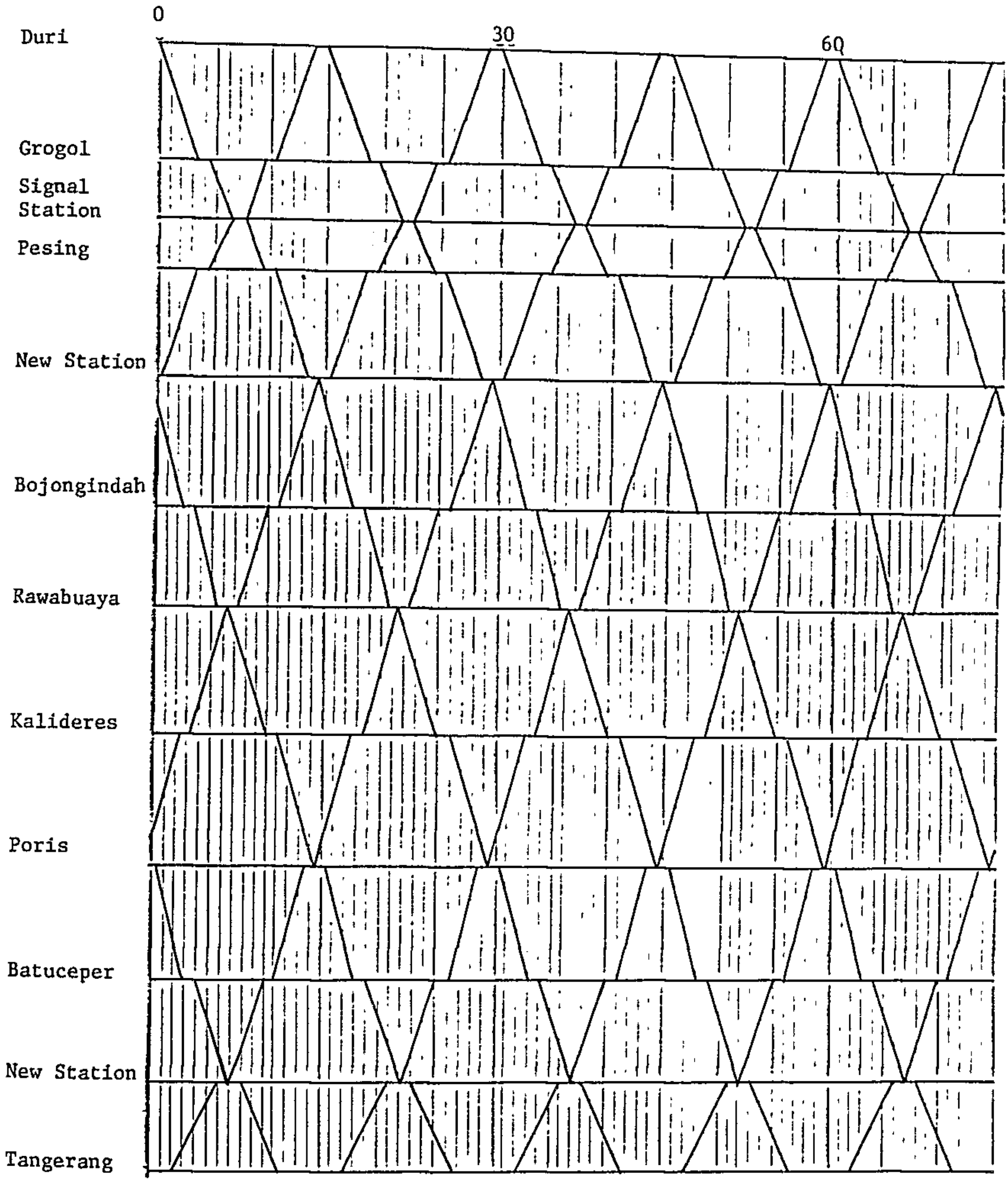


Fig. 5.7 Train Operation Diagram (Single Track with speed restriction due to of squatters)

5.3.3 Train Operation after Completion of Track Doubling

(1) Train operation time

Train operation time is indicated in Table 5.3. The speed restriction between Duri and 5 km 500 m and between 18 km 000 m and Tangerang of 40 km/h and at entrances of stations will be eliminated at the time of the track doubling. The signal statin at 2 km 750 m will be closed. Accordingly, the travelling time between Duri and Tangerang will be reduced to 35 minutes in both directions.

(2) Train operation plan

Since only one type of train is operated between Duri and Tangerang and the double track has a large capacity, there are no problems for the train operation plan. Based on the traffic demand, the required train headway can be determined.

5.3.4 Train Headway, Train Formation and Number of Railcars Required

During the single track stage, train headways will be 15 minutes in the peak-hour period. The capacity will 4 car train under peak 2 hours is 9,000 passengers. However, at time of completion of electrification in 1989, traffic demand will be about 11,000, therefore a train should consist of 8 cars. Table 5.4 indicates the train headway and number of cars required by year.

Table 5.3 Train Operation Time (Double Track)

(min. : sec)

Station	Kilometerage	Station distance (km)	For Tangerang		For Duri		Station Stop
			Calculated	Adjusted	Calculated	Adjusted	
Duri	0						
		1.700	2:18	2:30	2:24	2:30	
Grogol	1.700						1:00
		2.036	2:34	2:30	2:36	2:30	
Pesing	3.736						1:00
		1.704	2:18	2:30	2:18	2:30	
New Station	5.440						1:00
		2.208	2:42	3:00	2:45	3:00	
Bojong-indah	7.648						1:00
		1.188	2:03	2:00	1:50	2:00	
Rawabuaya	8.836						1:00
		2.554	3:02	3:00	3:00	3:00	
Kalideres	11.390						1:00
		2.498	3:00	3:00	2:57	3:00	
Poirs	13.888						1:00
		1.800	2:18	2:30	2:24	2:30	
Batuceper	15.688						1:00
		2.062	2:42	2:30	2:37	2:30	
New Station	17.750						1:00
		1.547	2:14	2:30	2.15	2:30	
Tangerang	19.297						
Total		19.297	25:11	26:00	25:06	26:00	9:00
Travel time				35:00		35:00	

Table 5.4 Train Headway, Transportation Capacity and Number of Railcars Required

Year	Track Condition	Train Headway	Formation Train	Capacity (x1,000)	Number of Train set	Number of Railcar rqd.
89-96	Single	15 min.	8 railcar	18.1	7	60
97-98	Double	8 min.	8 railcar	34.0	10	88
99-01	Double	6 min.	8 railcar	45.3	14	124
02-04	Double	5 min.	8 railcar	54.3	16	140
05-	Double	4 min.	8 railcar	67.9	20	176

Remark: Load factor during peak 2 hours is 200%
Train headway is for during peak 2 hours.

The number of cars in the table includes 8% for maintenance. Since a train set is four cars, adjustment to a multiple of four is made after the calculation for reserves.

5.3.5 Railcar Operation Schedule

Care should be taken in making the operation schedule the same as that in paragraph 4.3.5.

Four trains are from depot (Bukit Duri or Depok) in the morning and are returned back to the depot at night. During the off-peak hour, 3 trains are stored at Tangerang, and 3 trains are stored at Tangerang over night. Fig. 5.8 indicates the railcar operation schedule.

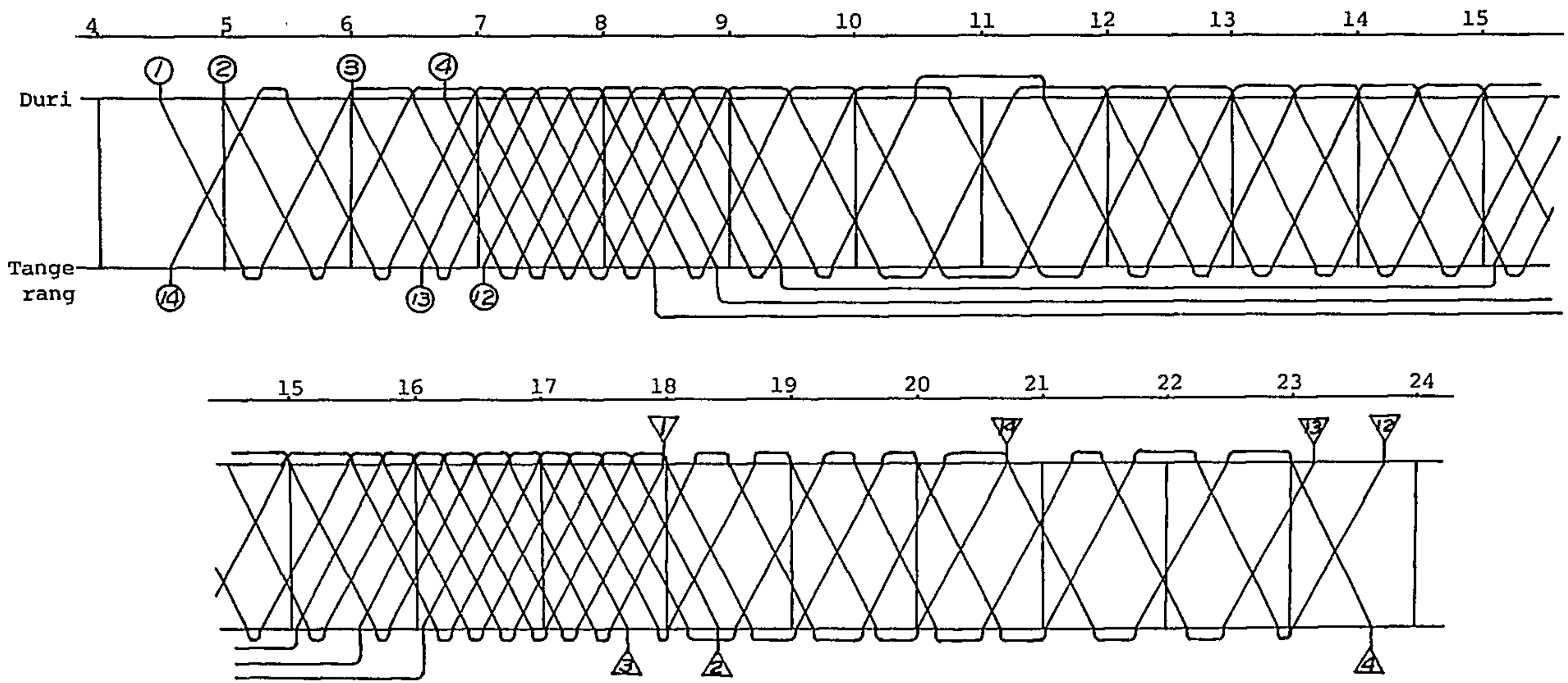


Fig. 5.8 Railcar Operation Schedule
(Single Track)

5.4 IMPROVEMENT PLAN

5.4.1 Existing State of Railway Facilities

(1) Track and structure

The Tangerang Line is 19.3 km in length. It was opened to traffic in 1916, but the service was suspended from 1975 to 1977.

(a) Roadbed

The line lies on a flat alluvial plain and partially on low hills near Tangerang, and mostly consists of embankments. The gradients are gentle and less than 5‰ , and Tangerang Station is only 12 m higher than Duri Station.

There are no sharp curves except for the curve of 250 m radius at the exit of Duri Station.

The standard cross section of the roadbed is "2nd class 1 degree III" of the old standard, the maximum design speed of which is 59 km/h. (Refer to Fig. 5.9.)

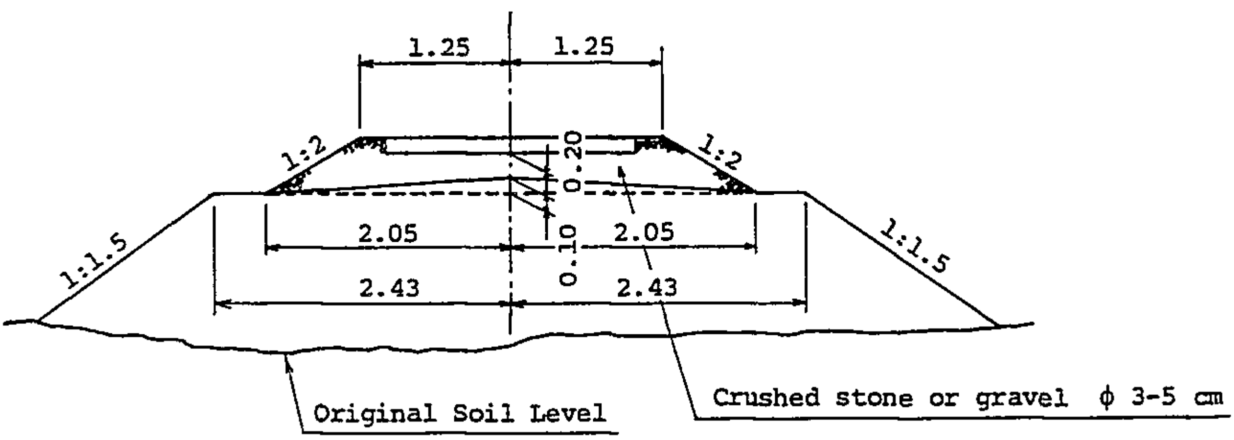


Fig. 5.9 Standard Cross Section of the Roadbed

As shown in the figure, the width of the formation level from the track center is 2.43 m and less than 2.75 m of the present standard.

The existing state of the roadbed is extremely bad and dangerous for train operation. The embankment shoulders have collapsed and are eroded, and the embankments have subsided at some places. The remaining parts of the embankments, however, are stable.

The roadbed of this line is used as roads for pedestrians, bicycles and motorcycles more than that of the Merak Line because of fewer trains, and this has contributed to the bad condition of the roadbed.

(b) Bridge and overbridge

The bridges are mostly steel girders and there is one truss. The through girders and the truss are considerably corroded particularly at the lower lateral bracings. The truss of the Banjir Kanal is severely corroded and needs to be replaced soon. The height of truss of the Banjir Kanal Bridge is 4.1 m and inadequate for electrification which is an additional reason for replacement.

The substructures are almost all made of plain concrete including cobblestones.

The bridges except the Banjir Kanal Bridge appear to be usable for present train operation but not to have enough bearing capacity for desirable future train operation, and the soundness and actual bearing capacity of the substructues must be confirmed by vibration test, etc.

(c) Track

The track of this line is in a bad and dangerous state. The rails are 25 kg/m rail and lack many joint bolts and spikes. Many sleepers are deteriorated and loose, and the alignment and level irregularities are extensive. The ballast is also lacking or buried in the embankment.

At the present time the trains are operated only at a low speed of less than 25 km/h. Emergency track rehabilitation for this line should be carried out without delay. The project of rail replacing is presently in progress, however, the emergency rehabilitation cannot wait for this.

(2) Station

Between Duri and Tangerang there are 9 stations (including both stations) and the average distance between each station is 2.4 km.

There are no actual crossing stations and signalling system, and only one train at a time can be operated on this line. Station buildings are installed on Duri, Pesing and Tangerang stations, and at the other stations no adequate facilities exist. (Refer to Table 5.5.)

(3) Road level crossings

On this line there are 22 road level crossings and their average distance apart is about 0.9 km, 2 of them being main roads. The warning system is not adequate and the condition of track and road surface is not good.

(4) Illegal housing

Along the line between Duri and 5 km 500 m between 18 km 000 m and Tangerang and in the yard of Duri Station, there are many illegal houses and they are close to the track. Their residents are using the roadbed as roads and living spaces.

(5) Signalling

At Tangerang Station, mechanical interlocking devices are installed, which have home and starting mechanical signals (disctype). Switch with indicator is operated by fieldmam at site.

Table 5.5 Existing Station Facilities

Name of Station	Facilities	Quantity	Remarks
Duri	Platform Platform Roof Main Track Side Track	95 m × 4 H = 0.18 m W = 1.9 ∿ 5.6 m O 3 2	* Including Western Line
Grogol	Platform Platform Roof Main Track	50 m × 1 H = 0.43 m W = 3.1 m - 1	
Pesing	Platform Platform Roof Main Track Side Track	85 m × H = 0.18 m W = 2.0 ∿ 2.1 m - 2 1	
Bojongindah	Platform Platform Roof Main Track	48 m × 2 H = 0.18 m W = 1.85 ∿ 3.1 m - 1	
Rawabuaya	Platform Platform Roof Main Track	50 m × 1 H = 0.43 m W = 3.2 m - 1	
Kalideres	Platform Platform Roof Main Track	95 m × 1 H = 0.18 m W = 2.0 m - 1	
Poris	Platform Platform Roof Main Track	- - 1	
Batuceper	Platform Platform Roof Main Track	- - 1	
Tangerang	Platform Platform Roof Main Track Side Track	115 m × 2 H = 0.18 m W = 4 m - 2 2	*

* Platform between two main tracks can not be used for frequent commuter service.

Siding tracks at the station yards are not used hence, only one main track is used. The block system, therefore, is the one engine block system. The equipment condition is such that they do not effectively function, and spare parts for these devices are becoming difficult to obtain.

(6) Road level crossing protection

The existing alarm bell installed at level crossing is not used, and protection is secured only using a manual barrier operated by a watchman. The watchman receives information of an approaching train by the train horn and the barrier is closed.

At level crossings with heavy road traffic, many vehicles continue to cross over even as the barriers are closing. Therefore, trains are obliged to slow down or even stop at level crossings.

(7) Telecommunication

Tangerang Station has dedicated telecommunication equipment include magneto telephone and morse telegraph. These are used for exchange of information with Duri Station. Magneto telephone is used for train operation messages, and Morse telegraph (T type) is for block message and train dispatching. Morse telegraph (B type) is used for exchange of information of train operation. Spare parts for Morse telegraph equipment are becoming difficult to obtain.

(8) Background for electrification work

In the land of PJKA especially between Duri and 5 km 500 m, and between 18 km 000 m and Tangerang there are many private houses close to the track.

In the sections where there are many houses close to the track the embankments are in poor condition and the roadbeds are cut for roads. In this case the embankment shoulder cannot accept catenary poles, especially between Pesing and Bojongindah. Hence, the poles are required to be longer than standard.

The clearance height of the Banjir Kenal truss bridge is 4.1 m. This bridge is required to be replaced before electrification because of the inadequate clearance for electrification and also the corroded condition.

There are some distribution lines and telephone wires crossing over the track.

There is no lighting at any of the stations.

5.4.2 Basic Improvement Plan (Stage Dividing)

(1) Characteristics of the line

The Tangerang Line is a 19.3 km line which provides only a commuter service within the Jakarta Metropolitan Area. A freight service is not operated at present and this study does not allow for it, but the future possibility is to be considered. It is considered that a freight service cannot function on this line unless medium and long distance freight trains are to be operated by a westward extension of this line or factories are constructed with exclusive sidings for dispatch and arrival of trains carrying at least 500 t/day. Road transfer service for the factories adjacent to this line means that handling the freight at the existing facilities within Jakarta City will be more economical than operating local short distance freight trains and providing new freight handling facilities along the lines. In addition, operation of trains will be uneconomical if a line is provided only for small quantities of freight.

(2) Project stage dividing

This project is ultimately to provide a frequent service by electric trains running on a double track. It is divided into the following 3 stages in consideration of the rise in demand, the effective use of capital and the schedule for the execution of works.

(a) 1st stage

This stage which is presently in progress and not included in this study involves rehabilitation of the existing track, roadbed, and road level crossings. The major work is replacement of rails and sleepers between stations, supplementation of ballast, repair of embankments and improvement of the crossing warning devices.

Diesel cars presently owned or to be procured are to be used to reinforce the commuter service to the greatest extent possible in conjunction with the rehabilitation work.

(b) 2nd stage (electrification on single track)

Step-by-step investment will occur with rising demand and therefore electrification and related improvements are to be performed in this stage on the single track. This stage is to achieve a commuter service of 15 minute headways with train formation increased within the stage from 4 to 8 cars. (Refer to 4.4.2 (2) (b).)

The improvement works to be carried out in the 2nd stage will be as follows:

1) Electrification
2) Improvement and new construction of crossing stations (including replacement of turnouts)
3) Improvements of Duri Station (including track layout modifications)
4) Improvements of signalling system, road level crossing protection system and telecommunication system.
5) Improvement of station facilities
6) Replacement of the truss of the Banjir Kanal Bridge.

(c) 3rd stage (Track doubling)

Provision of a double track is to be performed in this stage in accordance with the traffic demand which cannot be met by the performance given by the service of 15 minute headways with 8 car trains.

Improvement and reinforcement of station facilities including Duri Station and the raising of platforms to 0.95 m will also be performed.

Operation by single line working on the additional new track is to precede the operation on the double track, so that complete rehabilitation of the existing track can be carried out. These works will include widening of the existing formation in accordance with the present standard, addition or replacement of ballast, and replacement or reinforcement of bridge superstructures and substructures. Replacement of rails and sleepers would be already carried out in the 1st stage.

The service for this stage is to be a frequent commuter service of 10 ∿ 3 minute headways in peak times with 8 car trains, but increasing the train formation to 12 cars in some future stage is taken into consideration.

5.4.3 Design Standard

This project is to improve the line which is in operation by conducting improvements in 3 stages. In addition to the standard for the final stage, temporary standards are provided taking into consideration the work method, procedure and present condition.

The design standard is applied to the whole railway system. However, only the standard required for the feasibility study is detailed in this report.

1) Maximum train operation speed

a) Final (3rd) stage

80 km/h — The additional track and the existing track after the complete rehabilitation.

b) 1st and 2nd stages

80 km/h — The existing track after the rehabilitation of the 1st stage.

40 km/h — On the section where there are too many houses close to the track (Duri ∿ 5 km 500 m, 18 km 000 m ∿ Tangerang)

2) Minimum radius of curvature of main track

As the existing track (The existing track 250 m, the additional track actually 300 m)

3) Maximum gradient of main track

10‰

4) Track center to center distance

4.0 m

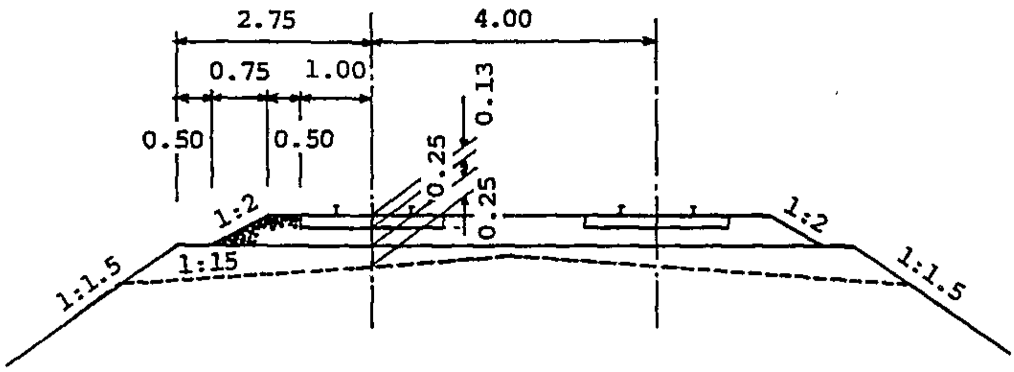
5) Width of formation level

a) Final (3rd) stage

2.75 m (from the track center) (Refer to Fig. 5.10.)

b) 1st and 2nd stages

As the existing state



Note: 1st class, 2nd degree
Speed: 100 km/h
Straight track

Fig. 5.10 Standard Cross Section of Roadbed

6) Track

a) 2nd and final (3rd) stages

Rail	UIC54 (or equivalent)
Sleeper (except turnouts)	PC (1,666/km)
Ballast thickness	25 cm
Axle load	18 t

b) 1st stage

Turnout	As the existing
Others	Same as the 2nd stage

7) Bridge bearing capacity

a) Final (3rd) stage

KS-16 (Freight service in future if it becomes necessary is taken into consideration)

b) 1st and 2nd stage

As the existing state

8) Strength of roadbed (Newly constructed part)

K20 $\geqq$ 7 kg/cm^3 (or equivalent complying with the condition of geological features or nature of soil)

9) Platform

a) Final (3rd) stage

Height	0.95 m	
Length	190 m	(Extention to 270 m in future is taken into consideration.)

b) 1st and 2nd stage

Height	0.18 m	(Before decision of raising the platform height to 0.95 m a temporary platform of 0.18 m height will be made.)
Length	190 m	

10) Electrification

Current and voltage	DC 1,500 V
Overhead contact wire catenary system	
	Simple catenary (St 90 mm^2/Cu 110 mm^2) with PC pole and cantilever or V-truss beam
Height of contact wire	
	Normal 5.3 m
	Minimum 4.1 m
	Minimum on road level crossing 5.5 m
Clearance of poles	2.7 m (pole center to track center)

11) Signalling system

a) 2nd and final (3rd) stage

Automatic block system
Relay interlocking system

5.4.4 Improvement Plan of 2nd Stage (Electrification on Single Track)

(1) Roadbed and structure

In the 1st stage the rehabilitation of the roadbed and track is carried out, but it is minimized by the use of a provisional standard. In the 2nd stage the roadbeds and structures will be used as this state. However, the truss of the Banjir Kanal Bridge will have to be replaced because of corrosion and lack of height for the electrification clearance. Repair of every steel girder is also necessary.

The width from track center of the existing formation is 2.43 m, which is 0.32 m narrower than the present standard of 2.75 m. However, this will not be widened in the 2nd stage, because it is difficult to obtain adequate strength by placing a thin earth layer onto the existing embankment, and it is uneconomical to extend both sides whether the construction of the roadbed is on embankment, in cutting or on the level. This can be widened to the double track in the 3rd stage.

For the design of the structure gauge for erecting electric poles and the height of the contact wire, the re-alignment and raising of the track in the 3rd stage must be considered.

In the sections between Duri and 5 km 500 m and between 18 km 000 m and Tangerang where there are too many houses close to the track, it is very difficult to remove them in a short period. Therefore the removal will be performed together with the land acquisition for the track doubling, and so in the 1st and 2nd stages the operation speed will be reduced to 40 km/h.

(2) Track

The track of the Tangerang Line is now in poor condition with 25 kg rails on wooden sleepers. The rehabilitation of the track and roadbed (refer to the 1st stage) as well as the rail replacement to UIC54 except in the stations and the renewal of sleepers and supplement of ballast is now in progress. The track after such improvement would serve the work of the 2nd stage. In the 2nd stage the crossing loops will be newly installed and the turnouts and the tracks in the station yards will be replaced.

(3) Station

The stations and signal stations must be improved or newly built to suit the 15 minutes headways with 8 car trains. The rough sketches of the track layout of Tangerang Line in the 2nd stage are shown in Fig. 5.11 and Fig. 5.12.

(a) Duri station

At Duri Station the Western Line portion will be left as it is, and only the Tangerang Line portion which occupies half in the east side of the station will be improved in this project. A temporary track will be laid and the width of platform will be narrowed during the 2nd stage because the illegal housing is densely built in the west of the station. In relation to the arrangement of crossing stations, 2 tracks will be provided for the Tangerang Line for the 15 minute headway operation.

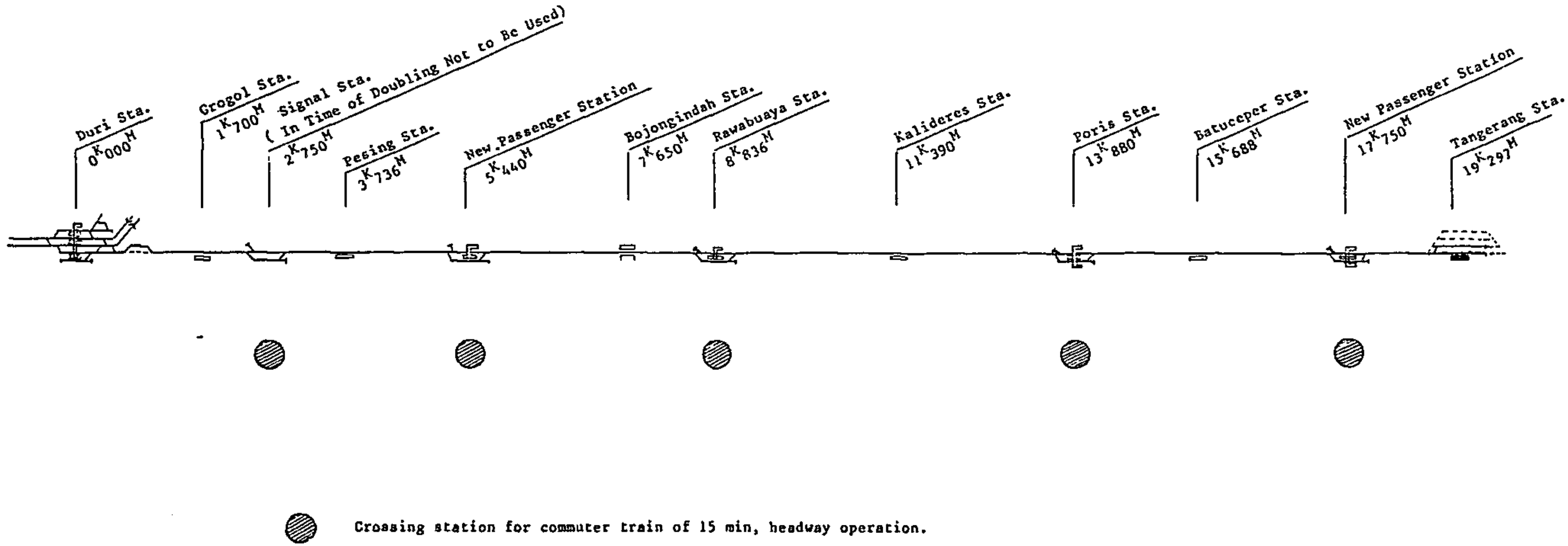


Fig. 5.11 Track Layout of Station on 2nd Stage

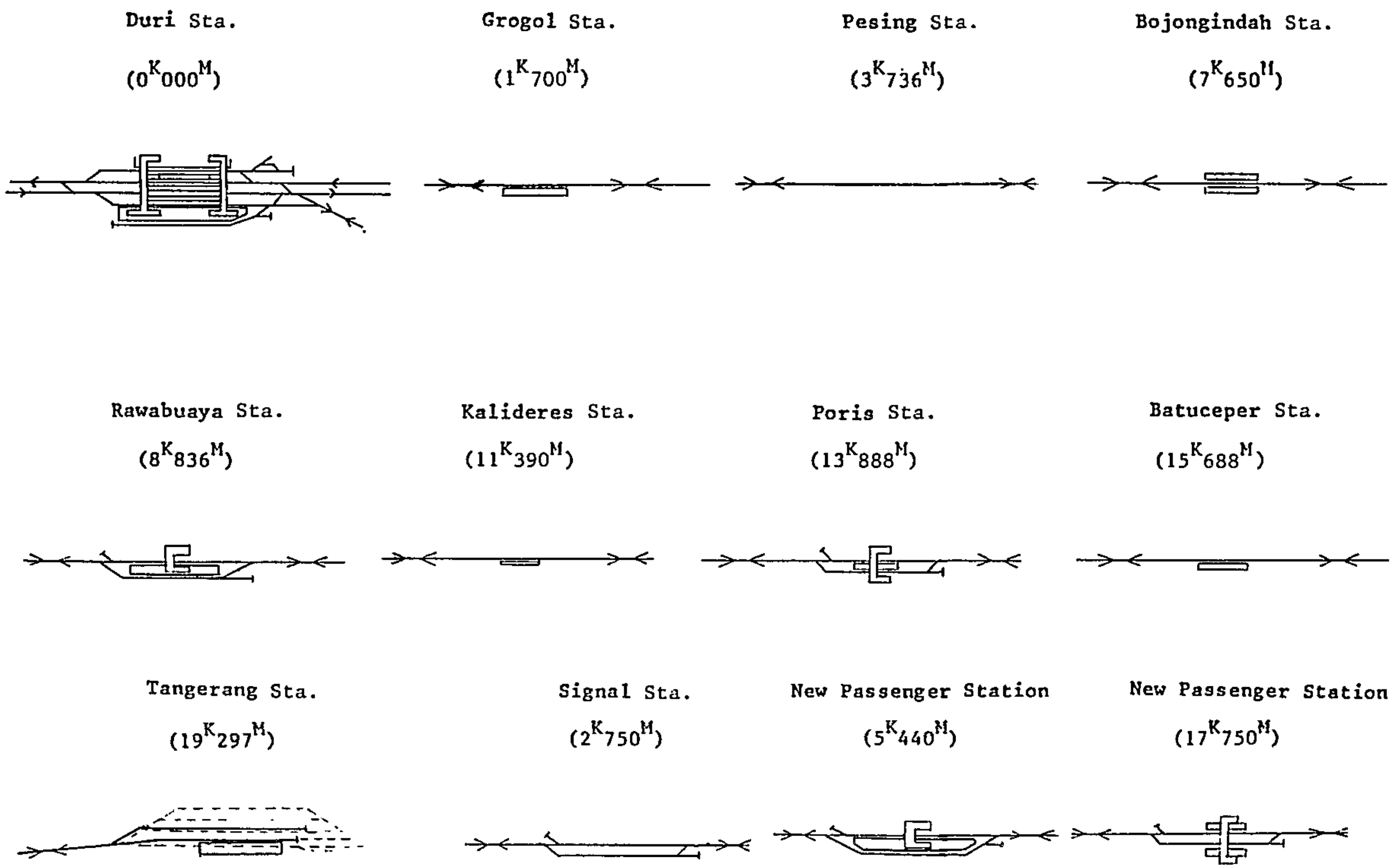


Fig. 5.12 Track Layout of Station on 2nd Stage

The commuter trains on the Tangerang Line turn round at this station. It is planned that the passengers connecting to the Western Line shall change trains here, but it is possible that the trains of the Tangerang Line will go onto the Western Line by way of a flat function providing the train diagram for the Western Line will not be unfavorable. It is of course necessary for trains to have access to the electric car depots such as Bukit Duri.

(b) Improvement and establishment of crossing stations

The crossing stations necessary for the 15 minute headway train operation will be Duri, Signal Station (2 km 750 m), New Station (5 km 440 m), Rawabuaya, Poris and New Station (17 km 750 m).

These intermediate stations now have only single track without turnouts and crossing loops will be installed. The new stations are located at the intermediate positions of the longer sections between stations, where new residential development will provide potential passangers. The signal station (2 km 750 m) must be built in the area of illegal housing and land acquisition will be most difficult.

At the non-crossing stations such as Pesing and Karideres, there are sidings which have not been used nor maintained for a long time and there will be no requirement for them in the 2nd stage.

(c) Storage track

2 storage tracks are to be built in the area previously used for the freight lines in the southern part of Tangerang Station in order to store electric cars for the night and off-peak times.

In addition each one of the main tracks at Duri and Tangerang stations will also be used so that there will be 4 storage tracks available for night storage.

For further storage and car inspection Bukit Duri and Depok depots are to be used. These depot facilities are considered under other projects, but the cost of them is to be shared by the Tangerang Line project.

(d) Platform, platform roof and station footbridge

Platforms, platform roofs and station footbridges are same as that of the Merak Line. (Refer to 4.4.4(3)(e) and (f).)

On the Tangerang Line station footbridges will be built at Duri, New Station (5 km 440 m), Rawabuaya, Poris and New Station (17 km 750 m) in the 2nd stage. At Duri Station 2, footbridges will be necessary because all passengers detrain the trains.

(e) Points to be observed about crossing stations

The points to be observed about crossing stations are the same as those of the Merak Line. (Refer to 4.4.4 (3)(g).)

(4) Road level crossing

In the 2nd Stage the improvement of the road level crossings is considered necessary for the frequent train operation, and automatic crossing warnings and gates must be installed. The track and road structures must also be strengthened. (Refer to Fig. 4.17.)

The existing main road level crossings are listed in Table 5.6.

Table 5.6 Main Road Level Crossings

Kilometerage	Name	Width (m)
0.860		5.5
1.655	Jl. Latume Raya	5.0
1.669	Jl. Latume Blat I	13.0
1.694	Jl. Latume Blat II	5.2
2.520	Jl. Sosial	4.5
3.220	Jl. Karya	4.5
3.920	Jl. Daan	28.0
4.306		9.0
5.320	Jl. Taman Kota	5.5
8.184		13.0
8.795		5.0
11.228		5.5
17.994		3.0
18.720		5.5
19.082		9.0

(5) Electrification

The electrification of the single track line is the main improvement work to be accomplished in the 2nd stage. A frequent commuter service of 15 minute headways with 4 to 8 electric car trains will also be provided.

The electrification system will be a DC 1,500 V system the same as other electrified lines in the JABOTABEK Area.

(a) Power supply

a) Power source

It is desirable that a 20 kV or 70 kV exclusive power source is used for the electric railway. There is an existing PLN 150 kV substation at Tangerang, and there is a 150 kV transmission line passing through the vicinity of Rawabuaya. In addition, there is also a 20 kV distribution line on the side of the road following the Tangerang Line. Therefore, there will be no particular problem regarding the incoming power supply for the PJKA electric railway substations.

b) Substation location

Substations for DC electrification will be located at approximately 10 km intervals based on consideration of voltage drop. The planned locations for the substations are Duri, Kalideres and Tangerang, and the intervals between them are 11.8 km and 7.9 km, based on consideration of basic intervals, geographic conditions, existing conditions related to power supply and future maintenance potential within the district. A substation for the Western Line electrification is located at Duri and this substation will also be appropriate to provide power for the Tangerang Line. Rawabuaya was investigated as a location for an intermediate substation however the low ground elevation would be a handicap for preventive maintenance and therefore Kalideres was selected.

The substation sites are within PJKA's area, however it will be necessary to remove private houses on the sites. This removal will entail compensation costs.

c) Substation capacity

The 15 minute headways by 8 car trains are considered to be the maximum for single track operation.

In consideration of the rapid increase of the traffic demand the capacity of each substation is initially planned to be 3,000 kW. It is also planned to increase the capacity by another 3,000 kW facilities in accordance with the increased demand after the completion of the double track, when the headways become less than 8 minutes.

(b) Overhead contact wire system

a) Description of facilities

a. Catenary system

Simple catenary system

b. Wire Types

Feeder	Hard-drawn copper stranded wire	300 ∿ 400 mm^2
Messenger wire	Galvanized steel wire	90 mm^2
Contact wire	Hard-drawn groove trolley wire	110 mm^2
Ground wire	Galvanized steel wire	55 mm^2

c. Height of contact wire

Normal	5.3 m
Minimum	4.1 m
Maximum	5.9 m
Minimum on road level on crossing	5.5 m

d. Maximum gradient of contact wire

Main track	5/1,000
Siding	15/1,000

e. Supporting structure

Prestressed concrete pole
V-truss beam (inside station)
Cantilever beam (between stations)

f. Clearance of pole

2.7 m (pole center to track center)

The standard mounting for the overhead contact wire system are as shown in Fig. 4.18 and Fig. 4.19.

b) Special structure gauge taking consideration of complete rehabilitation in the future

It is considered advisable to strengthen the track structure by increasing the embankment shoulder and ballast by shifting the track center line towards the widening work and raising up the rail level.

Prior consideration of the length of the cantilever and the structure gauge (clearance of pole and height of contact wire) at the time of single track electrification is therefore necessary.

c) Length of electrification poles

The existing roadbed condition of the Tangerang Line is extremely poor, and there are many places where they have no fixed state due to the presence of houses and roads adjacent to the line. Consequently, the roadbed soil will not have sufficient bearing strength for the electrification poles and so these will have to be founded in the natural soil beneath the roadbed. The length of the poles will, therefore, have to be longer than the standard length.

d) Truss bridge

There is a 40 m long truss bridge between Duri and Grogol, and the height between rail level and the lower parts of upper lateral structures is 4.1 m. In addition the truss itself is considerably corroded and the bridge is, therefore, to be replaced when the line is electrified.

e) Overcrossing wires

There are many distribution lines and telephone wires crossing over the track in the urban areas, and they will have to be dealt with before electrification.

f) Houses obstructing electrification

There are many houses along the line close to the track in the urban areas, and these will become obstruction to pole erection prior to the track doubling. At that time only the minimum number of houses will have to be removed and compensation for them will be necessary.

(c) Power facilities

a) High-voltage distribution line for signalling system

Each PJKA substation will have an exclusive transformer for signals and level crossing protection system. It will be a 6.6 kV single-phase one-circuit distribution line, and the voltage will be dropped where necessary. It will not be used as the power source for electric lighting facilities at stations. (There are PLN distribution lines along the Tangerang Line, so the power sources for electric lighting facilities can be provided by them. Accordingly, the exclusive line will be only for the signalling system and it may be signale-phase.)

b) Lighting facilities

There are practically no lighting facilities at any of the existing stations, so it will be necessary to provide lighting facilities for the main parts of each yard, platform and station building. The power sources for these will be provided from PLN distribution lines.

(6) Signalling

As described in the preceding paragraphs, the existing signalling system is old and inadequate to function well and to meet increasing

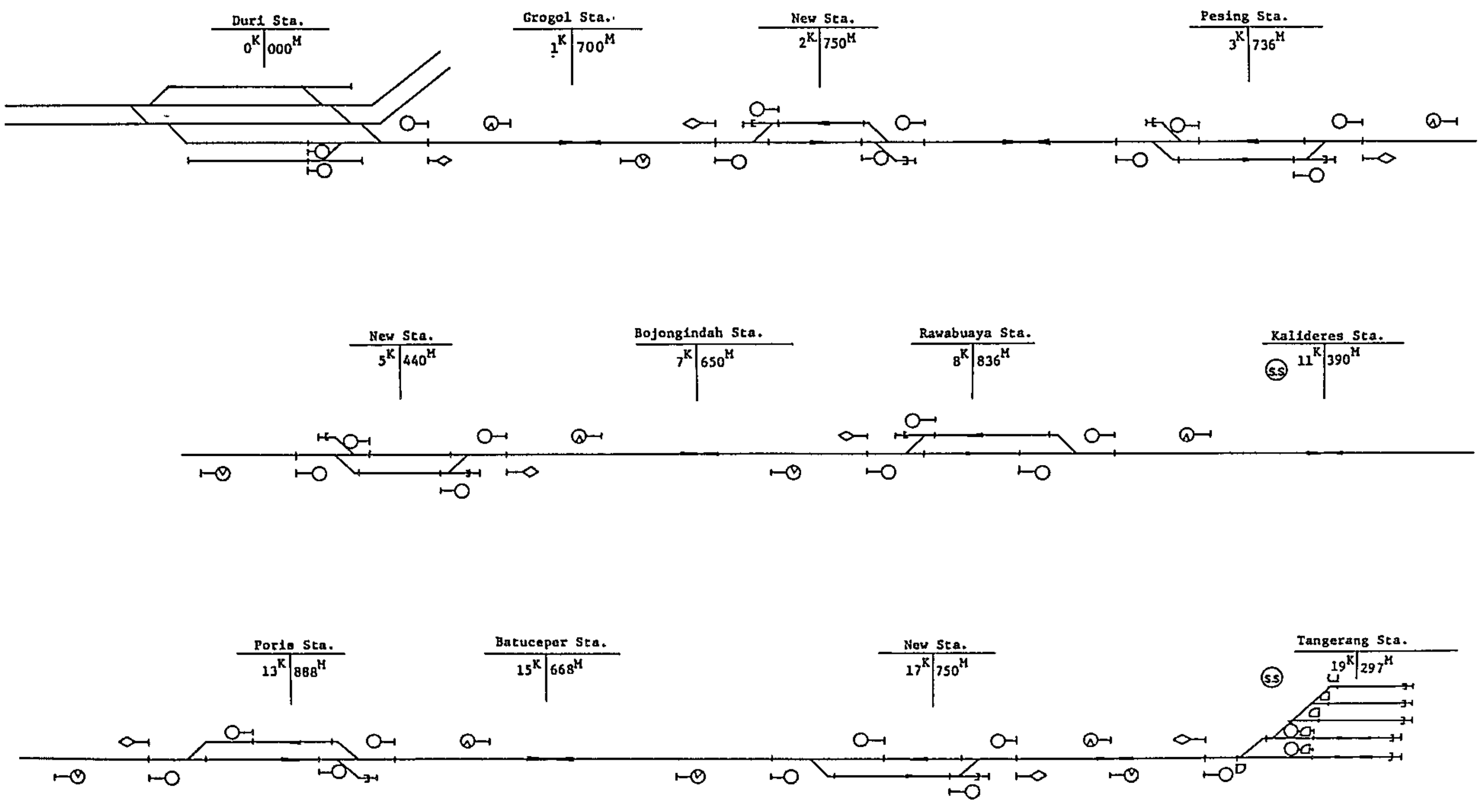


Fig. 5.13 Configuration of Signalling System

traffic demand. In order to deal with further increase in traffic demand, it is essential to modernize the existing system. In this modernization the signalling system is planned on the basis of a train operation of 15 minute headways on the single track (2nd stage), 5 minute headways on the double track (3rd stage) and 3 minute headways on the double track (3rd stage in future).

The outline of the signalling system in the 2nd stage is shown in Fig. 5.13.

(a) Block system

When a train is proceeding on a main-track route, no other trains or cars may be allowed on the same section of the route at the same time. In order to secure this, a block system which make up a route of blocking sections and allow only 1 train to operate in each section is to be provided.

For the single track operation in the 2nd stage, between stations the section is to be blocked by the train itself and train direction is to be decided by the operators of both stations, and within a station yard sections are blocked by the train itself or the signal operator.

(b) Signal system

The signal system is to be such that a speed condition for the proceeding train is indicated by a signal aspect. Signal is to be provided at a boundary of blocking sections and automatically controlled by the train itself. Home and starting signals are also to be manually controlled by the signal operator. The signal aspects are basically to be 3 colors of green, yellow and red, and if necessary green-yellow and/or yellow-yellow are to be used.

For shunting a train or cars, a shunting signal of position lights is to be provided, which is designed to indicate the clearance of the route. A shunting signal is not, however, to be provided for a simple station yard with small shunting movements. Instead, a locking switches at the site is to be provided to enable the shunter to lock the route controlled by relay interlocking devices.

(c) Interlocking system

The interlocking system is to be a relay type designed to operate a route under remote control by levers for signals, shunting signals and related electric switch machines in order to increase the operator's efficiency and ensure safety. The interlocking device is to provide a lock between these controlled units on the fail-safe principle.

(d) Train detection system

Automatic signals and relay interlocking devices require train detection for which a commercial frequency AC truck circuit system is to be adopted as the simplest and both highly reliable and economical system. Between track circuits, insulated rail joints are to be inserted and in order to make traction current return impedance bonds are to be provided.

(e) Switch system

The switch system is to be a motor type to provide reduced switching time for a increased train speed and a traffic density. Electric switch machines controlled remotely on the control panel of the relay interlocking devices are to be provided.

(f) Automatic train stop system (ATS)

The train route is to be ensured by the relay interlocking device and the safety of the train is secured as long as the train enters at a speed in accordance with the signal aspect. Should the signal aspect be ignored due to sudden illness or negligence of the operator, a serious accident could occur.

In order to prevent such an accident, an automatic train stop system (ATS) is to be installed as a backup system for the operator.

(g) Level crossing protection system

In order to prevent a traffic accident under the growing road traffic volume and increasing train operation speed and dencity, a system with level-crossing signals and automatic barriers is to be installed. This is controlled automatically by the level-crossing controller. It would be necessary to arrange for a watchman to ensure smooth traffic flows.

(h) Signal cable

Signal cable in station yards and at the specified areas are to be housed in reinforced concrete troughs, while the others installed along railways are just to be buried.

(7) Telecommunication

Under increasing train operation speed and density, the telecommunication system must be modernized to ensure safety and efficiency of operation, to improve services for users and to make railway management more efficient. The system is necessary to be optimal, and it will have to be compatible with the system proposed in the Intermediate Program for the JABOTABEK Area.

(a) Telecommunication cable

The telecommunication cable is to be the unit cable housing communication circuits between various divisions, command circuits for train operation, circuits to control substations, block circuits for signals and maintenance circuits.

(b) PCM cable carrier system

The PCM cable carrier system, which is less sensitive to induced noise distortion and suitable for a high-speed data circuit, is to be used to ensure much higher-quality transmission to provide multiplication of data transmission channels.

(c) Dispatch telephone equipment

In order to ensure the best train operation by recognizing operational conditions such as delay of a train, dispatch telephone equipment designed to convey information from the center directly to the out-stations is to be provided.

(d) Talk-back equipment

At a station where there are shunting works, talk-back equipment is to be provided for communication between the signal cabin (signal operator) and the field man.

At every station talk-back broadcast equipment is to be provided for a passenger guide service.

(e) Subscriber telephone

Subscriber telephones are to be provided at each station for communication between stations, signal stations, substations and administrative and other sections in PJKA. They are to be connected to the automatic exchange device (Philips UH-200) installed in Tanah Abang station.

(f) Wayside telephone terminal box

Wayside telephone terminal boxes are to be installed every 500 m along the railway tracks, so that a portable telephone can be connected to communicate information in case of a train accident, track failure or maintenance from the site to the nearest station or operation center.

(g) Facsimile telegraphy

The facsimile telegraphies are to be provided at each station, which allow transmission of important commands (in diagrams or characters) from the operation dispatcher to each station or all stations and enable recording of information by both sender and receivers.

(h) Electric clock equipment

To ensure the correctness of train schedule for the operational personnel and passengers, electric clocks are to be provided at station offices, signal cabins and platforms. These are to be controlled from the master clock installed at Duri Station.

5.4.5 Improvement Plan of 3rd Stage (Track Doubling)

(1) Outline of this stage

The initial aim of this stage is track doubling in order to achieve a frequent commuter service of less than 15 minute headways, when more than 18,000 peak 2 hour commuters use the service, which is the limit of the 15 minute headway commuter service with 8 car trains. And by increasing the number of cars and enlarging the maintenance and storage facilities such as workshop, depots and storage tracks in addition to the track doubling, the additional transportation capability up to 3 minute headways can be obtained. The workshop, depots and storage tracks are considered under other projects, but the costs of them are to be shared by this project.

This project is based on the assumption that the commuting demand would not exceed the transportation capability of a 3 minute headway commuter service by 8 car trains during the project life. The modification to 12 car trains in future, however, should the demand increase, is taken into consideration in this project.

The complete rehabilitation of the existing track is also suggested, so the improvement of the line has been minimized in the 1st and 2nd stages. The complete rehabilitation of the existing roadbeds, bridges tracks, etc. is estimated to require a construction period of 1.5 years using the new track for a single track operation during the time.

(2) Overview of the geographical and geological features

(a) Geographical features

The alluvial plain extends to the sea in the northern part around Jakarta, and the rolling volcanic hills are located to the south. The Tangerang Line runs through the alluvial plain to the west, bordering the diluvial uplands rising up to terminal Tangerang Station. The line mostly runs on low embankments on the alluvial plain passing over the rivers with bridge structures. Most sections are level, Tangerang Station being only 12 m higher than Duri Station, and there are no sharp curves except at the exit of Duri Station. (Refer to Fig. 5.14.)

(b) Geological features

The Tangerang Line borders the diluvial uplands where volcanic ash covers the bedrock of the Neogene formation made of clay rock or sandstone, and runs on the unconsolidated sediments from the eroded uplands in the south which cover the volcanic ash. Bedrock is located at less than 20 m depth.

(c) Geology and construction

a) Embankment

Careful embankment construction is required considering the geological features because the additional embankments are being added to the existing embankments on the alluvium which has been gradually settling over a long period. The mixture of sand which drains well and the lateritic soil cut from the diluvial uplands nearby will be used for the embankments.

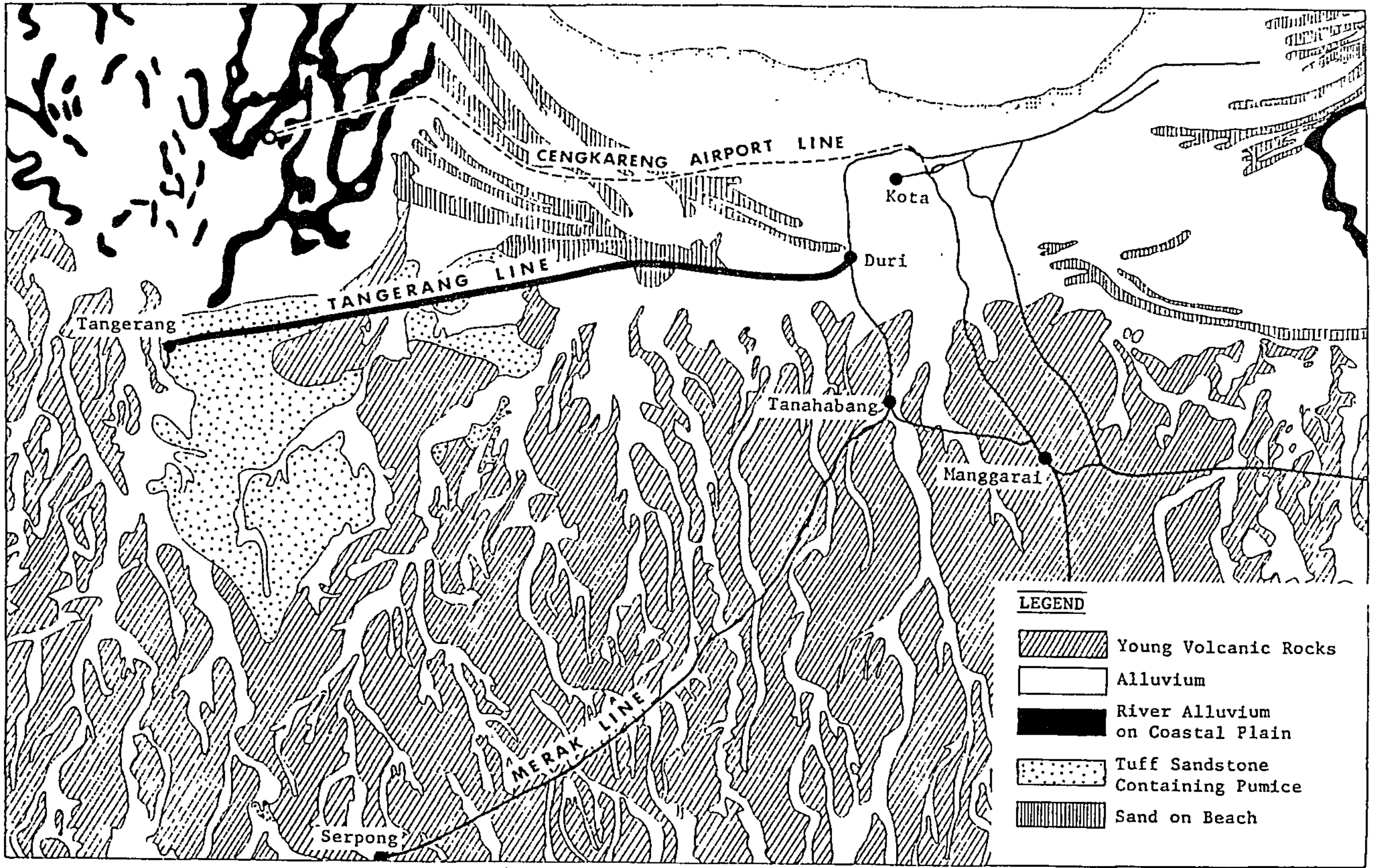


Fig. 5.14 Geological Map

b) Bridge

Since the bridges are built on the alluvial plain foundation piles driven to the bedrock should be used except in the case of small bridges. No bridges would require caisson foundations.

(3) Environment

The line runs through the urban district of the JABOTABEK Area between Duri and 5 km 500 m and between 18 km 000 m and Tangerang. In these areas illegal houses have been built close to the track on both sides and the trackbed is used as a road or a play ground. The scale of the illegal housing is so great that there would be a social problem to remove it. Accordingly, in the 2nd stage the train is planned to run slowly at a speed of less than 40 km/h for safety without removing it. In the 3rd stage removing the housing as well as enlarging the right-of-way for the new track is planned as a long term project.

The National Highway from Jakarta to Merak is approximately 1 km north of Tangerang Line on the higher part of the alluvial plain. Both sides of the highway are full of houses, shops and factories which continue to the Tangerang Line in some areas. From Karideres the line runs above the hills to Tangerang, and further development along the line can be expected.

(4) Alignment and profile of additional track

The alignment of the additional track is planned to be located near and parallel to the existing track. But at bridges the distance between the new track and the existing track should be 8 to 12 m to allow adequate construction space.

The track has a 250 m radius curve just after Duri Station, but the curve modification is not planned as the point is just after the station and train speeds are not high. (The sharpest curve of the additional track will actually become 300 m radius.)

The profile of the additional track is planned to be almost the same as that of the existing track. The alignment and profile of the additional track are shown in Fig. 5.15 and Fig. 5.16 and the standard cross-section is shown in Fig. 5.10. The detail alignment is shown in the Drawings (separate volume).

When doubling the track, the existing track will be improved (complete rehabilitation). Therefore, the condition of the existing track (such as the track center) after the improvement will have to be considered fully, when establishing the alignment and profile of the additional track.

(5) Roadbed and structure

(a) Additional track

The structures for this project are almost all embankments. Bridges are only used for the rivers and flood openings.

The types of the bridges on the additional track are steel girders (composite grider) for more than 30 m spans, prestressed concrete I-section girders for spans between 15 m and 30 m, and reinforced concrete girders or culverts for less than 15 m spans. (Refer to Fig. 4.24.) The substructures will be made of reinforced concrete and if the geological features require, reinforced concrete piles will be driven.

The planned profile which gives rough estimated volume of the earthwork is shown in Fig. 5.17 and the planned main bridges are listed in Table 5.7.

The line lies in residential (or becoming residential) district and so all the bridges are planned to have ballast in order to reduce noise.

For the design of the river bridges any river improvement plans will have to be taken into consideration. For the design of the embankments sufficient flood openings will have to be considered.

To widen the formation in earthworks for the additional track, embankments of sufficient width for double track to the new standard (including the existing embankment) will have to be constructed. In the complete rehabilitation the center of the existing track will be moved towards the new line to increase the shoulder width to the new standard.

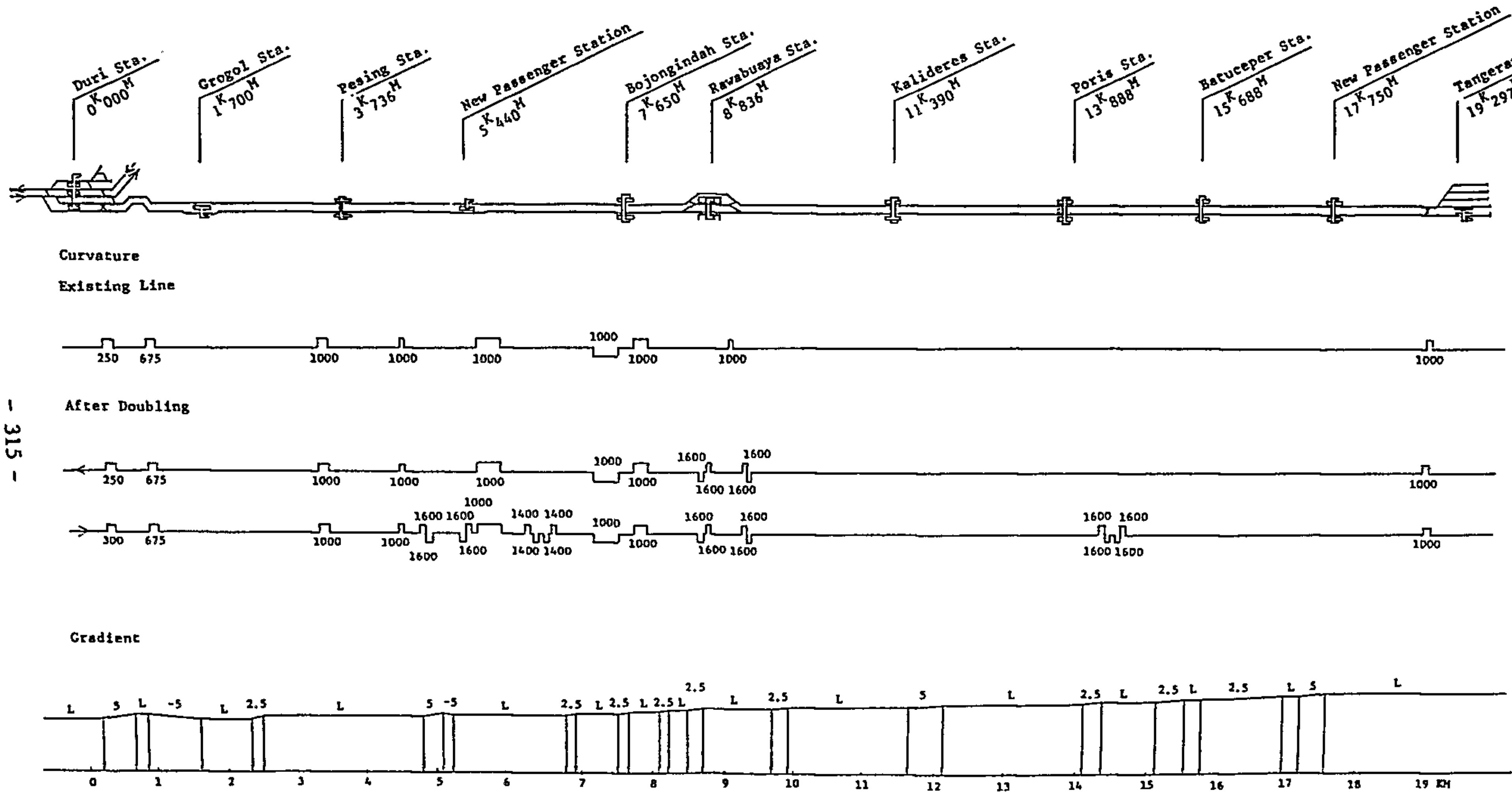


Fig. 5.15 Alignment and Profile of the Tracks on 3rd Stage

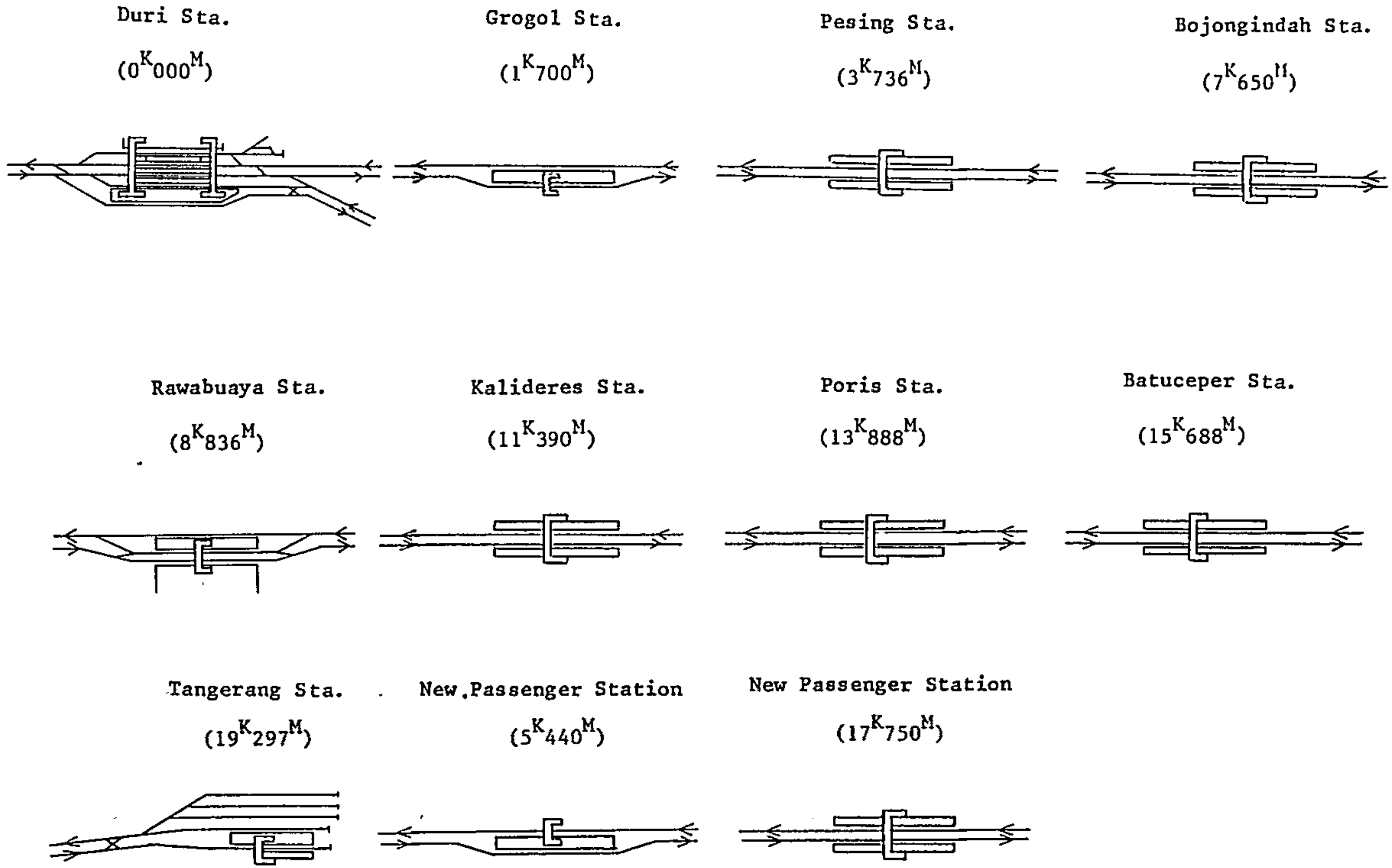


Fig. 5.16 Track Layout of Stations on 3rd Stage

Tangerang Line

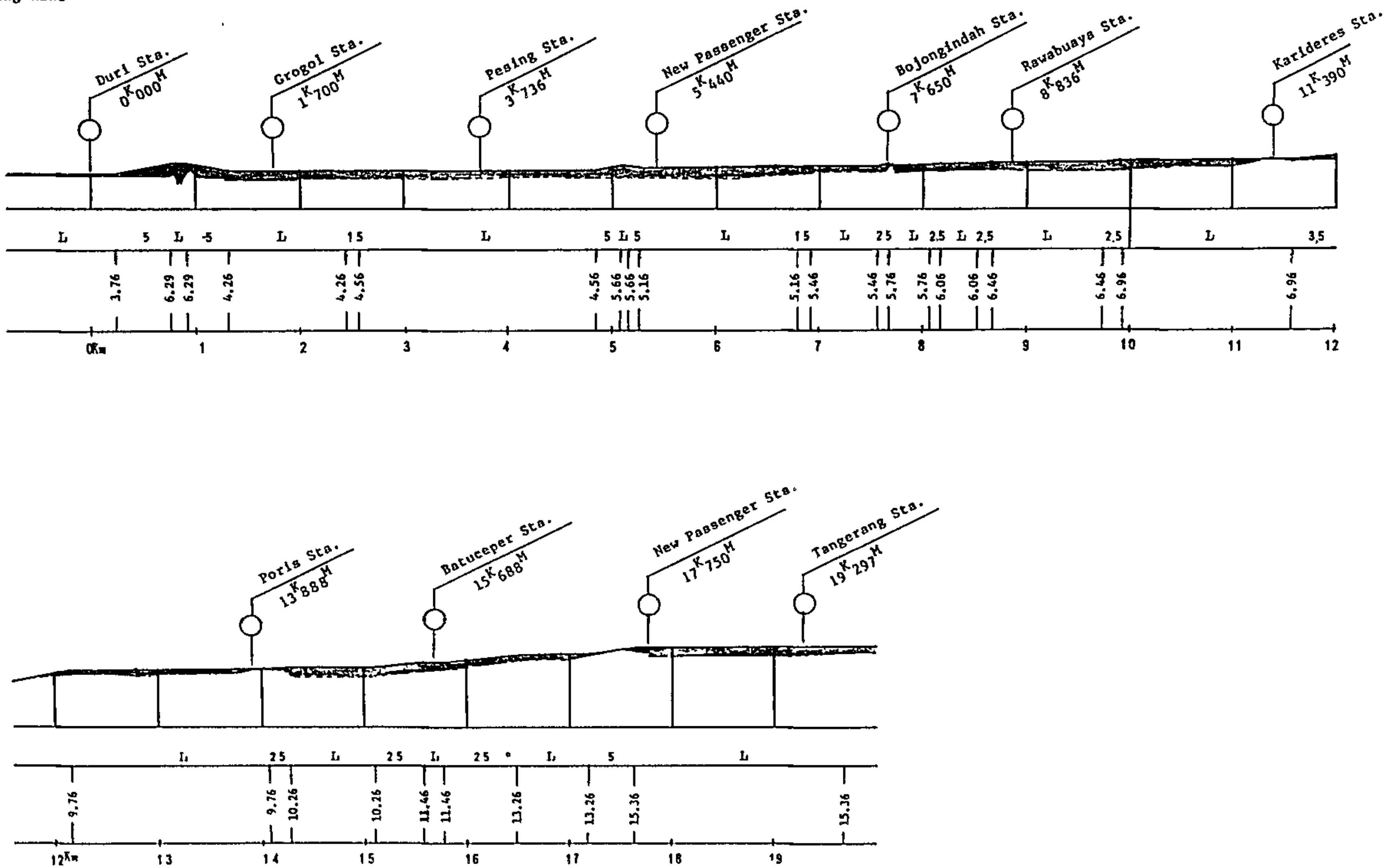


Fig. 5.17 Profile of Track

For this line, flood openings are important because the line passes through the alluvial plain and across the many small rivers from the valleys of the diluvial hills.

Table 5.7 Main Bridge List

Kilo-meterage	Name	Existing Bridge		Planing Bridge	
		Type	Span	Type	Span
0.807	Banjir Kanal	Truss (Through)	1 × 40	Composite Girder	1 × 40
1.673	Kari Grogol	Steel Girder (Through)	1 × 15	PC Girder	1 × 15
5.089	Kari Cisadona	Steel Girder (Through)	1 × 20	PC Girder	1 × 20
5.426		Steel Girder (Through)	2 × 10	RC Girder	2 × 10
6.388	(Under Construction)	Steel Girder	2 × 15 1 × 30	PC Girder PC Girder	2 × 15 1 × 30
14.066		I Beam	1 × 6	RC Girder	1 × 8
14.514		Steel Girder (Through)	2 × 10	RC Girder	2 × 10
16.107		I Beam	1 × 5	RC Girder	1 × 8
18.243		I Beam	1 × 5	RC Girder	1 × 5

(b) Complete rehabilitation

After the completion of the additional track, with single track operation on the new track, the complete rehabilitation of the existing track will be carried out. Based on detailed inspections, replacement of bridges, either superstructures only or including substructures, will be implemented at the same time. The complete rehabilitation should include improvement or addition of flood openings.

The strength of the existing girders appears to be insufficient for the loads for this project and the girders are planned to be replaced.

(6) Track

(a) Additional track

For the additional new track UIC54 (or equivalent) rails and PC sleepers - 1,666/km with elastic fastenings are used with ballast thickness of 25 cm, for the maximum speed of 80 km/h and frequent commuter service by electric cars.

(b) Existing track

After the rehabilitation of the 1st stage, for the existing track UIC 54 rails and PC sleepers with elastic fastenings are used. In the complete rehabilitation ballast will be replaced or cleaned and filled up. Estimated passing tonnage is shown in Fig. 5.18.

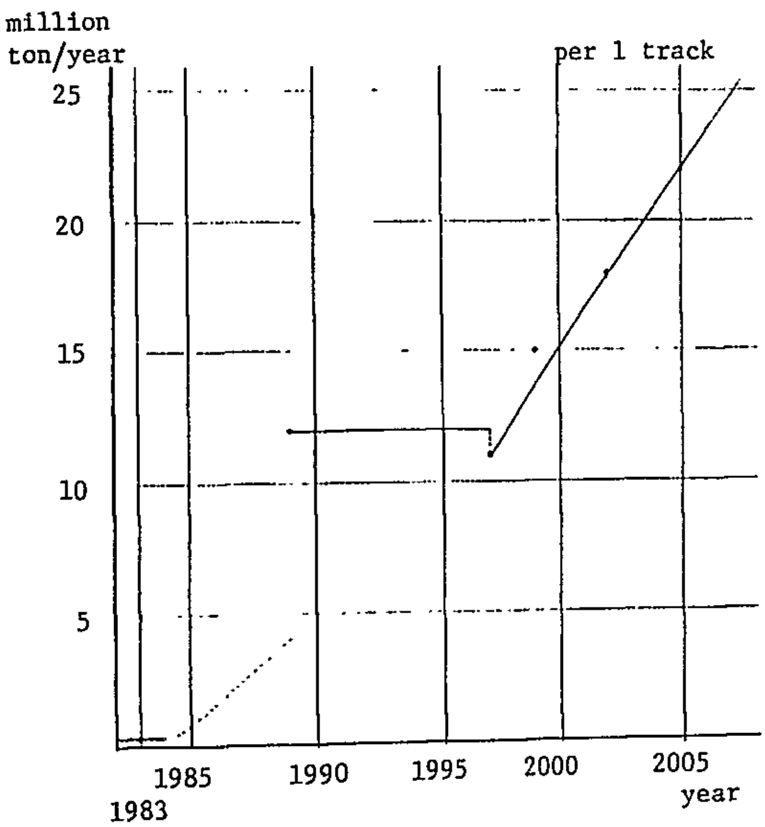


Fig. 5.18 Estimated Passing Tonnage

(7) Stations

The improvement of the stations in this stage will be carried out so that commuter trains can operate more frequently than 15 minute headways on double track.

The rough drawings of track layout of the Tangerang Line are shown in Fig. 5.16.

(a) Duri station

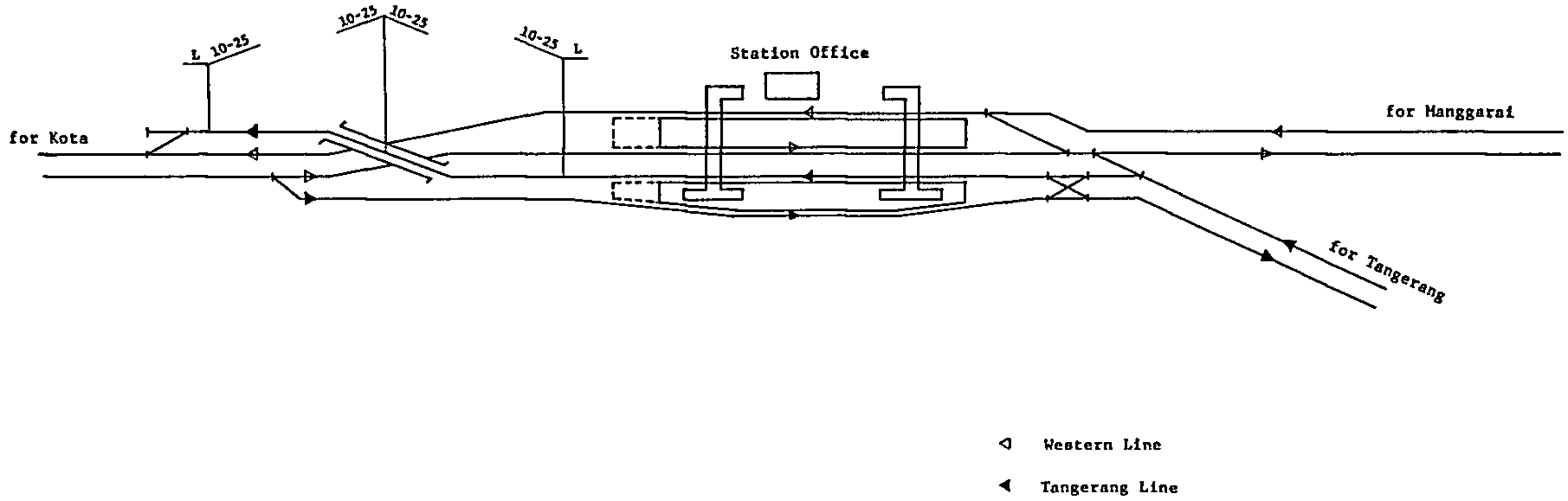
At Duri Station, 2 tracks are prepared for the Tangerang Line in the 2nd stage. Basically the plan of this station does not differ from the 2nd stage. It is also planned that passengers connecting to the Western Line shall change trains here. In this stage removal of the illegal housing in the west of the station and platform expansion will be carried out. (Refer to 5.4.4 (3)(a).)

In the future, the traffic demand for the Tangerang Line will increase, and transport capacity of the Western Line and handling capacity of changing passengers at Duri Station will become inadequate. The Western Line development project to cope with this problem, such as a grade separated crossing for the both lines, a quadrupling of the Western Line and an expantion of Duri Station, should be carried out. However, this study is not included in this project. It requires the detail traffic demand forecast, and its timely execution is desirable. Allowances for a grade separated crossing and a quadrupling are taken into consideration in the improvement plans for Duri Station. Schematic plan of direct access by a grade separated crossing is shown in Fig. 5.19.

(b) Other station

At the intermediate stations only 2 main tracks without turnouts are installed except at Rawabuaya Station, where a siding is installed for emergency use.

Schematic Plan



5.19 Schematic Plan of Direct Access to Western Line

(c) Night storage

6 night storage tracks will be prepared with 1 and 2 of the main tracks at Duri and Tangerang stations and 3 storage tracks at Tangerang Station.

(d) Platform and platform roof

The length of platforms is planned to be 190 m for an 8 car train.

The height of the platforms is planned to be 0.95 m, and an early decision on raising the height is desirable.

Half of the platform length should be roofed.

(e) Passenger footbridge

In this stage at all passenger stations footbridges will be installed.

(f) Station main building

Station main buildings are planned according to the number of passengers and the purpose of the stations. For the plan smooth flow of passengers is a paramount factor in the design.

(g) Station plaza

The station plaza is necessary for the intermodal transfer to transportation by road. Its area is planned according to the number of passengers and the mode and the terminal arrangement of the access. For the access transportation facilities bus, minibus, microlet, taxi, bajaj, etc. are to be provided.

(8) Electrification

The electrification work for the additional track will be carried out with the same system as the existing track.

The 3,000 kW capacity for the substations is considered sufficient in the initial period of the double track operation.

When the headways with 8 car trains become 8 minutes, one more set of 3,000 kW facilities will be installed at each substation for both increasing demand and spare for the high density train operation.

There will still be one circuit for the high voltage distribution line for the signals but it was judged from the section environment conditions that one circuit could maintain the intensity of protective devices as a stable power source.

(9) Signalling

For the initial period of this stage the signalling system for 5 minute headways on the double track is planned. For future the system is planned to be improved for 3 minute headways.

All the automatic block sections with track circuits will be sectionalized to meet high-speed and high-density train operation on the double track. This is to be controlled as automatic block signals (home, starting, and intermediate) by the train.

The outline of the signalling system is shown in Fig. 5.20 and Fig. 5.21.

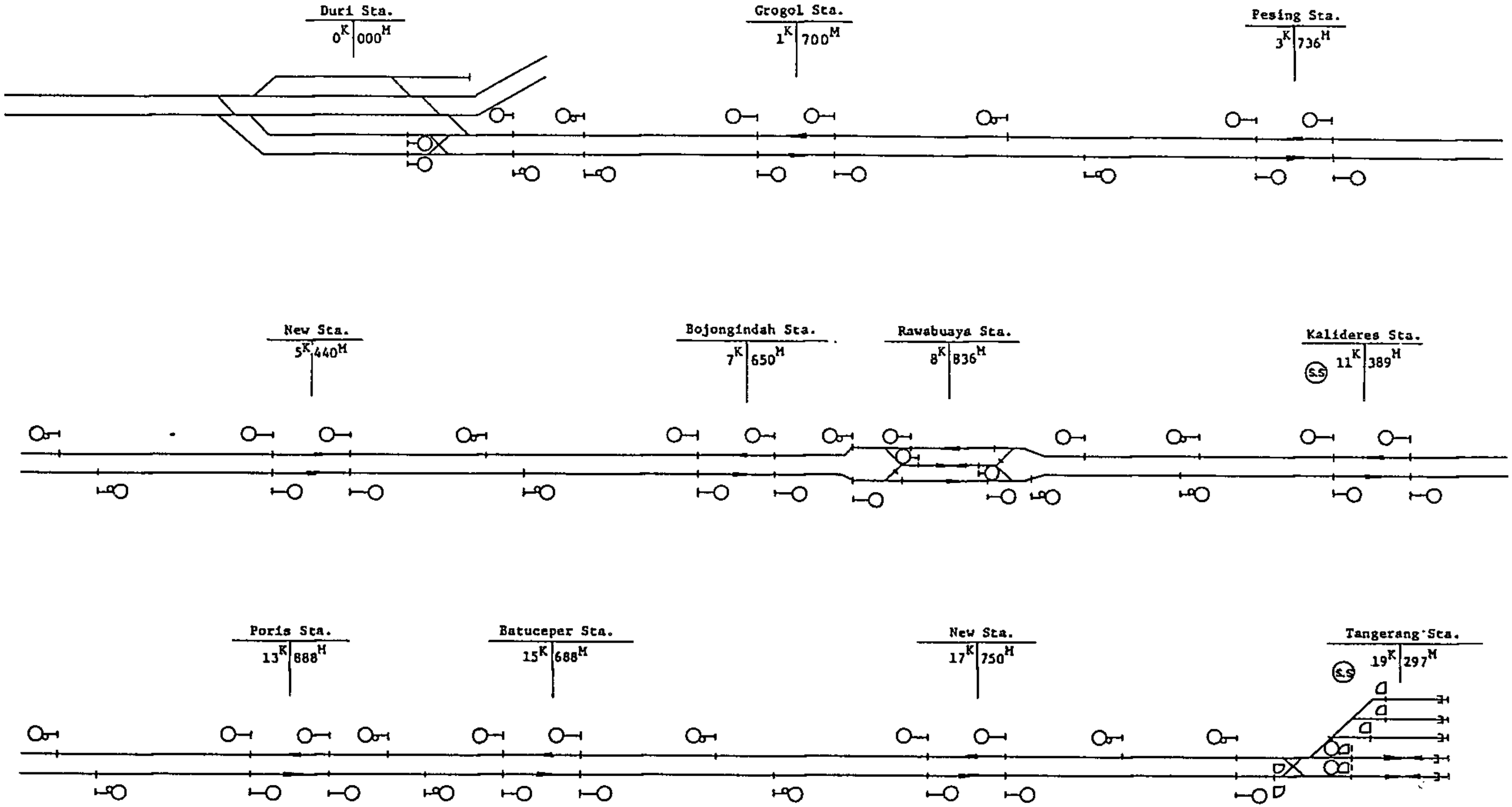


Fig. 5.20 Configuration of Signalling System (5 Minute Headways)

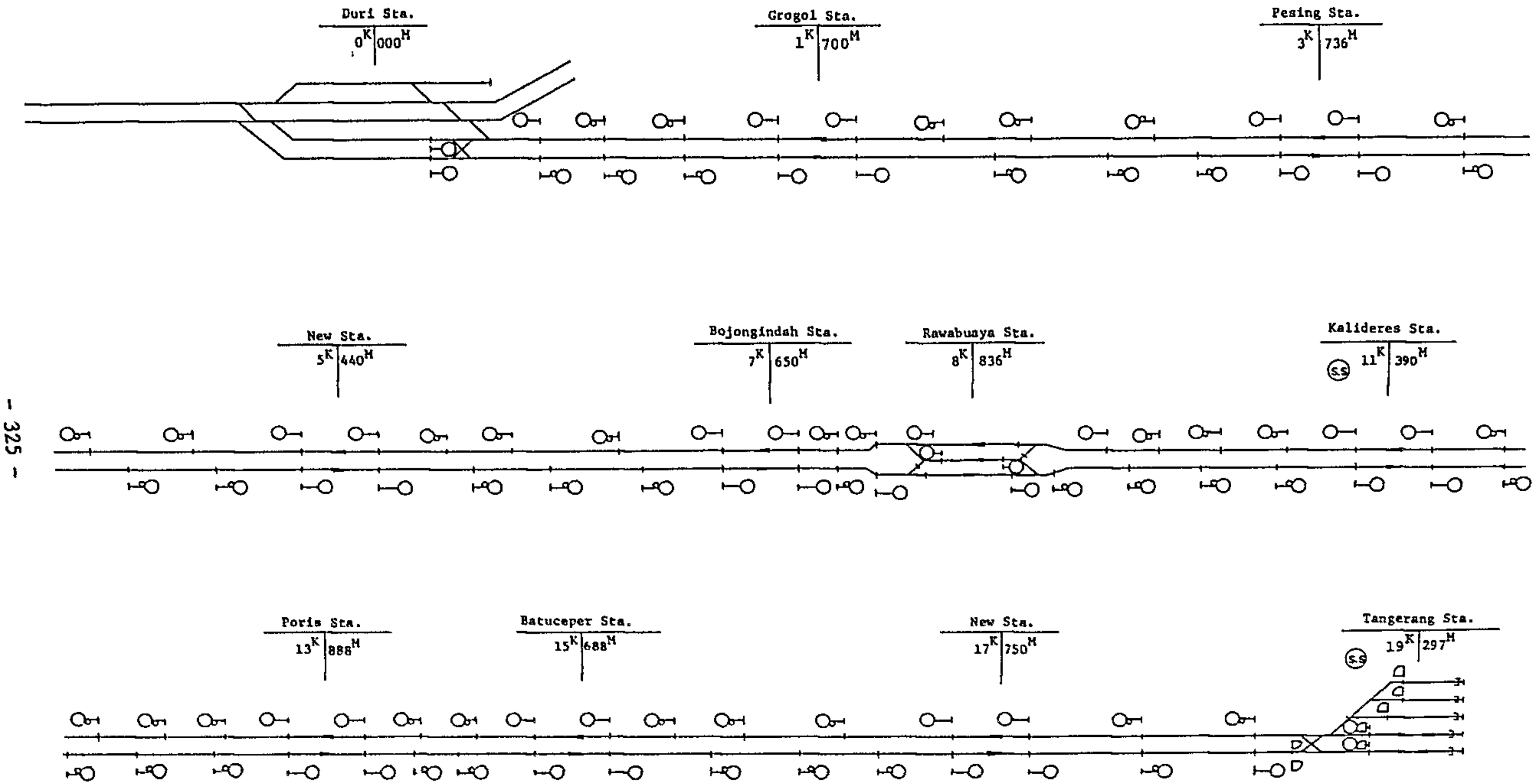


Fig. 5.21 Configuration of Signalling System (3 Minute Headways)

5.5 GRADE SEPARATED CROSSING WITH ROAD

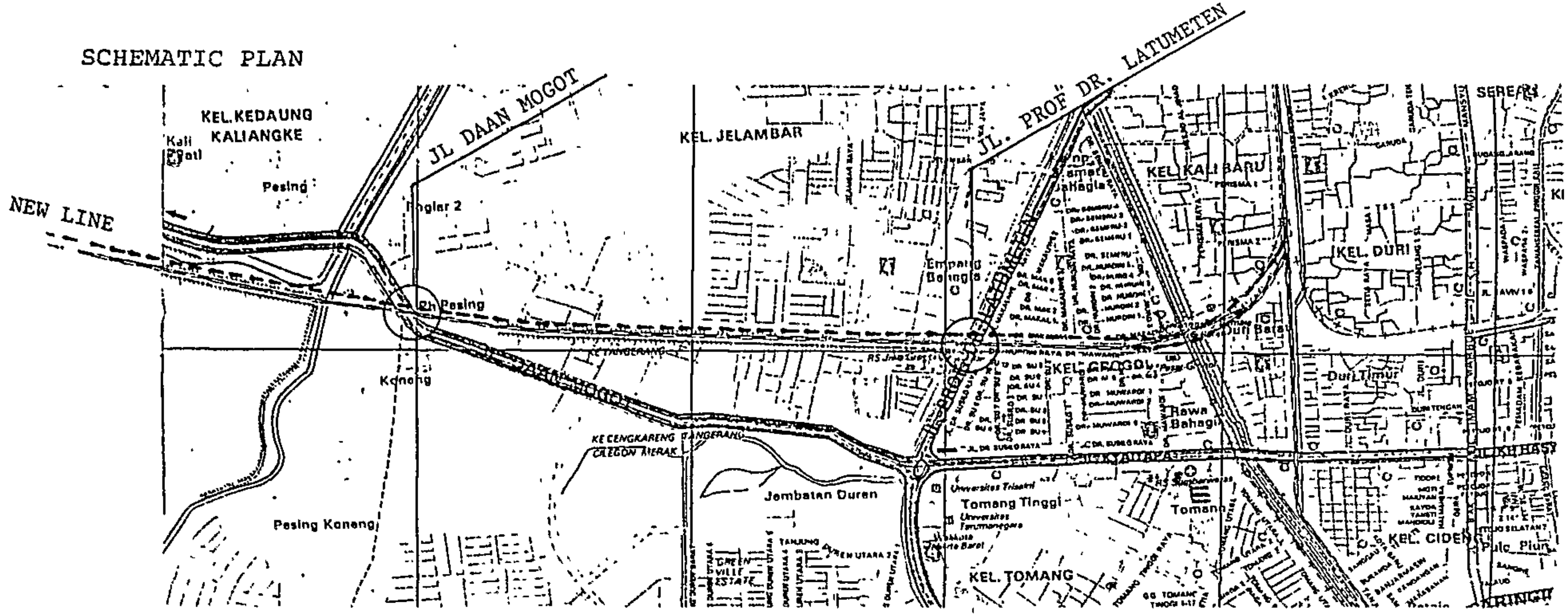
The crossings with Jl. Prof. Dr. Latumeten and Jl. Daan Mogot have especially large traffic volumes, and grade separated crossings will therefore have to be constructed. On both crossings flyovers of roads are suitable because of the locations and the future plans for the roads. (Refer to Fig.5.22.)

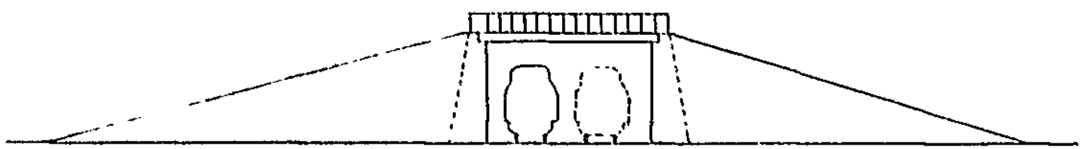
5.6 SCHEDULE OF THE PROJECT

The schedule for the execution of the project is as shown in Fig. 5.23. Judging from the demand forecast, the execution of the 2nd stage should be carried out as early as possible.

Expecting the positive impact to be an early improvement of the housing situation in the JABOTABEK Area by active development along the line, the track doubling all the line is planned to be carried out at once. Since it is commuter service in a radial direction, however, the traffic demand will be greater and will exceed earlier the carrying capacity for 15 minute headways with 8 car trains on Duri side than on Tangerang side. Accordingly, in the actual execution, track doubling step by step in order from Duri side could be considered based on financing conditions. In this case providing increased train service in the doubled section will be possible. The crossing stations are located based on a 15 minute headway pattern net diagram, so there is no bottleneck section. Also step by step in order from Duri side track doubling should be carried out. Track doubling earlier in a intermediate section will be meaningless because of not matching to the traffic demand and no reduction of travelling time.

SCHEMATIC PLAN





EXISTING-CONDITIONS OF ROAD TRANSPORT

JL DAAN MOGOT

	1995 YEAR	2005 YEAR
A PASSENGER CAR (A CONVERSION TABLE)	78,000 CARS	212,000 CARS

JL. PROF DR. LATUMETEN

	1995 YEAR	2005 YEAR
A PASSENGER CAR (A CONVERSION TABLE)	515,000 CARS	754,000 CARS

Fig. 5.22 Grade Separated Crossing with Road

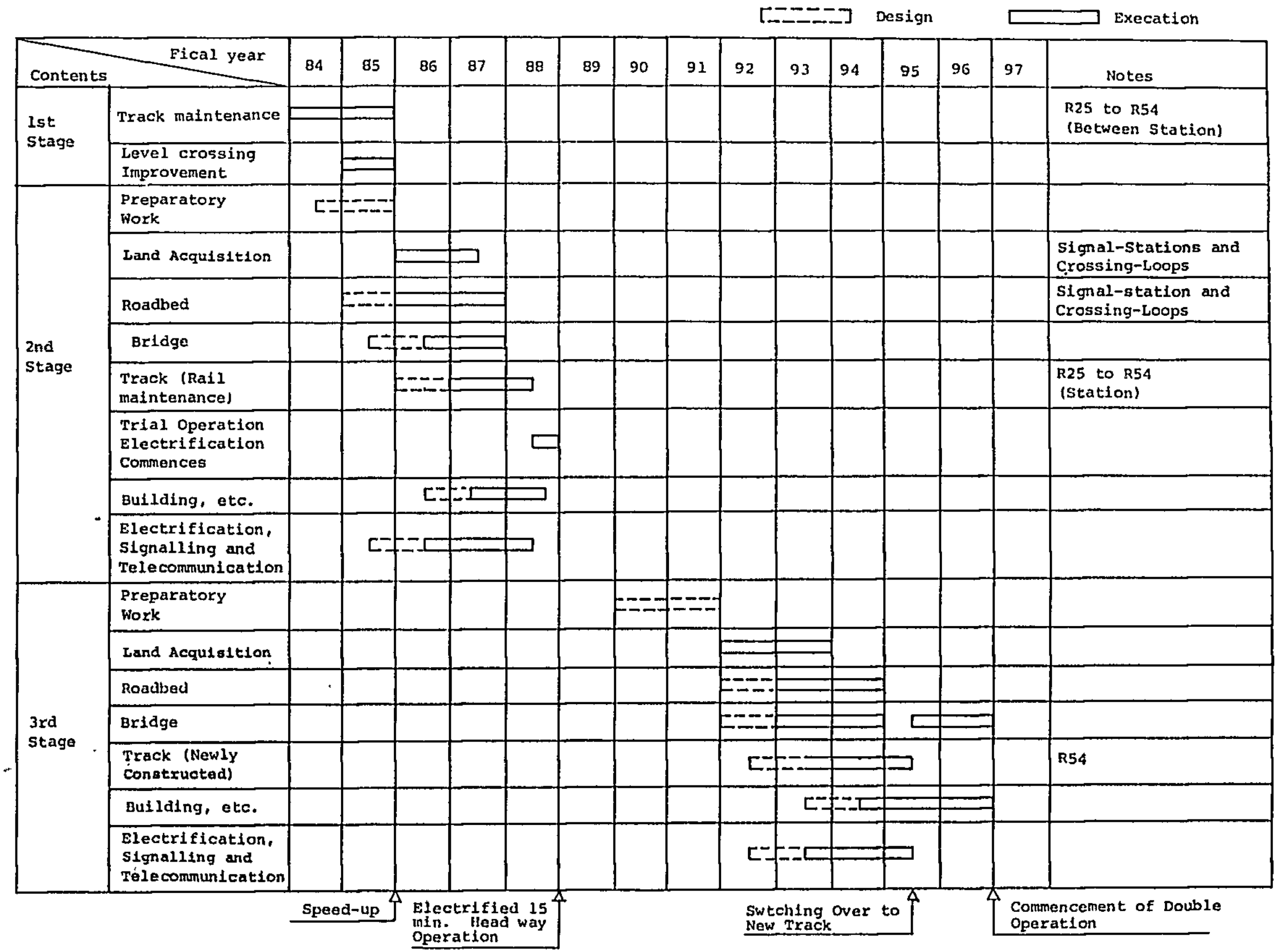


Fig. 5.23 Schedule of the Project

5.7 SQUATTER SURVEY AND STUDY FOR COMPENSATION

It is necessary to remove squatters who live along the Tangerang Line to allow for track addition.

A home interview survey of squatters was carried out in order to get the basic data to decide an appropriate method of compensation and to estimate the compensation cost. The squatter area is divided into three sections, Duri - Grogol, Grogol - Pesing and Tanahtingi - Tangerang. 42 families from each of the first two sections and 21 families from last section were sampled, totalling 105 families. Sampling was undertaken amongst the squatters who live in the side to be widened. Survey date was the 23th September 1983.

(1) The results of the survey

Summary of the survey results along the Tangerang Line is as follows:

Number of a family member is average 6.5 persons. Religion is Islam 88%, Christianity 8%, Hinduism 3% and other 1%. Original place of the family head is: from Java outside DKI Jakarta 62%, DKI Jakarta 22%, and outside Java 16%. Length of stay at present place is average 12.2 years.

Average land area of one house is 56 m^2. 61% have no fence, wooden fence is 15%, brick fence is 14% and others 11%. 67% are without trees, 6% have fruit trees, 17% have flowering tree, and other 9%.

The status of the house is: permanent 33%, semi-permanent 41% and temporary 26%. Average floor area is 48.2 m^2 (7.4 m^2 per capita). 22% have one bedroom, 40% have two bedrooms, 18% have 3 bedrooms and 20% have more than 3 bedrooms. Average age of a house is 11.6 years.

Potable water is obtained from; well 56%, vendor 25%, pipe 17% and river water 2%. For lighting, 32% use oil lamp, 66% use electricity, 2% is hibrid of oil lamp and electricity. The fuel for cooking is; 90% use kerosene, 7% use gas and other 3%. Sewerage disposal is; 20% flow to river, 42% use drainage, 29% use septic tank and others is 9%.

Income of one family per month averages 91,061 Rp, expenditure is 76,990 Rp and saving is 14,071 Rp. Monthly income per capita is 14,009 Rp, monthly expenditure per capita is 11,845 Rp and monthly saving per capita is 2,164 Rp.

The employment of family head is, Sector III 94%, and Sector II 6%. The means of commuting is as follows: walking 44%, motorcycle 25%, bus 16%, bicycle 6%, other 9%. The time for commuting averages 21 minutes and costs an average 4,851 Rp per month.

48% of the families have their job in their house. 46% is Sector III and 2% is Sector II. Space for the job is average 9.5 m^2 and they earn average 58,826 Rp per month by the job.

Average distance to primary school is 21 minutes on foot. Average distance for shopping is 16 minutes on foot. The degree of satisfaction to community is: mean 60%, satisfied 33% and not satisfied is only 7%.

When they are forced to move, 43% have alternative places to live but 57% have no expected place, they estimate the present value of their own house to average 64,216Rp per m^2.

(2) Study for compensation

(a) House compensation

Even though they are squatters, compensation for at least their housing is necessary.

The construction cost of new house and assumed depreciation period is as shown in Table 5.8.

Floor area of one house averages 48 m^2. Average age of the house is 11 years. Fence and tree are almost negligible for compensation. As the ratio of housing level is permanent 30%, semi-permanent 40%, and temporary 30%:

- Permanent 190,000 × 1/2 = 90,000 Rp/m^2
- Semi-permanent 130,000 × 1/3 = 40,000 Rp/m^2
- Temporary 80,000 × 1/4 = 20,000 Rp/m^2

Average: 90 × 0.3 + 40 × 0.4 + 20 × 0.3 = 49,000 Rp/m^2

Average 49,000 Rp per m^2 compensation (including equipment)

Average compensation per one house
48 m^2 × 49,000 = 2,350,000 Rp

Table 5.8 Construction Cost and Depreciation Period of House

(1)	Construction cost of new house (1983 price)	
	Permanent housing	190,000 Rp/m^2 ± α
	Semi-Permanent housing	130,000 Rp/m^2 ± α
	Temporary housing	75,000 to 90,000 Rp/m^2
	Source : DKI AGRARIA	
(2)	Depreciation period (assumption)	
	Permanent	20 years
	Semi-Permanent	15 years
	Temporary	13 years

(b) Job compensation

People who work in their house lose their income immediately when they move. Therefore, compensation for their job at least for one month will be necessary.

The rate of family who have job in their house is 46%. Average space is 10 m^2 and average income is 59,000 Rp/month. Therefore, compensation is 6,000 Rp per m^2.

(c) Land aquisition cost

For acquiring land outside PJKA Land, land price along Tangerang Line is as shown in Table 5.9.

Table 5.9 Land Price along Tanglrang line (1983)

	Station	(1983 price) Agricultural land (Rp/m^2)	Residential land (Rp/m^2)
DKI Jakarta	Duri	--	45,000 to 50,000
	Grogol	--	60,000 to 76,000
	Pesing	--	12,000 to 18,000
	Bojongindah	--	15,000 to 25,000
	Rawabuaya	--	15,000 to 25,000
Tangerang	Kalideres	2,000 to 4,000	3,000 to 15,000
	Poris	2,000 to 4,000	3,000 to 15,000
	Batuceper	2,000 to 4,000	3,000 to 15,000
	Tangerang	2,000 to 6,000	4,000 to 25,000

Source: DKI AGRARIA
Tangerang AGRARIA