6 DETAILED DESIGN AND DRAWINGS

6. DETAILED DESIGN AND DRAWINGS

6–1 Right-of-Way

As it is expected to take a long time to acquire the right-of-way, it would be difficult to acquire it in two steps, or acquiring land for a single track at this time and acquiring more when the time comes to double track. Therefore, right-of-way for double track will be acquired at once under this project. The extra space will be used as service road during construction and as service road for maintenance after single track operations are started.

6–1–1 Demarkation of Right-of-Way Boundary

Boundary of right-of-way required for acquisition was determined as follows:

(1) Boundary of embankment sections was determined as the outer side of the small banks located at the foot of the embankment slope.

(2) Boundary of right-of-way along roads, rivers and ditches was determined at the foot of the embankment slope.

(3) Boundary of elevated sections was determined at a distance of 0.5 m from the outer edge of electric pole foundations or stock yard signal equipment.

(4) Boundary of right-of-way at stations, signal stations and substations will be determined separately on the basis of design drawings.

(5) Boundary of right-of-way within the airport area will be in accordance with ones already determined by the airport authority.

6–1–2 Ground Obstacles and Underground Objects

Ground obstacles in right-of-way were determined on the basis of topography maps and verified by field survey and related information. Major obstacles other than buildings are as presented in Table 6–1–1. On the other hand, information on underground objects could not be collected.

Table 6-1-1 List of Ground Obstacles

Type	Location	Quantity	Remarks
High-voltage transmission steel towers	10 km 680 m	4 units	New construction; Discussed and approved by PLN
High-voltage transmission steel towers	14 km 700 m – 18 km 300 m	8 units	New construction and relocation; Discussed and approved by PLN
High-voltage power lines	around 8 km 840 m	3	
Telephone cables	around 8 km 840 m	8	
High-voltage power lines	11 km 500 m	3	
Telephone cables	11 km 500 m	18	
Telephone lines	13 km 180 m	5	
Telephone lines	13 km 263 m	5	
High-voltage power lines	13 km 355 m	3	
Telephone lines	13 km 653 m	5	
Electric light lines	13 km 680 m	4	
High-voltage power lines	13 km 653 m – 13 km 680 m	3	Buried under roads
Electric light lines	13 km 938 m	4	
Electric light lines	14 km 048 m	4	
Telephone lines	14 km 056 m	3	
Electric light lines	14 km 108 m	4	
Electric light lines	14 km 160 m	4	
Electric light lines	14 km 212 m	4	
Electric light lines	14 km 219 m	4	
Electric light lines	14 km 260 m	4	
Electric light lines	14 km 268 m	4	
Electric light lines	14 km 286 m	4	
Electric light lines	14 km 823 m	4	

Type	Location	Quantity	Remarks
Telephone lines	15 km 590 m	6	
Telephone lines	15 km 626 m	2	
Electric light lines	15 km 626 m	4	
Electric light lines	15 km 855 m	4	
Electric light lines	16 km 015 m	4	
Electric light lines	16 km 100 m	4	
Electric light lines	16 km 120 m	4	
Electric light lines	16 km 140 m	4	
Electric light lines	16 km 160 m	4	
Electric light lines	16 km 183 m	4	
Electric light lines	16 km 343 m	4	
Electric light lines	16 km 370 m	4	
Electric light lines	16 km 400 m	4	
Electric light lines	16 km 513 m	4	
Electric light lines	16 km 536 m	4	
Electric light lines	16 km 645 m	4	
Electric light lines	16 km 775 m	4	
Electric light lines	16 km 870 m	4	
Electric light lines	17 km 060 m	4	
Electric light lines	17 km 086 m	4	
Telephone lines	17 km 150 m	8	Parallel to main line
National Railway communica-tion lines	17 km 365 m	12	Parallel to main line
Telephone lines	17 km 365 m	17	Parallel to main line
Electric light lines	17 km 365 m	8	Parallel to main line
Electric light lines	17 km 510 m	4	
Electric light lines	17 km 770 m	4	

Type	Location	Quantity	Remarks
Electric light lines	17 km 780 m	4	
Telephone lines	17 km 800 m	10	Parallel to main line
Telephone lines	18 km 000 m	10	Parallel to main line
National Railway communication lines	18 km 821 m	2	
National Railway communication lines	18 km 843 m	26	
Electric light lines	18 km 865 m	4	

6–2 Route

Route A selected by the Government of Indonesia on the basis of the Feasibility Study, was plotted on topographic maps of scale 1/1000 and 1/500.

After making the map route selection, field surveys were conducted to investigate the following points;

- Public facilities such as schools and temples
- Angle of intersection with major rivers and roads
- Horizontal and vertical intersection with steel towers for high-voltage transmission
- Buildings considered to be difficult to relocate
- Points of separation from the Western Line and the Central Line

Reflecting the survey results, the general route was revised, for which a centerline survey was carried out. After completion of the survey, the route was reconfirmed.

6–2–1 Horizontal Alignment of Route

As maximum speed of the Airport Line is designed at 100 km/h, curves of more than 1,000 m radius were established not to overstep the speed limit, except for curves of 500 m radius at point 18 km 000 m where the route comes close to the Western Line and in the section where it crosses the tracks of Kota Depot.

The route was selected with double-tracking in the future in mind, the additional track to be constructed on the north side.

(1) Route General Description of Areas through which the Route Passes

The Airport Line starts from the point 193.51 m from the rotary in the airport, and passes the first level crossing, Kali Rawa Bokoy and the second level crossing before going out of the airport area.

After leaving the airport area the route crosses the airport access road. Discussions were held with BINA MARGA regarding this crossing, and it was decided that the access road would be relocated and the railroad cross over the road. After this crossing, the route passes through a farm area in a southeasterly direction to pass through or run close to a coastal bank with good soil condition. It then passes under a high-voltage transmission line at point 10 km 675 m, to arrive at point 11 km 019 m in Kali Baru which is now under construction.

Between 11 km 650 m – 12 km 550 m, the route passes through an industrial zone which contains factories such as for light electrical appliances.

The route further extends in a northeasterly direction to reach a point 12 km 750 m, which is an embankment section and situated at the lowest level of the route.

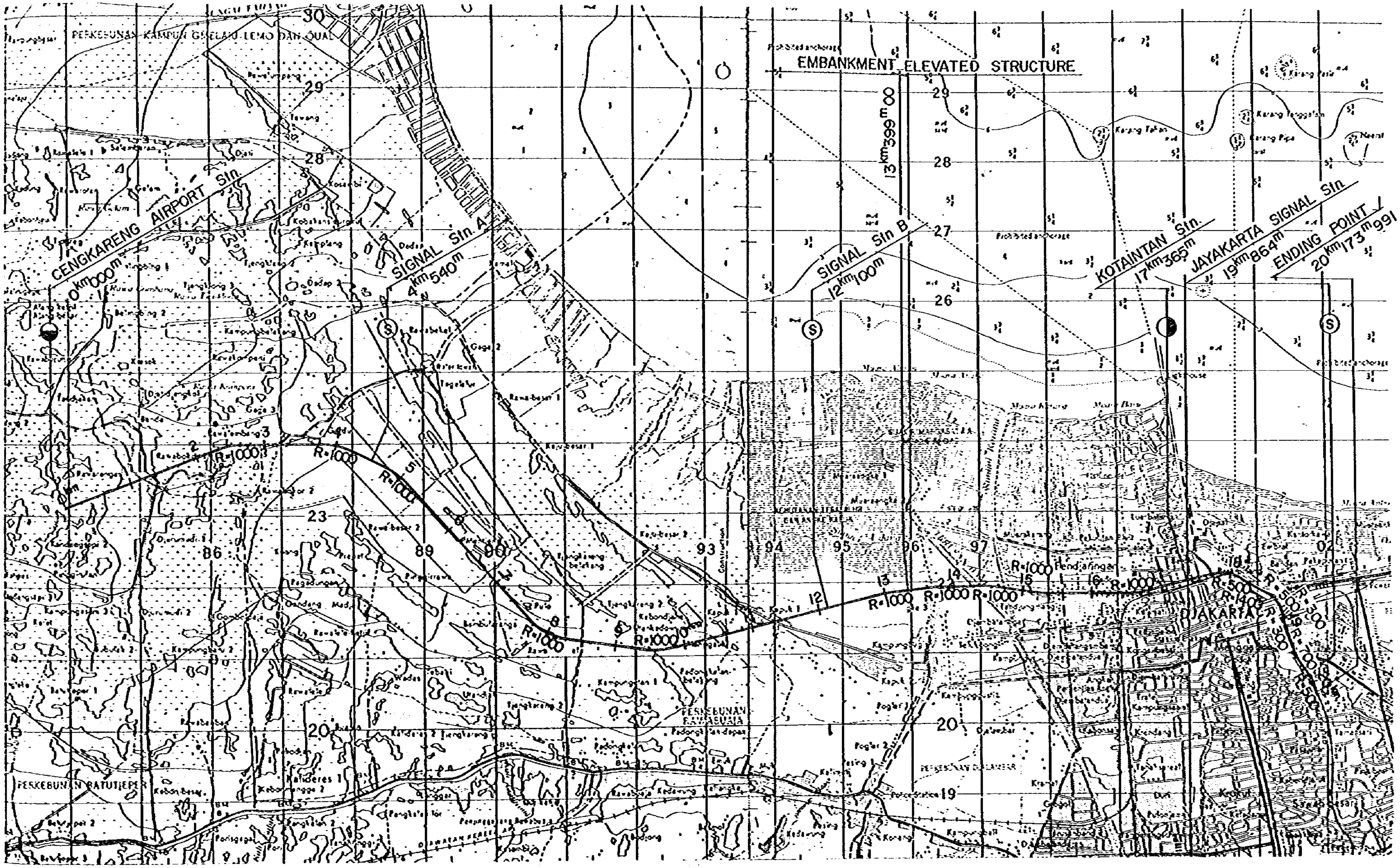


Fig. 6-2-1 Railway Plan

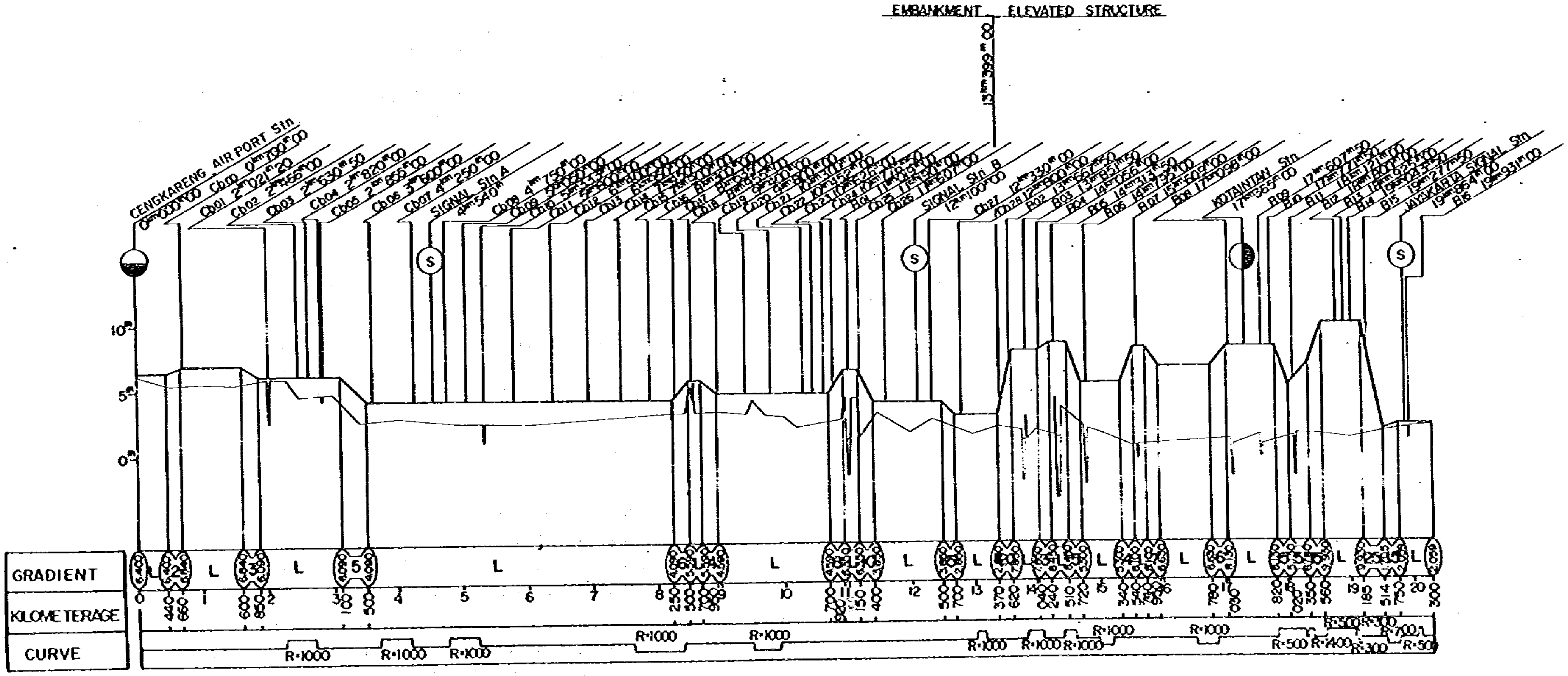


Fig. 6–2–2 Railway Profile

The embankment section extends to a point 13 km 400 m after which the route is elevated. After passing through a new housing area between 13 km 100 m – 13 km 400 m, the route enters urban area, detouring around schools and temples at 14 km 050 m point and crossing under a high-voltage transmission line at 15 km 100 m point, to reach Jl. Jembatan Tiga.

The route comes close to the Western Line near Karianke, urban area of Jakarta, and runs parallel to and between the proposed Harbor Road and the Western Line, and then moves away from the road around Lodan bridge in a southerly direction. After crossing the Western Line, Jakarta Gudang Freight Yard and Kota Depot, the route merges with the Central Line at Jayakarta Station which will be elevated.

For the section where the Airport Line runs parallel to the existing line, space between track centers was determined with consideration to working space so as not to disturb the existing line; for the section between 16 km 900 m – 17 km 800 m along the Western Line, the spacing was set at 12 m on account of newly constructed Kota Intan Station;

7 m at around point 18 km 500 m; 12 m at around point 19 km 400 m where the Airport Line and the Central Line because both lines become continuous elevated structures beyond this point. In addition, in consideration of the possible delay in elevating the Central Line, a temporary route was designed to return to ground level after crossing over Kota Depot and then to join the existing Central Line.

(2) Intermediate Stations

In order to maintain high speed as feature of airport access railway, only one intermediate station, Kota Intan Station (17 km 365 m), will be provided. For single track operation, two signal stations, at 4 km 540 m and 12 km 100 m, will be provided as intermediate passing loop.

6–2–2 Vertical Alignment of Route

On determining the vertical alignment of the route, an attempt was made to reduce the construction cost by designing the structure of minimum height, avoiding long spans for bridges, and by employing embankment as much as possible. Low embankment was used in the section between the starting point and a point 13 km 400 m, and level crossings at an intersection with roads.

In the urban area between 13 km 400 m point and the terminal, the roadway will be of elevated structure, with grade separation where crossing roads and existing railroad lines. As the embankment sections are located in frequent flood area, formation level in principle, was set higher than the maximum flood height. To determine the formation level, interviews with local residents were made to find out the flood level as there were no records obtainable on flood damage. The result is presented in Table 6–2–1. Accordingly, the formation level of embankment was determined at each flood level plus 0.7 m.

On the other hand, a formation level at river crossing sections was determined at H.W.L. of rivers, 1.0 m clearance to the soffit plus height of beams.

Table 6–2–1 Survey Result on Flood Level

Location	Ground Level	Flooded Depth	Flood Level	Remarks
Around 3km 400m	2m 66	1m 00	3m 66	
Around 3km 950m	2m 73	0m 70	3m 43	
Around 5km 330m	2m 87	0m 40	3m 27	
Around 6km 400m	2m 65	0m 45	3m 10	
Around 8km 050m	3m 23	0m 20	3m 43	
Around 9km 450m	3m 20	0m 30	3m 50	
Around 9km 650m	3m 32	0m 30	3m 62	
Around 10km 700m	2m 00	0	–	
Around 11km 500m	2m 45	0	–	
Around 12km 050m	1m 28	0m 90	2m 18	
Around 13km 200m	2m 26	0	–	

Note: Between 3km 400m – 9km 650m, flood level is around 3.5 m.
Between 11km 500m – 13km 200m, flood level is low at around 2.2 m on account of a new river by the Cengkareng Drainage System.

The formation level at road crossing sections is determined by adding road surface level, clearance to the soffit and height of beams; clearance below the soffit is 5.1 m for major roads, 4.5 m for general roads and 3.0 m for service roads for river maintenance. The formation level at crossings with the existing railroad lines is determined by adding the R.L. and clearance to the soffit, plus height of beams; clearance to the soffit is 5.0 m, taking into account additional clearance for electrical work to 4.6 m.

Vertical curves are avoided in transition curve sections for safety of train operations.

Planned formation levels at major points are as shown in Table 6–2–2. Elevations are indicated by P.P. (Priok Peil Low Low Water Level = P.P. 0 m) to show F.L..

Table 6–2–2 Planned Formation Level

Station (km m)	Name	Planned Width m	Structure and Span m	P.G., R.L. or H.W.L. m	Space beneath Beams m	Required Formation Level m	Planned Formation Level m
2 070	KALI RAWA BOKOR		10.2 x 2 (Cb)	River bed 2.34	3.0	6.09	6.09
3 950				H.W.L. 3.43	Allowable height 0.66		4.09
8 050				H.W.L. 3.43	Allowable height 0.66		4.09
11 019	KALI BARU	river bed 24.0	20+40+20 (Pc)	H.W.L. 2.78	1.0	6.28	6.35
13 075	Jl. KAPUK MUARA	18.0	25 x 1 (Pc)	1.80	4.5	7.80	7.85
13 890	Jl. 8	10.0	25 x 1 (Pc)	1.80	4.5	7.80	7.85
13 935	–	6.5	10 x 1 (Rc)	1.50	4.5	7.00	7.85
14 051	Jl. 2A	7.0	30 x 1 (Pc)	1.70	3.0	6.95	7.85
14 223	Jl. 2A	7.0	30 x 1 (Pc)	1.40	4.5	8.15	8.40
14 263	Jl. V1	8.0	30 x 1 (Pc)	1.70	4.5	8.45	8.45
14 287	Jl. 11	18.0	35 x 1 (Pc)	1.80	4.5	8.40	8.45
14 402	RIVERS ROADS	6.0	35 x 1 (Pc)	3.45	3.0	8.45	8.45
14 795	KALI MUARA KARANG	river bed 22.0	40 x 1 (Pc)	H.W.L. 1.795	1.0	5.29	5.30
15 609	Jl. JEMBATAN TIGA	55.0	30 x 2 (Pc)	1.0	5.1	8.00	8.10
16 016	–	5.0	Viaduct (Rc)	1.0	4.5	6.50	6.63
16 344	Jl. KERTA JAYA	7.0	Viaduct (Rc)	1.0	4.5	6.50	6.63
16 642	–	5.5	10 x 1 (Rc)	1.0	4.5	6.50	6.63
17 074	Jl. GEDONG PANTANG	46.0	25 x 2 (Pc)	1.4	5.1	8.00	8.13
17 217	Jl. SUMUT	6.5	10 x 1 (Rc)	1.5	5.1	7.90	8.13
17 504	Jl. EKOR KUNING	6.0	10 x 1 (Rc)	1.6	5.1	7.90	8.13
17 775	Jl. TONGKOL	18.0	25 x 1 (Pc)	1.4	5.1	8.00	8.13
18 677	WESTERN LINE	double tracks	Viaduct (Rc)	R.L. 2.35	5.0	8.55	9.93
18 825	GUDANG YARD	tracks	30 + 25 (Pc)	R.L. 1.65	5.0	9.10	9.93
18 853	Jl. RAYA KAMPUNG	24.0	30 x 1 (Pc)	1.90	5.1	9.25	9.93
19 028	WESTERN LINE & APPROACH TO CAR SHED	tracks	28 + 33 (Pc)	R.L. 1.95	5.0	9.20	9.93
19 091	EASTERN LINE & APPROACH TO CAR SHED	tracks	30 + 26 (Pc)	R.L. 2.64	5.0	9.89	9.93
19 235	Jl. MANGGA DUA	47.0	15 x 1 (Rc)	1.50	5.1	8.20	8.68
19 638	Jl. JAYAKARTA	33.0	25 x 2 (Pc)	2.40	5.1	9.20	9.29

6-3 Track Layout at Stations

6-3-1 Design Criteria for Track Layout at Stations

Based on the result of coordination with Indonesian side, design criteria for the track layout at stations will be as indicated in Table 6-3-1 in addition to those as stated in paragraph 5-2.

Table 6-3-1 Design Criteria for Track Layout at Stations

Item		Standard
Effective Track Length		210m (20.7m x 8 + 20m + 20m = 205.6m) Length of Train + Surplus Length for Exceeded Running + Signal Visibility
Passenger Platform	Platform Width	Cengkareng Airport Station 8.0m Kota Intan Station 6.0m
	Platform Length	8 cars 190m (20.7m x 8 + 20m = 185.6m) 4 cars 100m (20.7m x 4 + 10m = 92.8m) Length of Train + Surplus Length for Exceeded Running
	Platform Height	0.95m
	Distance between Platform Edge and Track Center	1.6m
Turnout	Main Track	12# (Simple Turnout and Curved Turnout to inner direction)
	Emergency Track	10 # (Simple Turnout)
	Safety Siding	10 # (Run-over Turnout)

6-3-2 Track Layout at Stations and Signal Stations

(1) Cengkareng Airport Station

Cengkareng Airport Station will be a terminal station and the starting point of the Cengkareng Airport Line. Layout of the station is shown in Fig. 6-3-1 and the details are shown in paragraph 6-8.

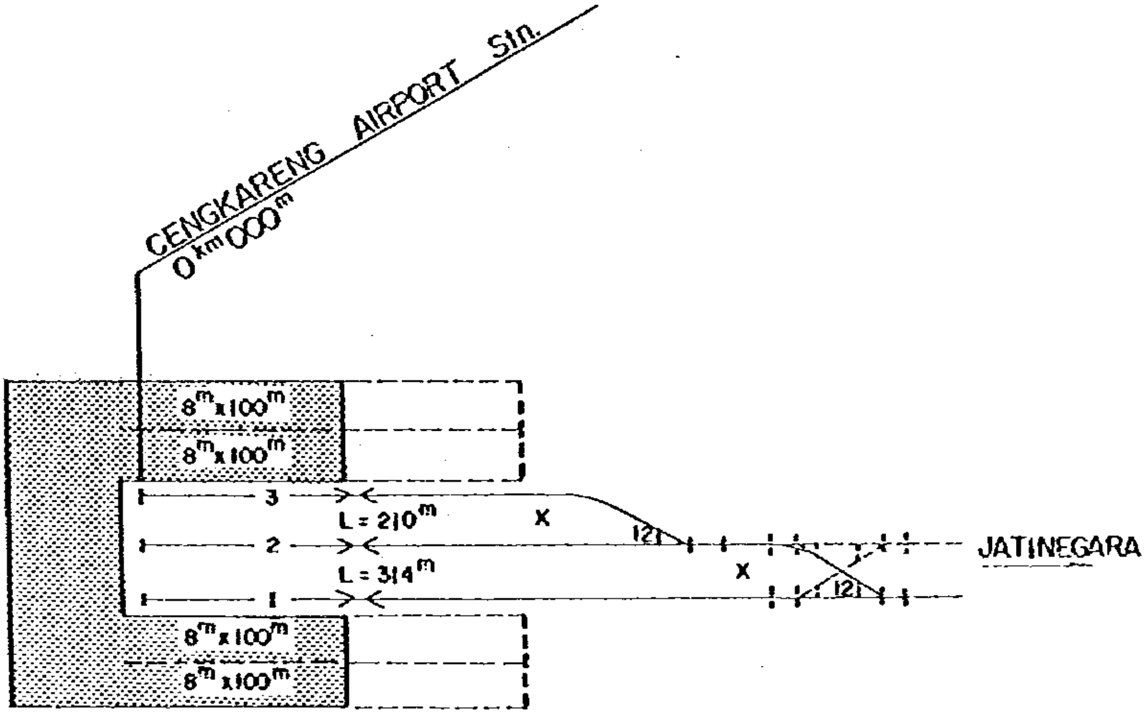


Fig. 6-3-1 Cengkareng Airport Station Schematic Layout

(2) Kota Intan Station

Kota Intan Station will be the junction connecting the Airport Line with the Western Line.

As there are no station facilities provided on the Western Line, a station will be newly provided for the convenience of the passengers transferring from/to the Airport Line. Track layouts will be straight lines as shown in Fig. 6-3-2, and a length of 210m has been reserved for a passing loop. However, as operation with 4 railcars has been planned for the time being (at initial stage) only 100m of the platform will be constructed at this time. Due consideration will be given to cope with the future 8-car operation.

As a harbour road has been planned to the north of the project area in parallel with the railway line, the center of track for the Airport Line has been laid 12.0m from the center of track of the adjoining Western Line so as to position the Airport Line as close as possible to the Western Line.

In addition, a station plaza will be provided at the south side of the Western Line station to be the main entrance and exit.

As the existing Western Line is on an embankment sector, connection with the elevated station of the Airport Line will be made through the concourse to be provided under the track of the Western Line.

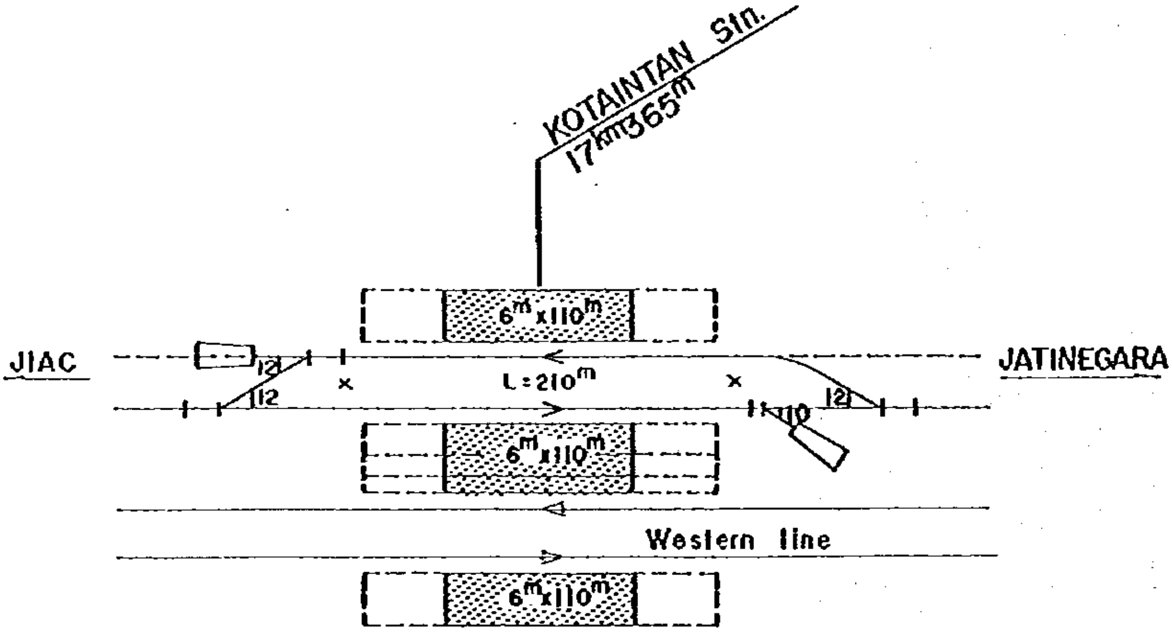


Fig. 6–3–2 Kota Intan Station Schematic Layout

(3) Jayakarta Station

Jayakarta Station will become the junction for the Airport Line and Central Line, and track layout of this station is closely related to the phase of the project for elevating the Central Line. In case the delay of the project is anticipated, the Airport Line, as a temporary measure, will pass the Kota Depot and descend to the ground level and connect to the existing Central Line.

In the latter case, Jayakarta Station will be a signal station not handling passenger services in order to facilitate the construction of the elevated platform as shown in Fig. 6–3–4, and to reduce the burden on the Central Line and to accommodate longitudinally 2–train formations.

Where the project to elevate the Central Line precedes or takes place simultaneously with the construction of the Cengkareng Railway Line, as shown in Fig. 6–3–5, the station will be an elevated structure similar to those in the double tracking phase in the future, and the north-bound line of the Airport Line will be used for the north-bound line of the Central Line while north-bound line of Central Line will be used for north-bound line for the Airport Line temporarily.

Track will consist of double track for the Airport Line and Central Line, (respectively)two island type platforms will be provided, and the platform lengths of 270m for the Central Line and 190m for the Airport Line have been secured.

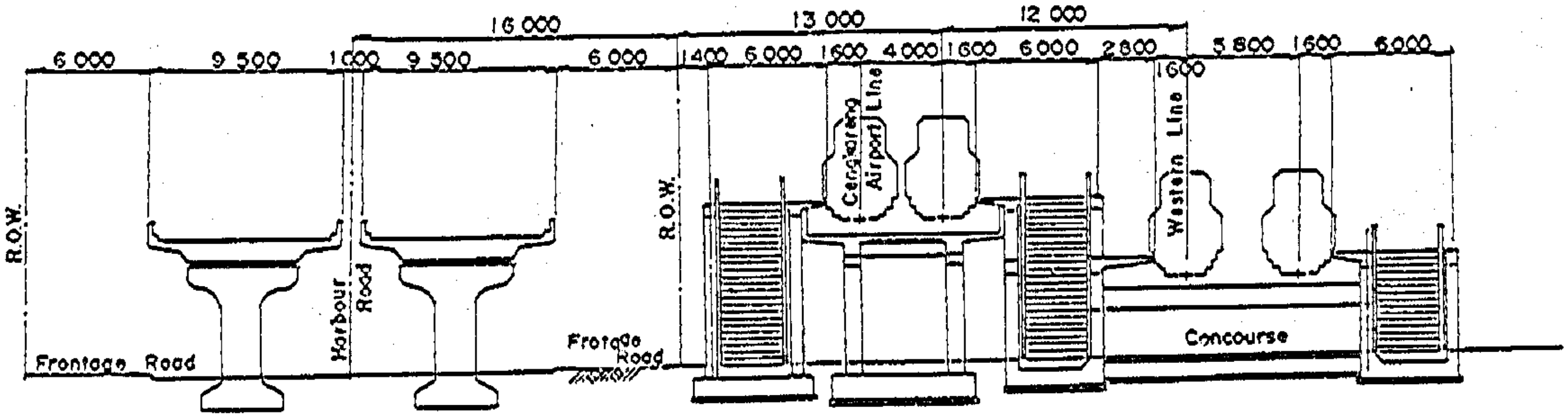


Fig. 6–3–3 Kota Intan Station Cross Section

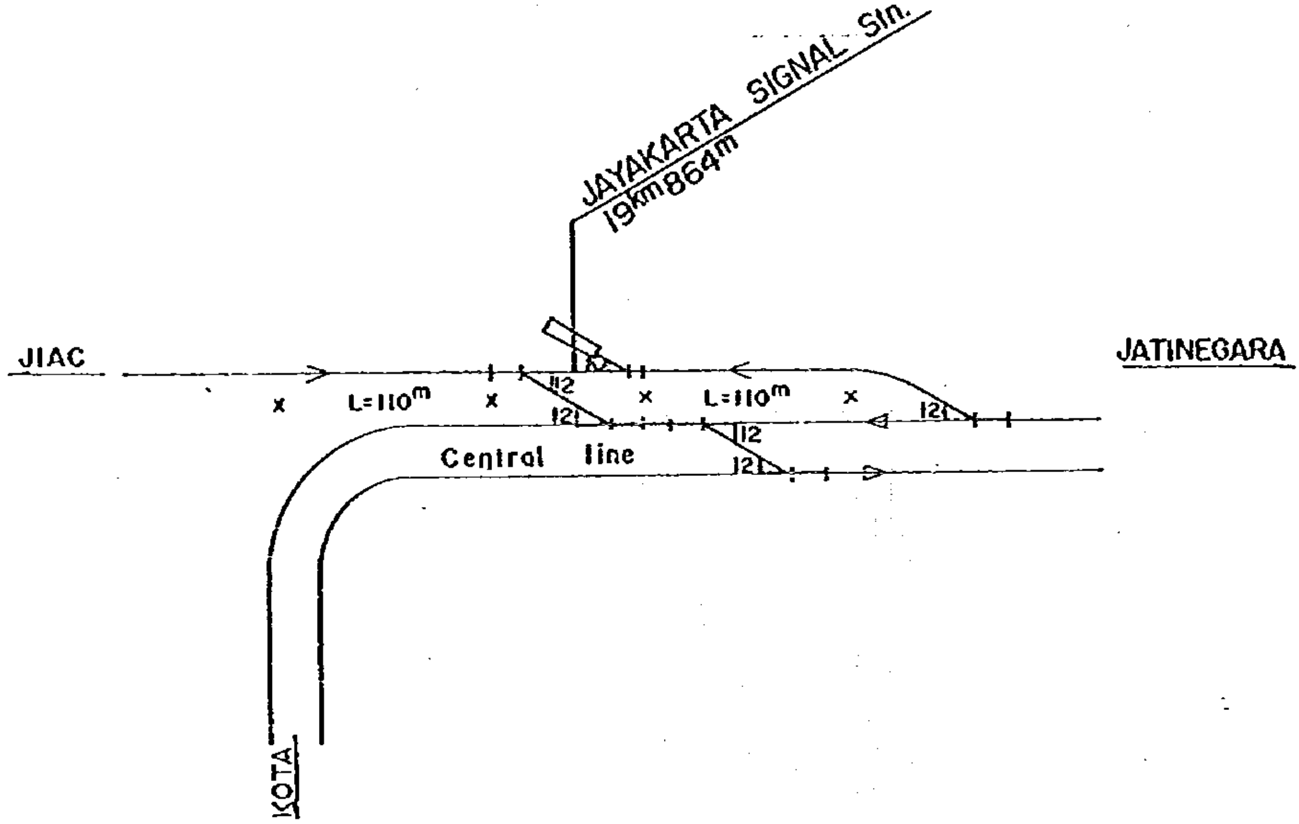


Fig. 6–3–4 Jayakarta Signal Station Schematic Layout (At Grade)

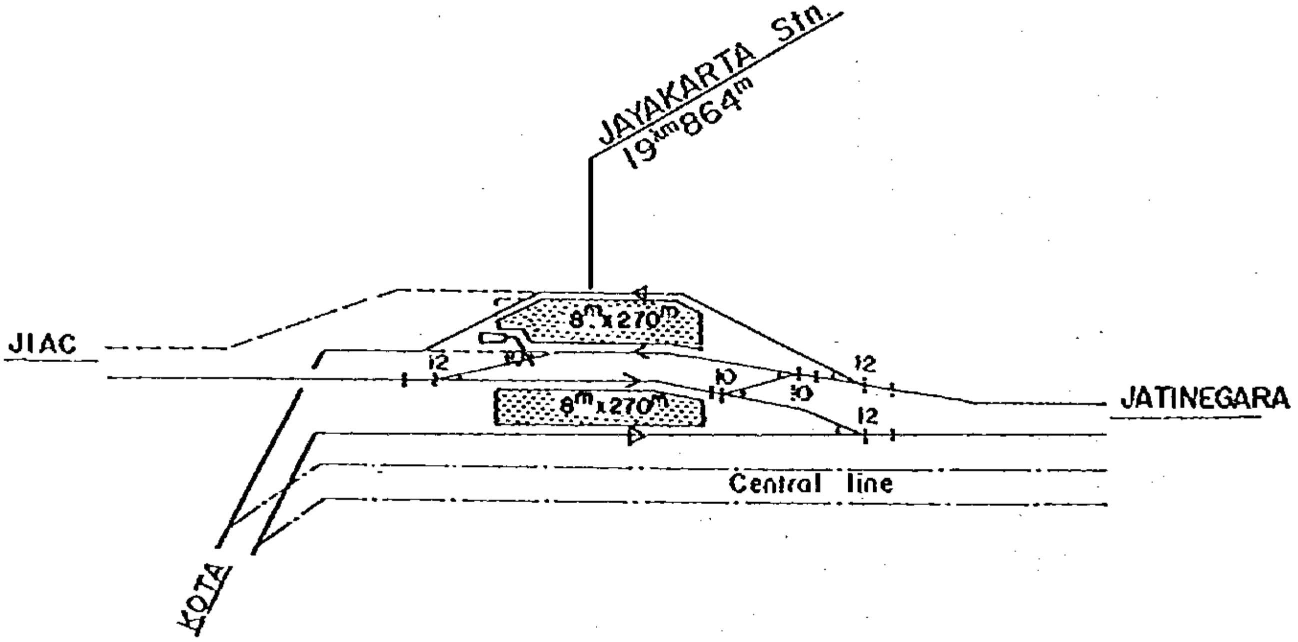


Fig. 6–3–5 Jayakarta Station Schematic Layout (Elevated Plan)

(4) Signal Stations

Since the distance between Cengkareng Airport and Kota Intan Station is approximately 17.4km, two (2) signal stations with the provision of a passing loop have been planned at locations 4km540m and 12km100m for trains going in opposite directions to pass.

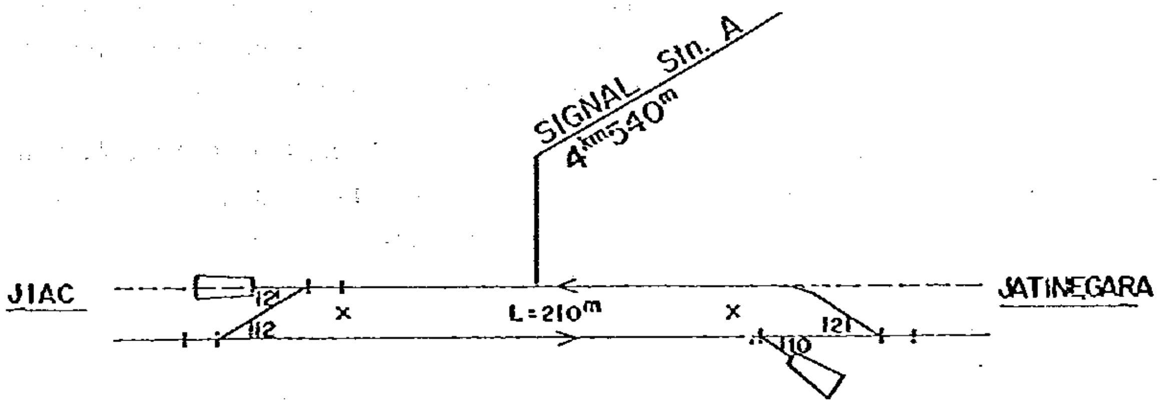


Fig. 6–3–6 Signal Station "A" Schematic Layout

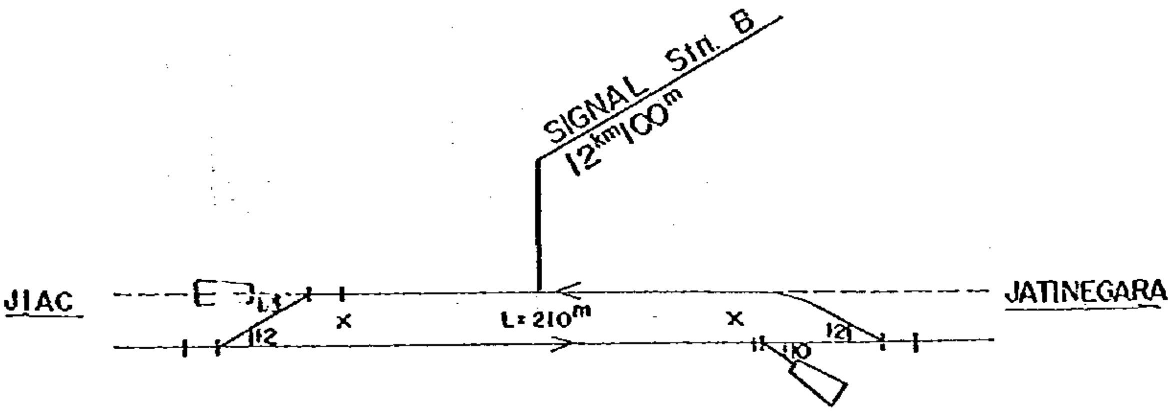


Fig. 6–3–7 Signal Station "B" Schematic Layout

As shown in Fig. 6–3–6 and 6–3–7, the track layout will consist of a through traffic track (east-bound)and a refuge track on the northern side where the future track addition is anticipated and the effective length of the track of 210m has been reserved.

In addition, where passenger handling may be required in the future as a result of the increase in traffic demand, consideration has been given for the provision of two (2) platforms (separate type, facing each other).

6–3–3 Rerouting Plan

(1) Western Line Over-pass and Gudang Freight Yard

The Western Line over-pass where the Airport Line will fly-over the existing Western Line at a slight slant will have to be either of rigid frame structure as shown in Fig. 6–3–8, and portal pier structure as shown in Fig. 6–3–9. As the portal pier structure profile will be approximately 3.4m higher than the rigid frame structure, the latter was therefore selected.

As construction under this plan cannot be executed on existing track, part of the Western Line will temporarily be shifted to the south side as shown in Fig. 6–3–10 and the intersection part will be constructed at the vacated area (open space).

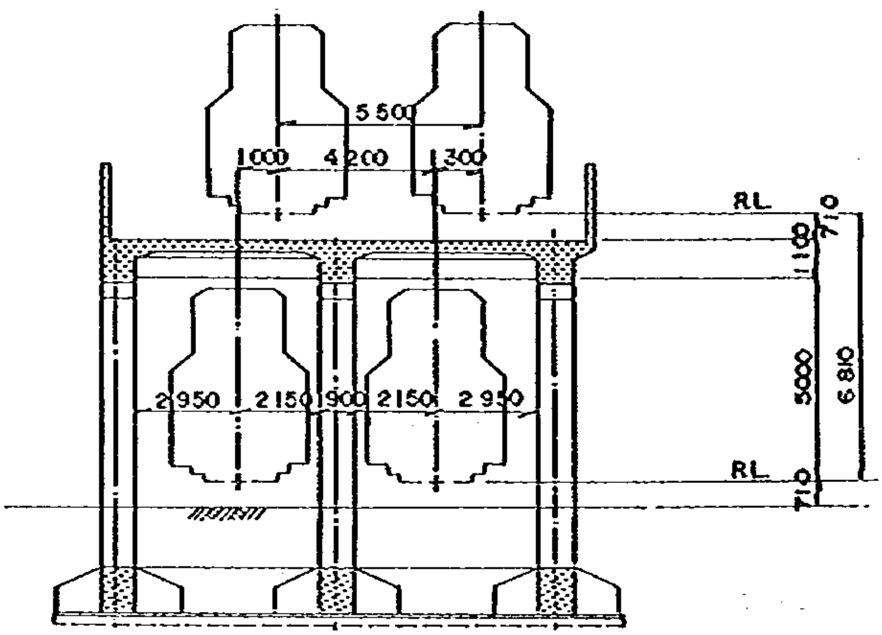


Fig. 6–3–8 Rigid Frame Viaduct Fly-Over Western Line

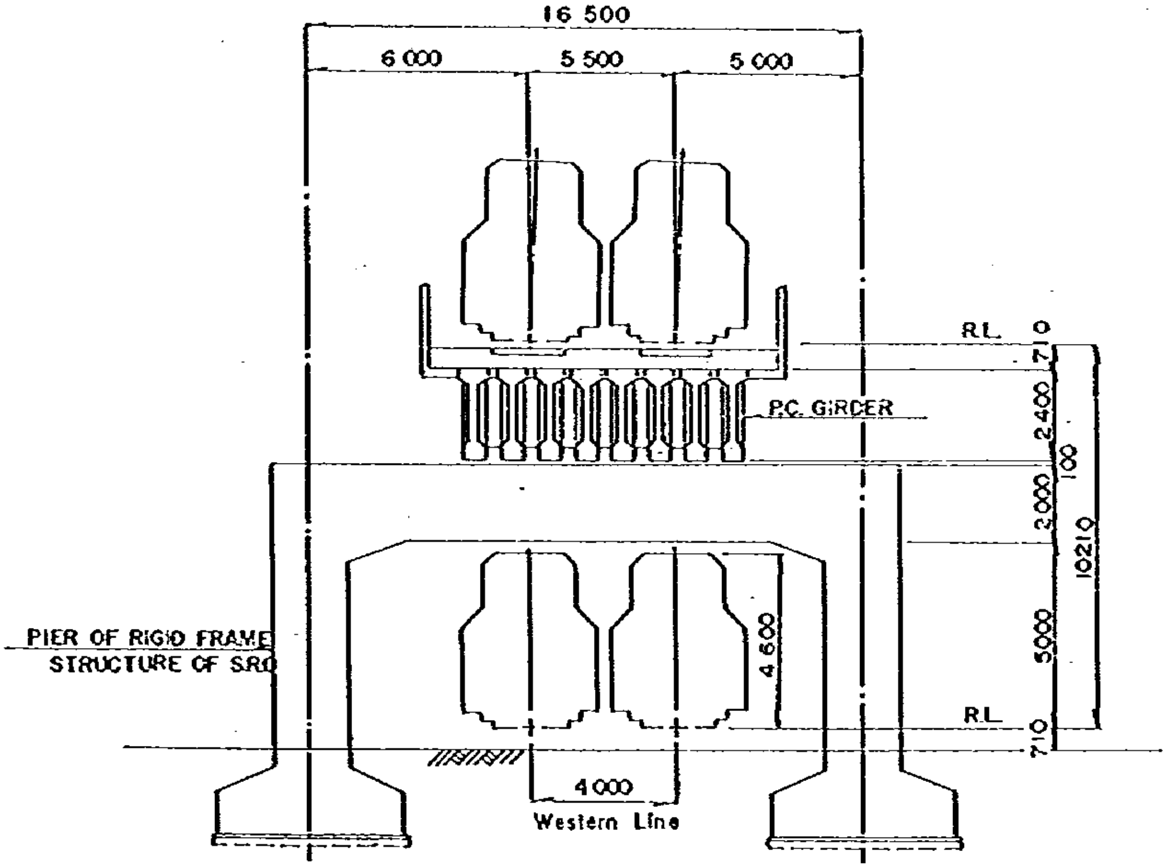


Fig. 6–3–9 Rigid Frame Pier Fly-Over Western Line

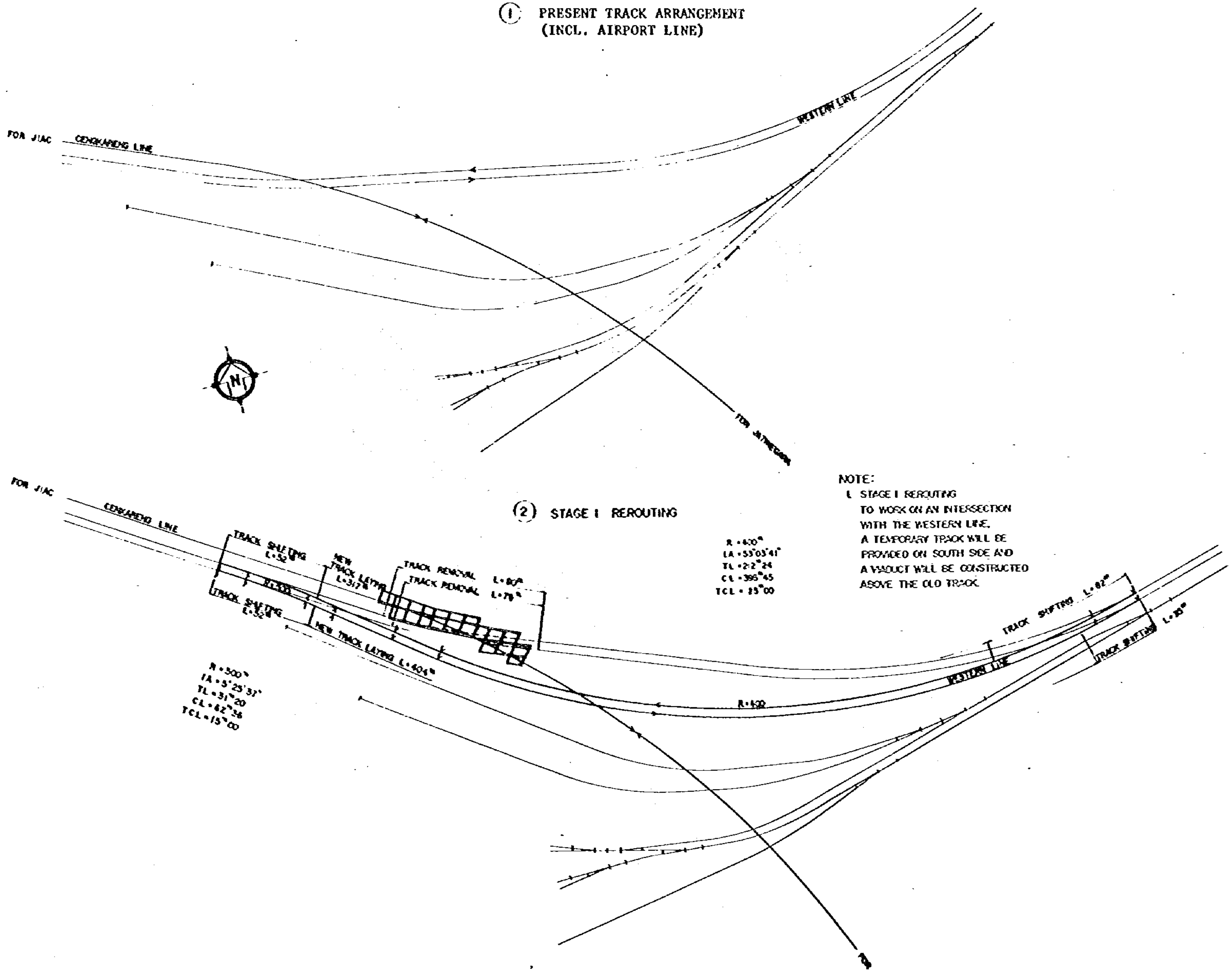


Fig. 6-3-10 (1) Rerouting Plan at Section Overpassing Western Line and Around Gudang Freight Yard

NOTE:
1. STAGE 2 REROUTING
THE WESTERN LINE WILL BE RESTORED TO A SPACE BENEATH COMPLETED VIADUCT, TO CONSTRUCT BRIDGES AT BOTH ENDS.

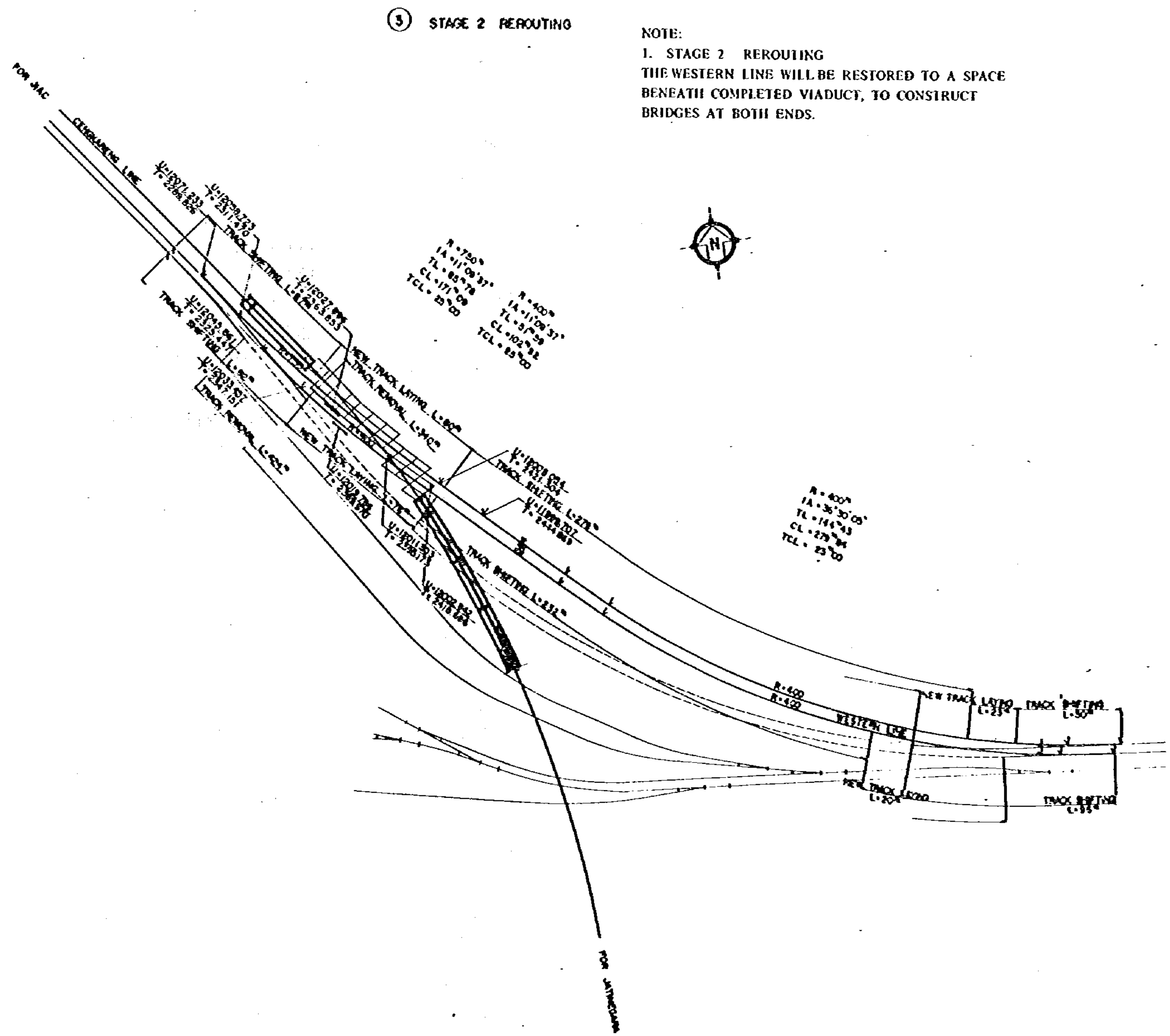


Fig. 6-3-10 (2) Rerouting Plan at Section Overpassing Western Line and Around Gudang Freight Yard

After completion of the work, the Western Line will be re-shifted under the elevated structure (viaduct).

At Gudang Freight Yard, the over-pass will cross the yard, bypassing the tracks presently not in use, by a one-span girder bridge, rerouting will not be necessary.

Moreover, as there is a plan to connect the East and West Lines in this area, a girder bridge with a span of 25m to 30m length to cope with these future plans has been designed.

(2) Eastern Area of Kota Station

The Airport Line will fly over the tracks almost at a right angle of the eastern area of Kota Station. However it will be necessary to shift temporarily the tracks that would affect the construction of piers.

In selecting the position of the piers, consideration was given to the girder span and position of the piers so that construction could be readily executed without shifting the tracks which are connected to the turnouts and electrified tracks.

It has therefore been planned to shift temporarily the Western Line and part of the Tanjung Priok Lines as shown in Fig. 6–3–11, and to suspend the operation of one of the loop lines of Kota Depot during the construction work.

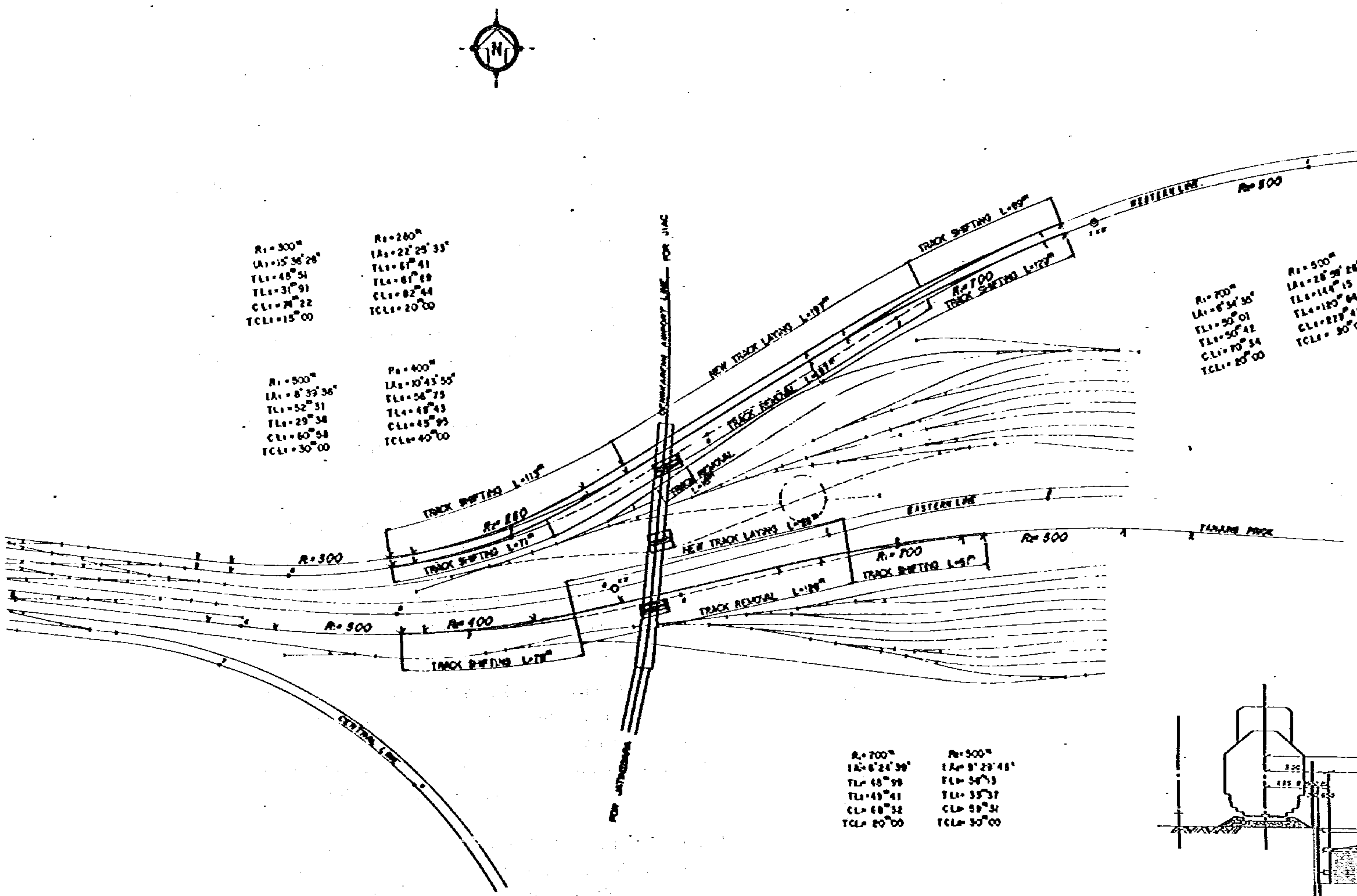


Fig. 6–3–11 Rerouting Plan in Eastern Part of Kota Station

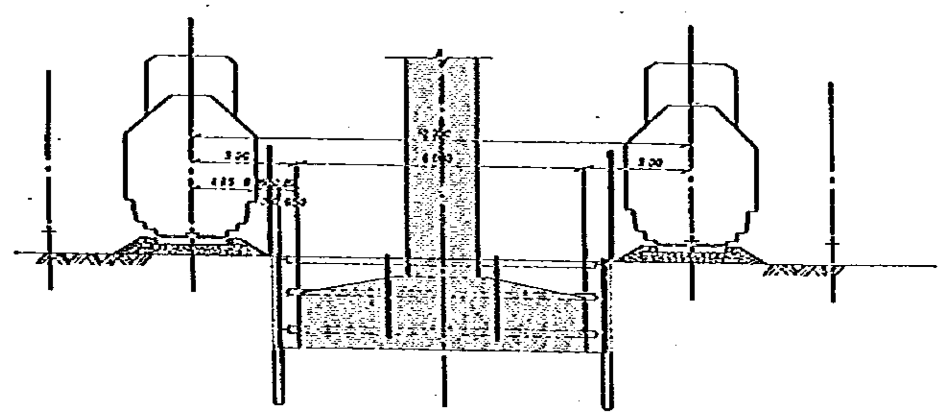


Fig. 6–3–12 Minimum Clearance Between Track Centers at Bridge Pier Construction Work

(3) Jayakarta Station

There will be no difficulties in constructing Jayakarta Station if this is constructed simultaneously with and as a part of a viaduct of the Central Line. However, when elevating of the Central Line is delayed and the Airport Line is temporarily constructed on the ground level, problems will arise at the time of elevating the Airport Line.

In this case, the temporary ground line will be constructed where the future outbound line will be in order to avoid acquiring additional land for the temporary line.

The elevated section in this area is in straight alignment and has a 14‰ grade to crossover the Central Line.

As the temporary line had to be so positioned as not to disturb the work on the elevated line, its alignment was planned by turning out of an S curve of 300m radius which confronts the easement curve at 19km052m 17 on the east side of Kota Station, as illustrated in Fig. 6–3–13.

Work to elevate the line from ground level will be carried out in sections in the sequence illustrated in Fig. 6–3–16 and described below:

1) Cengkareng Line will be temporarily lowered to ground level after crossing over Kota Station, to connect to the Central Line. In this case, Jayakarta Station will not handle passengers however, will be used as a signal station.

2) While operating the Airport Line and the Central Line on ground level, a viaduct for one track of the future Airport Line and one track of the inbound Central Line will be constructed.

   After completion of the viaduct, only the Airport Line on ground level will be switched to the elevated track. During this period, way stations of the Central Line up to Mangarai Station will experience inconvenience in passenger handling as the Airport Line and the Central Line will be operating on different levels, one on the elevated track, and the other on the ground level track.

3) The outbound Central Line will be constructed on the old Airport Line on ground level which has been switched to elevated track, and then both outbound and inbound Central Line will be switched to elevated tracks at the same time.

4) The Airport Line will be increased to double track by constructing a viaduct for single track in parallel to the existing line.

   As the station will be completed in the first phase, the plan is made to only require the change of tracks used to finalize the work.

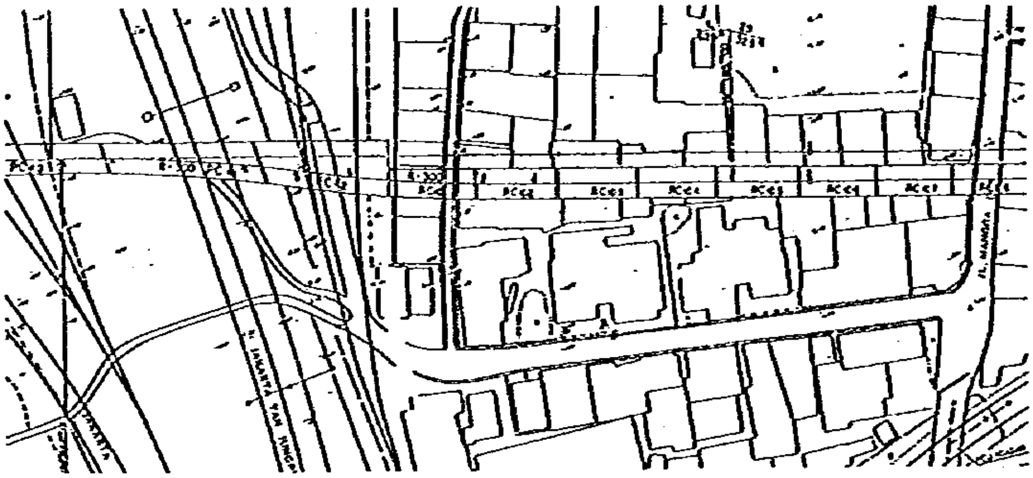


Fig. 6–3–13 Proposed Plan of Temporary Ground Line (At Shifted Location)

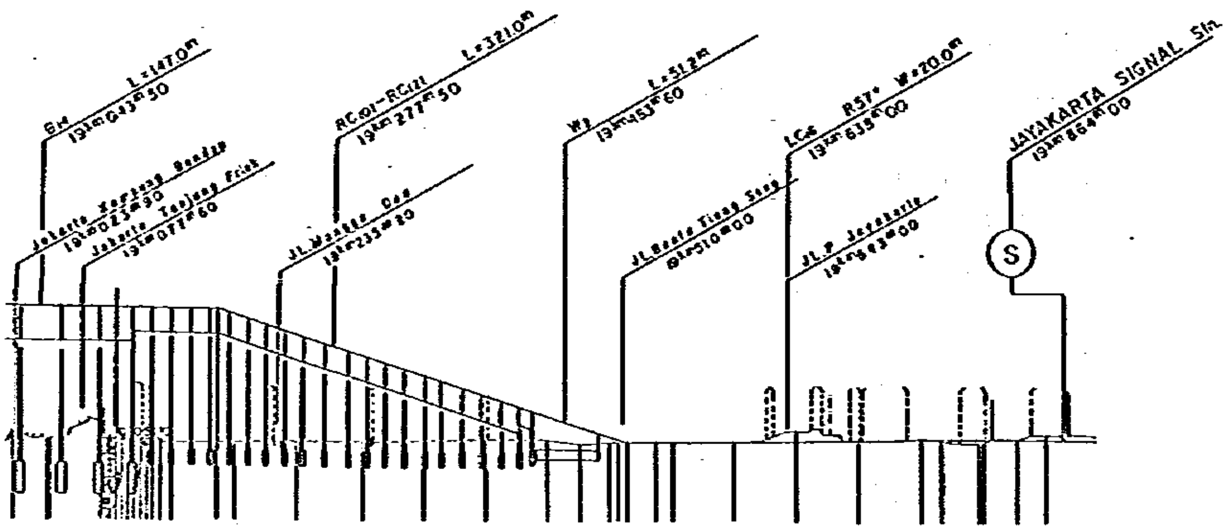


Fig. 6–3–14 Profile of Proposed Temporary Ground Line

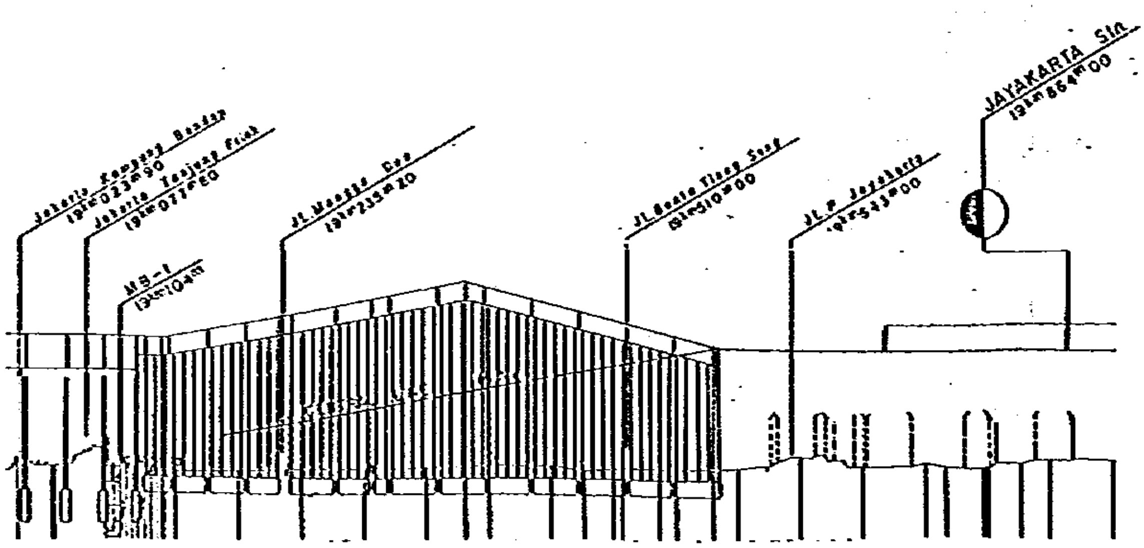


Fig. 6–3–15 Profile of Proposed Elevated Line

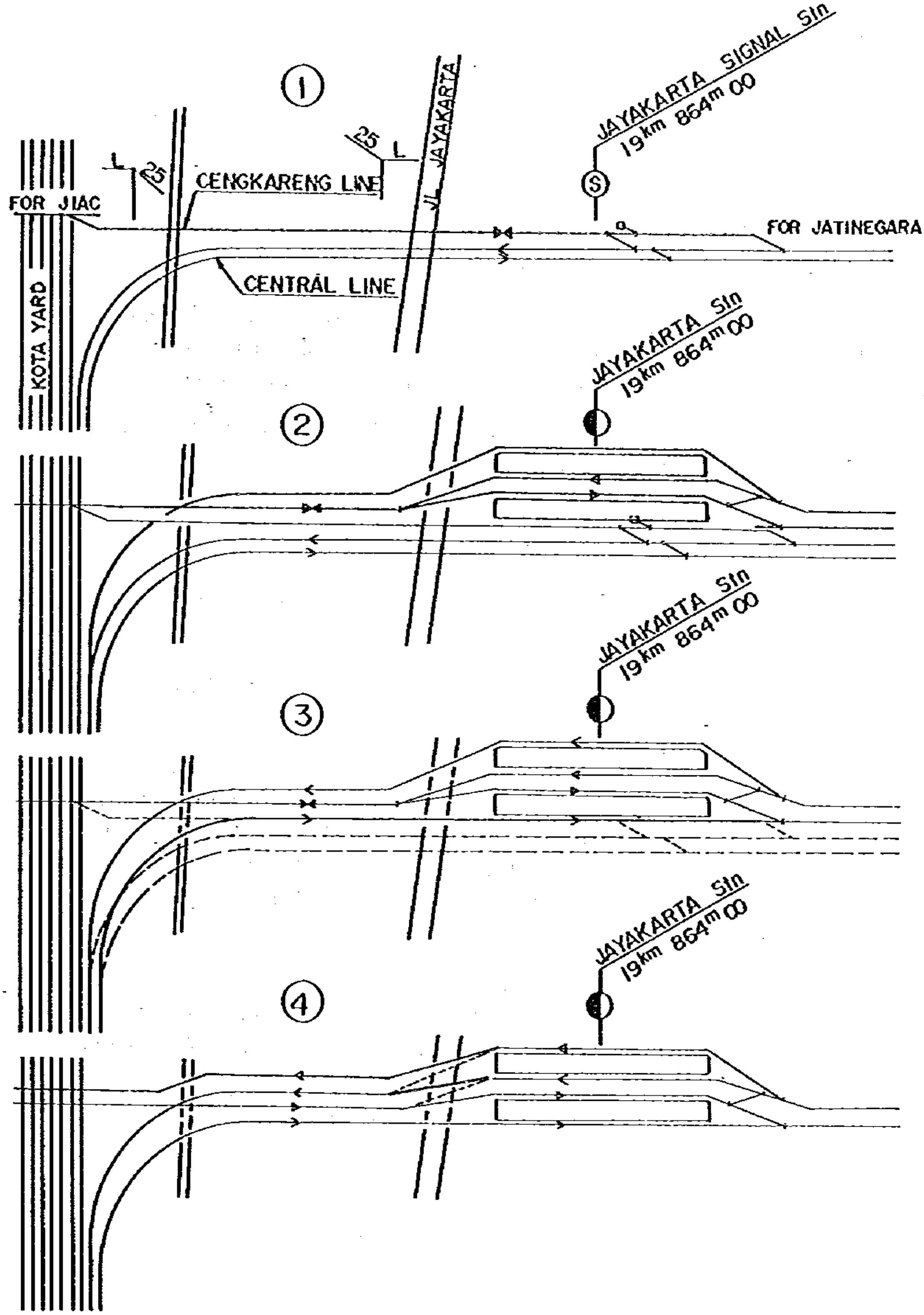


Fig. 6–3–16 Sequence of Work at Jayakarta Station

6–4 Roadbed

6–4–1 Roadway Diagraph

Roadway diagraph has been classified into general section and urban area section, as shown in Fig. 6–4–1 and Fig. 6–4–2.

6–4–2 Water Channel and Road Crossing Railroad

(1) Drainage Culvert

As the route will pass through rice field areas, drainage culverts will be built at appropriate intervals so that the embankments will not hamper drainage during floods. The culverts could also serve as footpaths for farmers and prevent them from crossing the railroad tracks.

Taking the above two purposes into account, standard drainage culverts are planned to be box culverts, in a dimension of 2.0 m x 2.0 m each, which will be installed at intervals of around 500 m.

(2) Level Crossing

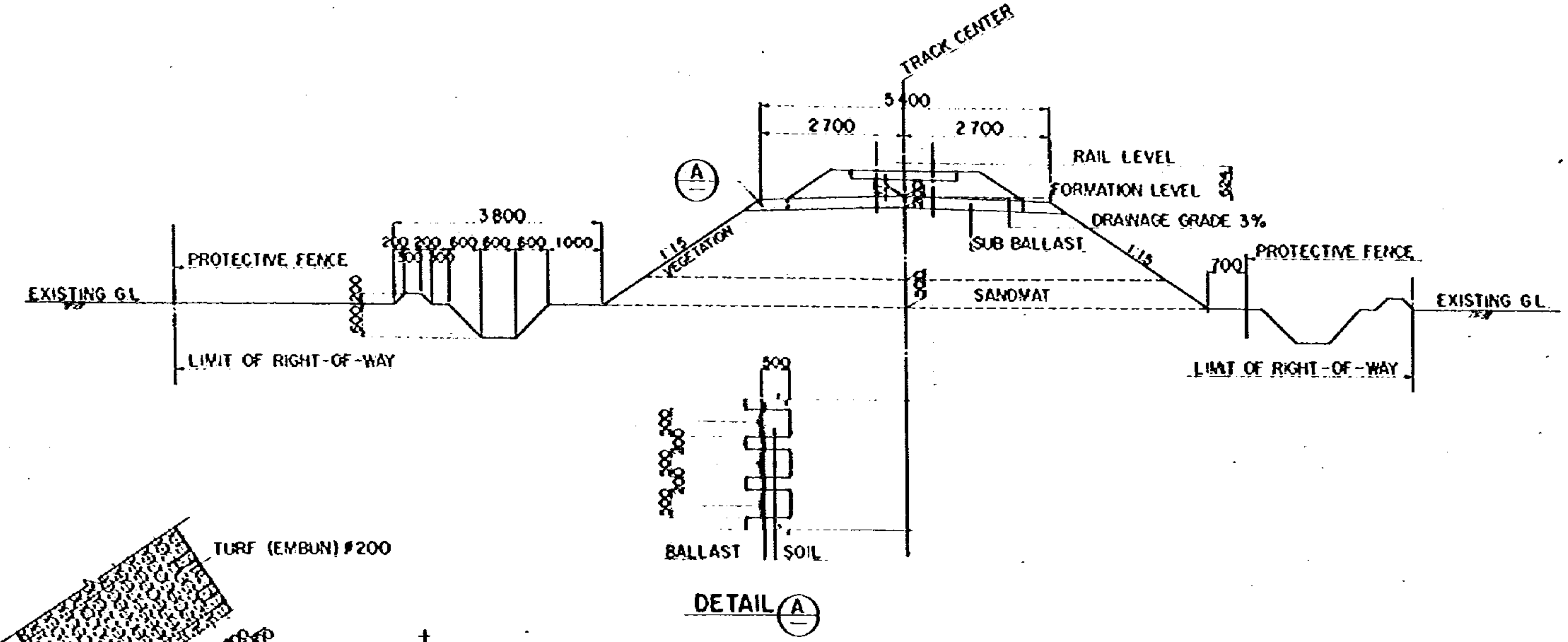
The embankment section of the Airport Line is from 0 km to 13.4 km and the provisional approach to the existing Central Line.

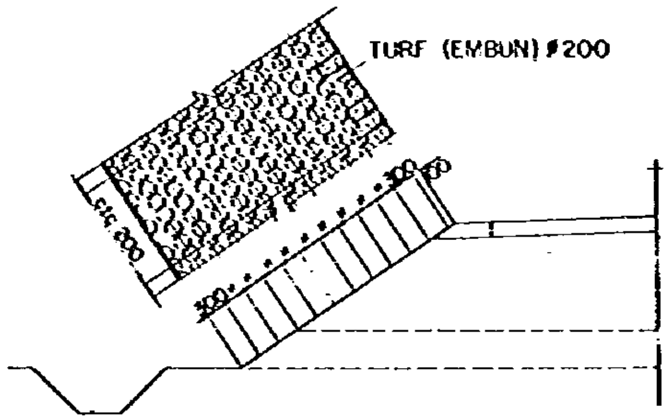
Over this sector there are 16 places where the route crosses the roads wider than 3.0 m at grade.

It is necessary to have the rail level at the same level as the road surface at the level crossings. As the formation level of the railway is designed to be slightly higher than the flood level of the surrounding area and as the track is laid on the roadbed, the track is usually 1.0 m to 2.0 m higher than the roads in the area. Therefore, the approach to the level crossing was designed to be within shortest possible extent with a grade of less than 8%.

6–4–3 Slope Protection Work for Embankment

Planting will be made on embankment slope to prevent erosion of the face and break-up of the surface layer. Rumput Embun was selected as planting material as this species is suitable to the local climate with long life and could be produced in quantity.





DETAIL OF TURFING

Fig. 6-4-1 Roadway Diagraph (Straight Section, General Area)

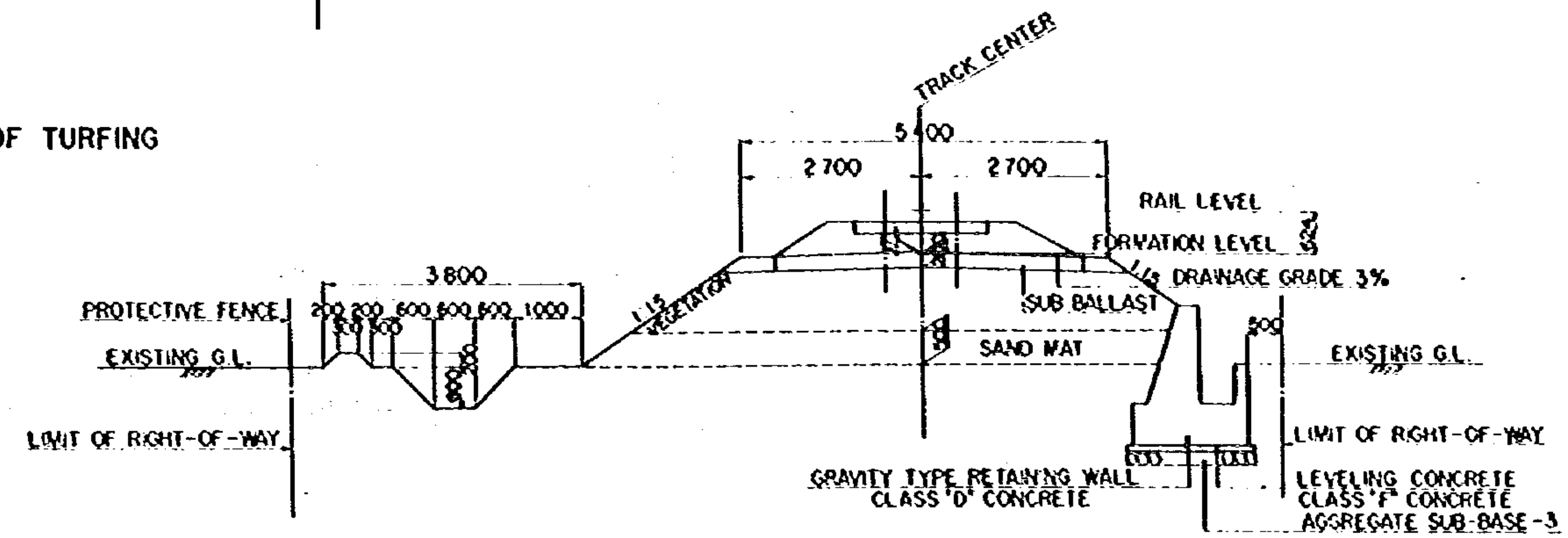


Fig. 6-4-2 Roadway Diagraph (Straight Section, Urban Area)

6-4-4 Study on Settlement and Stability of Embankment on Poor Soil Layer

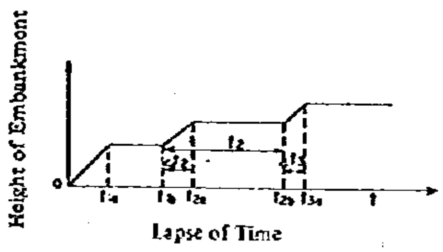
The objectives of stability calculation are to find the possibility of slide failure caused by embankment load, the safety factor, settlement and its rate, and total length of sections which are subject to settlement. For stability calculation of embankment sections, the depth of subject poor soil layers were first determined from geological profile, prepared on the basis of soil investigation. Then typical cross sections were selected from sections with high embankment or deep poor soil layer, which are likely to have a problem on stability.

Settlement calculation for the embankment was made to a point of every 500 m to estimate the earthwork volume. Stability calculation for the section in a pond ($3^{km}350^{m}$) was made to circular failure, replacing with suitable soil material.

(1) Design Calculation Principle

Design calculation principle on staged embankment construction is as follows;

1) Design calculation has been made for staged embankment construction in combination of gradual loading period and settlement period, as shown in the figure below;



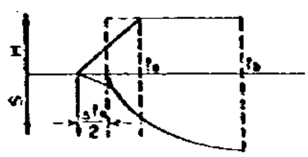
2) Embankment construction is carried out at the same rate during the loading period.

3) Height of embankment at the first stage will be limited within a safety factor of 1.2 against cohesion obtained in consolidation by embankment load could be maintained.

4) Embankment at the first stage will be left until consolidation by filling at the stage becomes 80%, then the next stage filling is continued.

5) Settlement and safety factor are calculated immediately after completion of embankment at each stage (tna) as well as when consolidation of 80% is reached (tnb).

6) Settlement and safety factor are calculated on the assumption that instant loading is applied after a half of the required time for embankment (Δtn) at the first stage, as shown in the figure below.



7) Decrease of embankment height by settlement, reduction of embankment load (when settlement by embankment load at stage n is large, or $S'n > 0.1$ hbn, and bottom of embankment is lowered below ground water level as a result of settlement), and decrease of thickness of poor soil layers will be adjusted at each stage.

8) For value of consolidation coefficient used at each stage, a value (Cvn) which corresponds to final stress (Pn-1) at preceding stage and intermediate stress (Pm) of final stress (Pn) at the stage will be used.

9) Entire degree of settlement at a certain period is obtained by accumulating consolidation settlement at each stage of embankment load which is calculated separately.

10) Cohesion at a given stage (n) after subjected to embankment load is expressed by the following formula;

$$C_n = C_o + 0.5m\,(P_n - P_{co})\,U_{tn} \quad (t/m^2)$$

m: Increase Rate of Cohesion against Additional Load

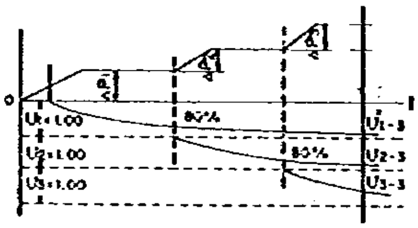
$$P_{co} = C_o/m$$

U_{tn}: Total Consolidation Ratio

$$U_{tn} = \frac{\Delta P_1}{P_n - P_o} U_{1-n} + \frac{\Delta P_2}{P_n - P_o} U_{2-n} + \cdots + \frac{\Delta P_n}{P_n - P_o} U_n$$

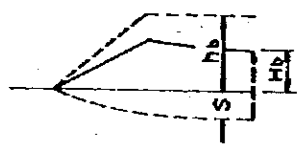
$U_{1-n}, \ldots U_n$: Progress Rate of Consolidation against Additional Load at Each Stage which is separately considered

$$P_n - P_o = \Sigma \Delta P_i$$



11) Limiting cohesion (Cdn) at each period is calculated by using the following formula;

$$Cdn = \frac{\gamma b.Hbn + (\gamma b - \Delta\gamma b)\,Sln}{Nsn} \quad \text{or} = \frac{\gamma b.hbn - \Delta\gamma b.Stn}{Nsn}$$



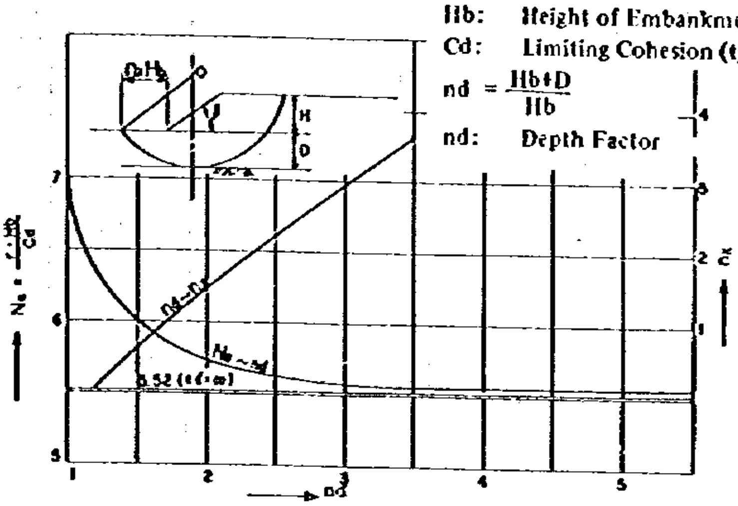
γb: Unit weight of embankment (t/m^3)
Hbn: Height of embankment (m)
hbn: Thickness of embankment (m)
γb': Unit weight of embankment below groundwater level (t/m^3)
Stn: Settlement (m)
Δγb: Decrease of unit weight of embankment below groundwater level
$\Delta\gamma b = \gamma b - \gamma b'$ (t/m^3)
Nsn: Stability factor

$$Cd = \frac{\gamma \cdot Hb}{Ns}$$

Ns: Stability Factor
γ: Unit Weight of Embankment (t/m^3)
Hb: Height of Embankment (m)
Cd: Limiting Cohesion (t/m^2)

$$nd = \frac{Hb+D}{Hb}$$

nd: Depth Factor



Relation of Stability Factor (Ns) when Grade of Slope is 1:1.5 (β=33°42')

12) Safety factor is expressed by the following formula;

$$Fn = \frac{Cn}{Cdn}$$

$Fn \geq 1.4$ is required on initial operation time.

13) Settlement in a year after starting operation is to be $\Delta s < 10cm$.

The result of the calculation, carried out in accordance with the above principles, is presented in Table 6-4-2.

(2) Analysis of Calculation Result

1) Single-stage filling could be done in most part.

2) Two-stage filling will be required in $11^{km}420^{m}$ – $11^{km}660^{m}$, $12^{km}000^{m}$ – $12^{km}330^{m}$ and $12^{km}450^{m}$ – $12^{km}950^{m}$.

3) Replacement method by sand will be required in $3^{km}350^{m}$ (in a pond).

4) As track work will be commenced one year after completion of embankment, the slow filling method will not affect the entire construction schedule.

5) Embankment for $19^{km}438^{m}$ – $19^{km}514^{m}$ should be commenced earlier, as this section will require a long period of time (586 days) to reach consolidation of 80%.

Table 6-4-1 List of Major Soil Factors Used in Stability Calculation of Embankment

M.B. No.	Subject Sections	Initial Cohesion of Poor Soil Layer Co (t/m^2)	Unit Weight of Embankment γb (t/m^3)	Increase rate of Cohesion (m)	Pco=Co/m	Limiting Height of Embankment $5.5 \times \frac{Co}{\gamma b} = a(m)$ $(\frac{a}{1.2}) = b(m)$
1	$19^{km}000^{m}$ ~ $19^{km}600^{m}$	1.1	1.7	0.18	6.11	a = 3.56 b = 2.97
7	$11^{km}500^{m}$ ~ $13^{km}600^{m}$	0.8	1.7	0.31	2.58	a = 2.59 b = 2.16
8	($0^{km}000^{m}$ ~ $1^{km}750^{m}$) ($8^{km}530^{m}$ ~ $11^{km}500^{m}$)	3.4	1.7	0.30	11.33	a = 11.0 b = 9.16
9	$5^{km}000^{m}$ ~ $7^{km}500^{m}$	1.6	1.7	0.23	6.96	a = 5.18 b = 4.31
10	($1^{km}750^{m}$ ~ $5^{km}000^{m}$) ($7^{km}500^{m}$ ~ $8^{km}530^{m}$)	1.1	1.7	0.21	5.24	a = 3.56 b = 2.97

Table 6—4—2 Result of Stability Calculation of Embankment

Location	Initial Cohesion of Poor Soil Layer Co (t/m^2)	Increase Rate of Cohesion m	Height of Embankment (m)	Thickness of Poor Soil Layer (m)	Settlement beneath Center of Embankment (m)	Period to reach Consolidation of 80% (day)	Filling Method	Sand Mat	Remarks
0km000m	3.4	0.3	0.16	2.80	0.00	27	Single-stage	Absent	
0km500m	3.4	0.3	1.08	1.00	0.02	10	Single-stage	Absent	
1km000m	3.4	0.3	1.26	1.60	0.02	16	Single-stage	Absent	
1km500m	3.4	0.3	1.33	2.60	0.03	36	Single-stage	Absent	
2km000m	1.1	0.21	1.70	1.60	0.03	17	Single-stage	Absent	
2km500m	1.1	0.21	1.56	5.40	0.08	110	Single-stage	Present	
3km000m	1.1	0.21	1.37	10.00	0.09	358	Single-stage	Present	
3km350m	1.1	0.21	3.61	(2.60) 4.60	0.10	51	Replacement	Absent	( ) Thickness after replacement of 2.0 m with sand
3km500m	1.1	0.21	1.48	4.60	0.06	82	Single-stage	Present	
4km000m	1.1	0.21	1.34	4.60	0.06	81	Single-stage	Present	
4km500m	1.1	0.21	1.74	4.60	0.08	83	Single-stage	Present	
4km600m	1.1	0.21	1.96	4.60	0.08	84	Single-stage	Present	
5km000m	1.1	0.21	1.71	3.00	0.05	40	Single-stage	Present	
5km500m	1.6	0.23	1.50	5.00	0.07	95	Single-stage	Present	
5km650m	1.6	0.23	1.85	5.60	0.10	120	Single-stage	Present	
6km000m	1.6	0.23	1.78	6.20	0.09	143	Single-stage	Present	
6km500m	1.6	0.23	1.44	6.60	0.08	160	Single-stage	Present	
7km000m	1.6	0.23	1.52	4.00	0.06	63	Single-stage	Present	
7km500m	1.1	0.21	1.21	1.60	0.02	15	Single-stage	Present	
8km000m	1.1	0.21	1.09	2.40	0.05	86	Single-stage	Present	
8km500m	1.1	0.21	2.58	3.80	0.10	63	Single-stage	Present	
9km000m	3.4	0.30	1.35	2.00	0.03	21	Single-stage	Present	
9km500m	3.4	0.30	0.50	2.00	0.01	17	Single-stage	Present	
10km000m	3.4	0.30	1.83	2.20	0.04	26	Single-stage	Present	
10km500m	3.4	0.30	2.35	4.00	0.08	68	Single-stage	Present	
10km900m	3.4	0.30	3.68	6.40	0.20	167	Single-stage	Present	
11km200m	3.4	0.30	4.85	6.80	0.25	194	Single-stage	Present	
11km500m	0.8	0.31	2.96	7.40	0.36	370	Two-stage	Present	Height of embankment per stage−2.30m
12km000m	0.8	0.31	2.36	6.80	0.24	170	Two-stage	Present	Height of embankment per stage−2.30m
12km500m	0.8	0.31	2.32	6.60	0.23	162	Two-stage	Present	Height of embankment per stage−2.30m
12km600m	0.8	0.31	2.93	7.00	0.33	224	Two-stage	Present	Height of embankment per stage−2.30m
13km000m	0.8	0.31	1.49	8.40	0.17	268	Single-stage	Present	
13km400m	0.8	0.31	1.39	10.00	0.17	349	Single-stage	Present	
19km438m	1.1	0.18	2.00	11.00	0.26	586	Single-stage	Present	

6–4–5 Prevention of Mud-pumping in Embankment Sections

Mud-pumping is related to various factors such as loading condition, soil in roadbed and drainage condition. As to soil in roadbed, hard rock muck of good quality is difficult to use due to the location of proposed route, therefore, laterized volcanic ash clay will have to be used, although not preferable, to prevent mud-pumping. To compensate for this, the following measures will be taken in respect to loading condition and drainage condition;

(1) Loading Condition

The amount of pressure received by the roadbed through the rails and sleepers when train is passing is dependent upon the train operating condition and track condition. Track condition is related to such factors as thickness of ballast, type of rail and sleeper, and rail joint. Among these factors, thickness of ballast is closely related to mudpumping in particular; as ballast is laid thicker, the roadbed pressure becomes smaller, which will be useful in advantageous on prevention of mud-pumping. Therefore, 20 cm thick sub-ballast will be laid on top of the Embankment.

(2) Drainage Condition

Presence of water has a critical relation to mud-pumping. Soil strength is reduced when it contains water above its optimum content, ballast will likely to subside into the roadbed. When the roadbed soil is of clayey soil, it will likely to be muddy condition to cause mud-pumping. Furthermore, when standing water is present, pore water pressure is increased to cause mud to raise and thereby, to further accelerate potential mud-pumping. In order to cope with this, drainage grade of 3% will be provided on top of the embankment for the effective drainage to prevent standing water.

6–4–6 Recommendation on Embankment Construction

(1) Treatment of Bearing Ground of Embankment

In embankment sections located in marsh land, water remains due to poor drainage. As embankment construction work will be done by machines, excess spreading of material will likely to occur due to a lack of trafficability, resulting in defective work which will become a negative factor in settlement and stability after completion.

In order to cope with this, areas with defective drainage should be provided with drainage ditches without lining and sump for proper draining during the dry season when the water level is low, to dry the ground which supports the embankment and thereby to secure trafficability before commencing embankment construction work.

(2) Treatment of Fishpond and Ponds for Household Use

There are large fishponds and various size of ponds for household use on the proposed route.

Filling work at these areas should be made following the digging of substitute ponds, the draining and drying the old ponds, and by filling up to the surrounding ground level avoiding excessive spreading of material so as to achieve even conditions to the settlement of the surrounding ground.

6–5 Bridges and Viaducts

6–5–1 Structure Program

The proposed site for bridges and viaducts is a developed district where many roads, rivers, and railways intersect each other. Conditions are expected to be unfavorable for construction and foundation work in this district. Extra attention was therefore paid in the designing of bridges and viaducts.

A beam slab type [3 + (4 x 8) + 3 = 38 m] of rigid frame viaduct was adopted for use in the regular sector of the elevated area. Also in the curved sector (R = 500 m) a rigid frame viaduct of [3 + (3 x 8) + 3 = 30 m] was adopted as a typical design considering the volume of shift.

A girder type of viaduct was employed in the area of Gudang Freight Yard as well as in the eastern part of Kota Depot,where the viaduct crosses over a number of railway lines.

As for the superstructure of bridges and girder viaducts, construction was planned with an erection girder of prestressed concrete girder in the areas where it would be impossible to perform the form work and shoring works because of rivers, railroads, and heavy traffic. As for the abutment and pier in the substructure of bridges, semi-gravity type structure will be used in anticipation of the railway line being double-track formation in the future.

6–5–2 Design for Structures

The allowable stress method, based on a theory of elasticity, to analyze the structures of reinforced and prestressed concrete has been used.

Design calculation was made based on static calculation and in stability calculation for the structures, verification was made that the safety factor for overturning of the supporting surface and footing, and safety factor for horizontal support and vertical support of ground and piles have exceeded the value as specified.

6–5–3 Designing Conditions

(1) Design Load

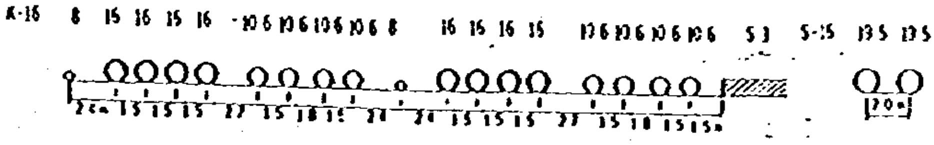
1) Dead Load

– Track assembly weight	0.45 t/m
– Roadbed ballast	1.90 t/m^3
– Reinforced concrete	2.50 t/m^3
– Plain concrete	2.35 t/m^3
– Structural steel	7.85 t/m^3
– Railings	0.20 t/m

Actual weight will apply to the unit weight of other materials.

2) Train Load

The train load will be equivalent to KS–16 loading scheme.



3) Impact Load

The above train load multiplied by the following coefficients of impact will be the impact load.

Coefficient of Impact (KS Load)

Span ℓ (m)	0	5	10	20	30	40	50	70	100
Impact Coefficient	0.60	0.48	0.43	0.37	0.34	0.32	0.30	0.27	0.24

For structures supporting a double-track line, however, the impact load will be expressed by the following equation (α) being multiplied by the coefficients of impact.

$$\alpha = 1 - \frac{\ell}{200} \qquad \ell \ : \ \text{span (m)}$$

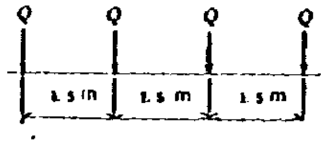
4) Centrifugal Load

The train load multiplied by the following coefficients (α) makes the centrifugal load. The centrifugal load is supposed to act both horizontally and at right angles on a railroad track, with the acting height being set at 1.8 m above the rail surface.

Curve Radius R (m)	Coefficient α
$R \leq 700$	0.12
$700 < R \leq 1000$	0.10
$1000 < R \leq 1800$	0.08
$1800 < R$	0

5) Lateral Load of the Rolling Stock

The lateral load of the rolling stock affected by the KS load corresponds to the parallel concentrative moving load (Q), which equals 15% of one driving wheel axle weight affected by the K load per track. This load is supposed to act both horizontally and at right angles on a railroad track at the height of the rail surface. The lateral load of the rolling stock shall apply to only one track in case of the structures supporting the line with two or more tracks.



6) Start and Brake Load

The following percentages of load are supposed to act as the start and brake load per track. This load works parallel to a track at the height of 1.8 m above the rail surface in the centerline.

Brake Load	15% of train load
Start Load	25% of driving wheel axle weight

7) Earth Pressure

Coulomb's and Rankine's coefficient of earth pressure shall apply.

8) Seismic Effect

The force produced by the effect of earthquakes shall correspond to dead load and surcharge load multiplied by the seismic intensity. The design seismicity based on the seismic intensity method is expressed by $Kh = 0.1$ and $Kv = 0$.

9) Temperature Change and Drying Contraction

The following values shall apply to the temperature change and drying contraction to be used for the analysis of statically indeterminate structures.

Temperature change: $\pm 10°C$
Drying contraction: $-15°C$

The thermal expansion coefficient of reinforcing bar and concrete is 1×10^{-5} per one degree C.

10) Electrified Pole Load (ordinary condition)

Vertical load: $V = 2.0$ t
Horizontal load: $H = 0.5$ t
Bending moment: $M = 5.0$ t.m

11) Multitude Load

The load created by the multitude of people on the concourse and platform is as shown below.

Slab calculation: 500 kg/m²
Beam calculation: 350 kg/m²
Earthquake calculation: 210 kg/m²

(2) Minimum Overhead Clearance below Soffit

1) Over-road Bridge

There is a variety of roads including trunk roads, collector roads, river control roads, and roads within residential areas. The minimum overhead clearance below the soffit is respectively established, as shown below.

Table 6–5–1

Type of Roads	Minimum Overhead Clearance (m)
Trunk Road	5.1
Collector Road	4.5
River Control Road	3.0
Residential Road	3.0

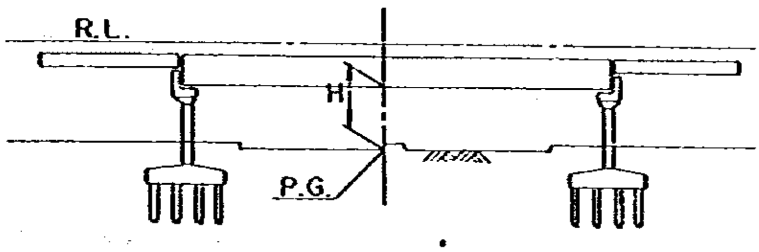


Fig. 6–5–1 Overhead Clearance for Over-road Bridges

2) Fly-over Bridge

The New Cengkareng Airport Railway is to cross over the Western Line, Gudang Freight Yard, Kota Depot and Central Line (after the Central Line is elevated). Pursuant to coordination with PJKA, the overhead clearance will be at least 4.6 m in case the new railway fly-over the existing lines. However, since the feeder line is too high in both Gudang Freight Yard and Kota Depot, the overhead clearance for these two yards has been increased to 5.0 m to reduce adjustment distance of the feeder line.

Table 6–5–2

Location	Minimum Overhead Clearance (m)
Western Line, Central Line	4.6
Kota Depot, Gudang Freight Yard	5.0

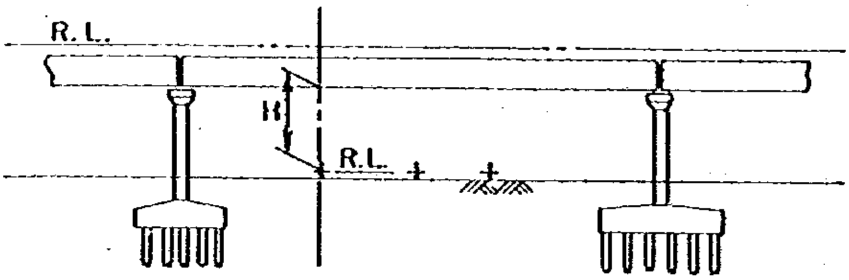


Fig. 6-5-2 Overhead Clearance for Fly-over Bridges

3) River Bridge

Overhead clearance of at least 1.0 m, from H.W.L. to the soffit of the girder has been secured for river bridges.

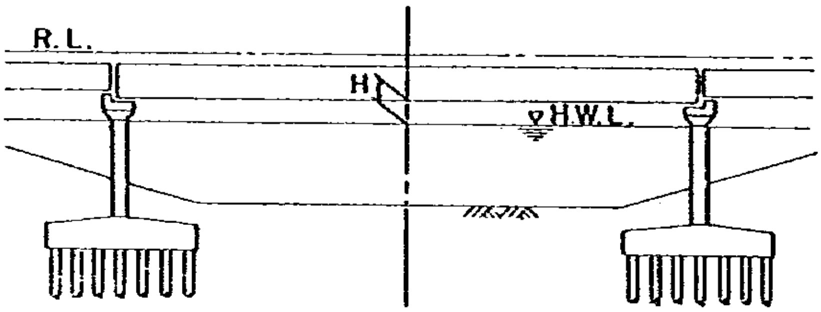


Fig. 6-5-3 Overhead Clearance for River Bridges

(3) Formation Width for Viaduct

The same formation width for a viaduct will apply to both straight and curved sections as shown below.

1) Single Track

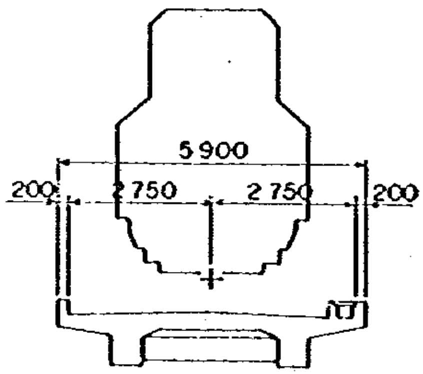


Fig. 6-5-4 Formation Width for Single Track Viaduct

2) Double Track

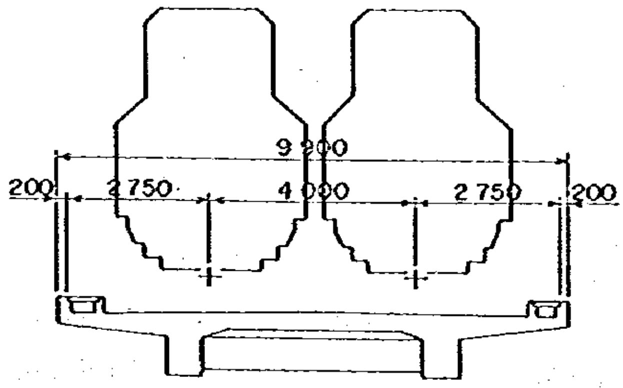
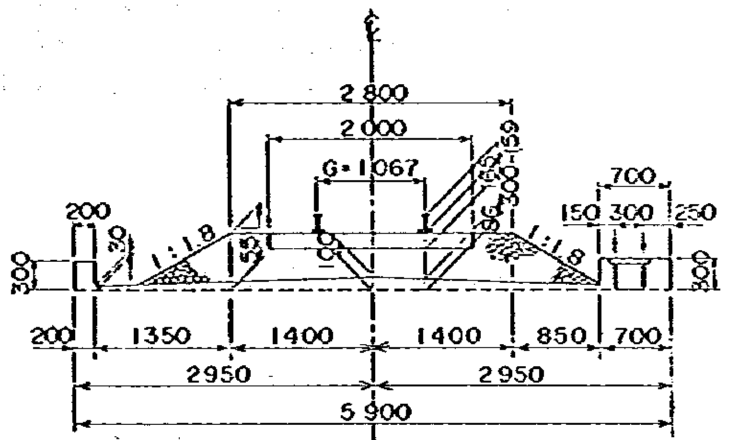


Fig. 6–5–5 Formation Width for Double Track Viaduct

(4) Facilities on Slab

The facilities on slab to be provided on the bridge and viaduct areas are as shown in Fig. 6–5–6.

Straight Line



Curved Line

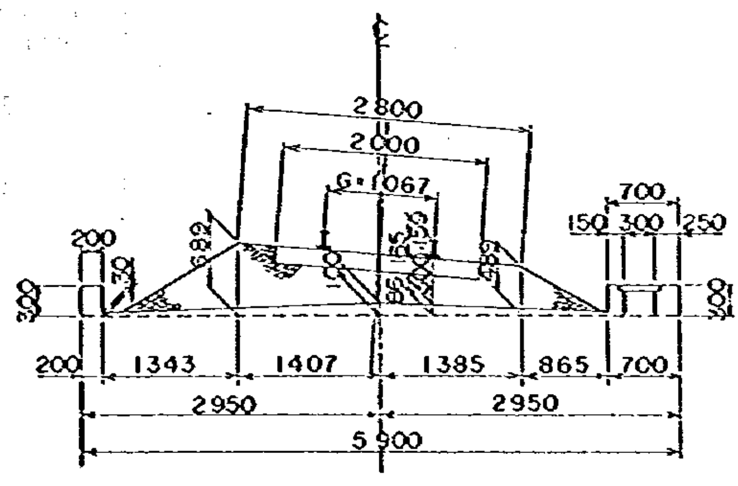


Fig. 6–5–6

(5) Materials for Structures

1) Concrete

Concrete is classified into the following six different categories.

Table 6–5–3

Type	Design Strength σck (kg/cm²)	Description
A	400 (480)	Prestressed concrete for main girder
B	300 (360)	Prestressed concrete for slab and cross girder
C	240 (290)	Reinforced concrete for R.C. girder, box culvert and viaduct
D	210 (250)	Reinforced concrete for abutment, pier and retaining wall
E	180 (220)	Plain concrete for retaining wall
F	140 (170)	Levelling concrete

Note: σck indicates the design strength established on the basis of cylinder (15 cm in diameter) compressive strength at the concrete age of 28 days. Values in ( ) indicate the design strength based on the compressive strength of a 15 cm cube.

2) Reinforcing Bar

Table 6–5–4 shows the type and strength of reinforcing bars.

Table 6–5–4

Type	JIS G3112		ASTM M 615	
	Category	Yield Stress kg/mm²	Category	Yield Stress kg/mm²
Round reinforcing bar	SR 24	24	Grade 40	28
Deformed reinforcing bar	SD 30	30	Grade 60	41

3) Prestressing Tendon

Table 6–5–5 shows the type and minimum strength of prestressing tendon.

Table 6–5–5

Type	JIS			ASTM		
	Category	Yield Stress kg/mm^2	Tensile Strength kg/mm^2	Category	Yield Stress kg/mm^2	Tensile Strength kg/mm^2
P.C. wire	G 3536	136	155	A 421	132	165
P.C. strand	G 3536 SWPR 7A	140	165	A 416 Grade 250	149	176
	G 3536 SWPR 7B	160	190	A 416 Grade 270	161	190
P.C. bar	G 3109 Type A	95	110	A 722 Type I	89	105

Note: Prestressing tendon is not locally available and therefore must be imported from abroad.

4) P.C. Pile

The standard dimension of P.C. piles is as shown in Table 6–5–6.

Table 6–5–6

Outer Diameter D (mm)	Thickness t (mm)	Length L (m)	Category	P.C. Steel Bar			Sectional Area of Pile (cm^2)	Secondary Moment in the Cross Section of Concrete (cm^4)	Design Bending Moment		Allowable Axial Load (t)	Weight per Unit Length (kg/m)
				Diameter (mm)	Q'ty (pcs.)	Cross Section (cm^2)			Crack (t.m)	Destruction (t.m)		
350	65	7–14	A	7.4	7	2.80	582	63,634	4.0	5.1	60	151
			B	9.2	10	6.40		65,527	5.6	11.3	55	
500	90	7–14	A	9.2	9	5.76	1,459	261,675	11.8	15.3	120	301
			B	11.0	14	12.60		269,216	16.2	32.3	115	

Note: 1. P.C. steel bar will be of JIS G 3109, Type D (Yield Stress 130 kg/mm^2, Tensile Strength 145 kg/mm^2) or equivalent.

2. The effective prestress for Categories A and B is 40 and 80 kg/cm^2 respectively.

(6) Allowable Stress

1) Reinforced Concrete

a) Basic Allowable Stress of Concrete

Table 6–5–7

			Basic Design Strength σck (kg/cm²)		
			180	210	240
Basic allowable compressive strength			70	80	90
Allowable shear strength	Members without diagonal tensile bar	Bending shear $\tau a1$	3.5	3.7	3.9
		Punching shear τap	4.8	5.1	5.4
	Members with diagonal tensile bar	$\tau a2$	15	16	17
Basic allowable bonding strength		Round reinforcing bar	7	8	9
		Deformed reinforcing bar	14	16	18

b) Basic Allowable Bearing Strength

– Full loading

$$\sigma ca' \leqq \frac{\sigma ck}{3}$$

– Partial loading

$$\sigma ca' \leqq \frac{\sigma ck}{3} \cdot \sqrt{\frac{A}{A'}}$$

A: Distribution area of bearing strength of concrete

A': Bearing area

2) Plain Concrete

a) Basic Allowable Compressive Strength

$$\sigma ca \leqq \frac{\sigma ck}{4} \qquad \sigma ca \leqq 55 \text{ kg/cm}^2$$

b) Allowable Tensile Strength

$$\sigma ca \leqq \frac{\sigma ck}{80} \qquad \sigma ca \leqq 3 \text{ kg/cm}^2$$

3) Reinforcing Bar

The basic allowable stress of reinforcing bar is as shown in Table 6–5–8.

Table 6–5–8

(kg/cm²)

Type of Reinforcing Bar	SR 24	SD 30
Basic allowable tensile strength determined by yielding point	1,400	1,800

The crack of concrete will be studied separately.

4) Prestressed Concrete

a) Construction Method

The Freyssinet method is a basic construction method applying to prestressed concrete.

b) Basic Allowable Strength of Concrete

Table 6–5–9 Basic Allowable Compressive Strength of Concrete

			Basic Design Strength (kg/cm²)	
			300	400
Prestressing (immediately after application)	Compressive strength	Rectangular section	150	190
		T or Box sections	140	180
	Axial compressive strength		120	145
Design loading (when applied)	Compressive strength	Rectangular section	120	150
		T or Box sections	110	140
	Axial compressive strength		90	120

Table 6–5–10 Basic Allowable Tensile Strength of Concrete

	Basic Design Strength (kg/cm²)	
	300	400
Prestressing (immediately after application)	12	15
Loading of total dead load (when applied)	0	0
Design loading (when applied)	8	10

Table 6-5-11 Allowable Diagonal Tensile Strength of Concrete

		Basic Design Strength (kg/cm²)	
		300	400
Design loading (when applied)	Shearing strength or torsional moment stress	11	13
	Shearing strength and torsional moment stress	14	17

c) Allowable Tensile Strength of Prestressing Tendon

Table 6-5-12

	Allowable Tensile Strength
During prestressing	0.8 σ_{pu} or 0.9 σ_{py}
Prestressing (immediately after application)	0.7 σ_{pu} or 0.85 σ_{py}
Design loading (when applied)	0.6 σ_{pu} or 0.75 σ_{py}

d) Basic Allowable Tensile Strength of Reinforcing Bar

Table 6-5-13

(kg/cm²)

Type of Reinforcing Bar	SR 24	SD 30
Basic allowable tensile strength determined by yielding point	1,400	1,800

5) Young's Modulus

a) Young's Modulus of Concrete

Table 6-5-14 shows the Young's modulus (Ec) of concrete against temporary load, which is applied to the design calculation of concrete.

Table 6-5-14

σ_{ck} (kg/cm²)	180	240	300	400
Ec (kg/cm²)	2.4×10^5	2.7×10^5	3.0×10^5	3.5×10^5

b) Young's Modulus of Reinforcing Bar

The Young's modulus of reinforcing bar is expressed by the equation $E_s = 2.1 \times 10^6$ kg/cm².

Note: The basic allowable stress constitutes the criterion to indicate the allowable stress against loading combinations.
(Basic allowable stress) x (Increase coefficient against loading combinations) = (Allowable stress against loading combinations)

(7) Safety Factor regarding the Stability of Foundation

The factor of safety, which is applied to a study of the stability of foundation, is shown in Table 6–5–15 below.

Table 6–5–15

Load Condition	Safety Factor
Ordinary load	3
Ordinary load plus temporary load	2
Seismic load	1.5

(8) Foundation Pile

As a result of the design work based on the data of soil analysis and boring histogram of geological survey, P.C. piles were used as foundation piles, as shown in Table 6–5–16.

Table 6–5–16

Structures	Outer Diameter and Type of Piles	
Rigid frame viaduct	D350	Type A Type B
Abutment, pier and other structures subject to earth pressure	D500	Type A Type B

(9) Concrete Minimum Cover

Table 6–5–17 shows the standards pertaining to the minimum cover of structures.

Table 6–5–17

Structures and Members		Minimum Cover (mm)
R.C. and P.C. girders	Slab	25
	Beam	30
Rigid frame viaducts	Slab	25
	Beam	30
	Column	35
Abutment, retaining wall and box culvert	Front side	30
	Back side	50
Pier		50
Footing	Top	50
	Side	50
	Bottom	75

Note: The core cover of reinforcing bar, 150mm, was applied to the bottom of footing, where p.c. piles are used.

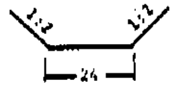
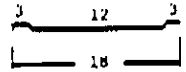
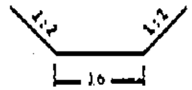
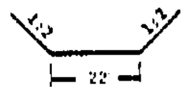
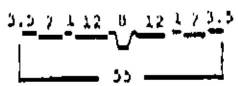
6–5–4 Bridge Design

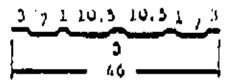
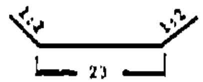
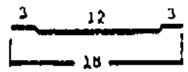
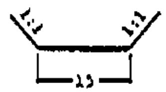
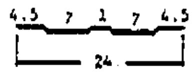
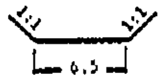
(1) List of Bridges

Table 6–5–18 shows the list of bridges flying over the New Cengkareng Airport Railway. The list includes 8 river bridges and many others crossing over principal roads and railways.

Table 6-5-18 List of Bridges

H.W.L.: High Water Level
P.G. : Profile Grade
R.L. : Rail Level

Bridge No.	Location	Name of Rivers and Roads	H.W.L. P.G. or R.L.	Expansion Program	Structure and Proposed Span	Minimum Overhead Clearance
B01	$10^{km}979^{m}00$ ~ $11^{km}059^{m}00$	Cengkareng Floodway	H.W.L. = $+2.^{m}78$		P.C. girder $20^{m}+40^{m}+20^{m}$	
B02	$13^{km}655^{m}00$ ~ $13^{km}680^{m}00$	JL. Kapuk Muara	P.G. = $+1.^{m}50$		P.C. girder 25^{m}	$4.^{m}5$
B03	$13^{km}744^{m}00$ ~ $13^{km}929^{m}00$	Kali Muara Angke	H.W.L. = $+1.^{m}93$		P.C. girder $20^{m}+30^{m}+20^{m}+20^{m}+20^{m}+25^{m}+20^{m}$	
B04	$14^{km}041^{m}00$ ~ $14^{km}071^{m}00$	JL. 2A	P.G. = $+1.^{m}70$		P.C. girder 30^{m}	$3.^{m}0$
B05	$14^{km}211^{m}00$ ~ $14^{km}416^{m}00$	Banjir Kanal	H.W.L. = $+2.^{m}81$ P.G. = $+1.^{m}50$		P.C. girder $30^{m}+30^{m}+35^{m}+35^{m}+40^{m}+35^{m}$	$4.^{m}5$
B06	$14^{km}775^{m}00$ ~ $14^{km}815^{m}00$	Kali Muara Karang	H.W.L. = $+1.^{m}795$		P.C. girder 40^{m}	
B07	$15^{km}579^{m}00$ ~ $15^{km}639^{m}00$	Jl. Jembatan Tiga	P.G. = $+0.^{m}90$		P.C. girder $30^{m}+30^{m}$	$5.^{m}1$

Bridge No.	Location	Name of Rivers and Roads	H.W.L. P.G. or R.L.	Expansion Program	Structure and Proposed Span	Minimum Overhead Clearance
B08	$17^{km}048^{m}00$ ~ $17^{km}148^{m}00$	JL. Godong Panjang Kali Sunter	P.G. = $+1.^{m}28$ H.W.L. = $+0.^{m}076$		P.C. girder $25^{m}+25^{m}+25^{m}+25^{m}$	$5.^{m}1$
B09	$17^{km}590^{m}00$ ~ $17^{km}625^{m}00$	Kali Krukut	H.W.L. = $+0.^{m}49$		P.C. girder 35^{m}	
B10	$17^{km}759^{m}00$ ~ $17^{km}784^{m}00$	JL. Tongkol	P.G. = $+1.^{m}29$		P.C. girder 25^{m}	$5.^{m}1$
B11	$18^{km}106^{m}00$ ~ $18^{km}136^{m}00$	Kali Ciliwung	H.W.L. = $+1.^{m}181$		P.C. girder 30^{m}	
B12	$18^{km}720^{m}00$ ~ $18^{km}880^{m}00$	Gudang Freight Yard JL. Raya Kampung	R.L. = $+1.^{m}65$ P.G. = $+1.^{m}68$		P.C. girder $25^{m}+25^{m}+25^{m}+30^{m}+25^{m}+30^{m}$	R.L. $+5.^{m}0$ P.G. $+5.^{m}1$
B13	$18^{km}880^{m}00$ ~ $18^{km}970^{m}00$	Kota Depot (1)	R.L. = $+2.^{m}02$		P.C. girder $30^{m}+30^{m}+30^{m}$	$5.^{m}0$
B14	$18^{km}970^{m}00$ ~ $19^{km}117^{m}00$	Kota Depot (2)	R.L. = $+2.^{m}64$		P.C. girder $30^{m}+28^{m}+33^{m}+26^{m}$	$5.^{m}0$
B15	$19^{km}117^{m}23$ ~ $19^{km}438^{m}25$	Tentative Connection at Grade adjacent to Jayakarta Station	JL. Mangga Dua P.G. = $+1.^{m}50$		R.C. girder $12@16^{m}+7@15^{m}+14^{m}+10^{m}$	$5.^{m}1$
B16	$19^{km}922^{m}50$ ~ $19^{km}939^{m}50$	Kali Ciliwung			Through plate girder 17^{m}	

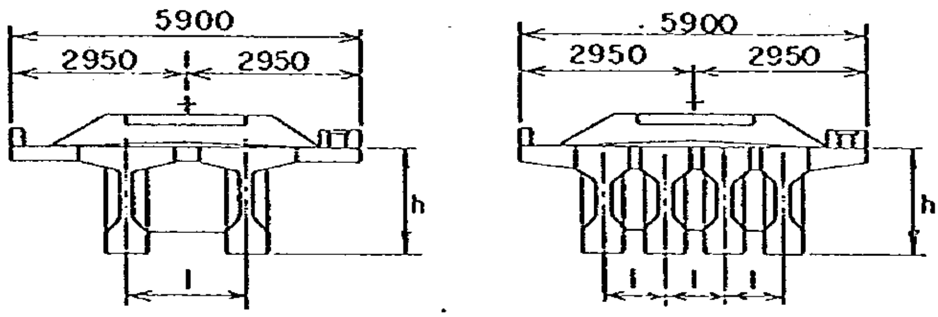
(2) Bridge Superstructure

Basically, girders of single-track formation will be used for the superstructure of bridges, including river bridges as well as over-road and over-railway bridges. The single track shall be arranged in a row in preparation for the double-track line at the time of expansion work in the future. Orthogonal girders will be used in most cases, and in case a diagonal girder must be used, its angle shall be designed to exceed 60°. The length of P.C. girders will range between 20 and 40 m. Table 6–5–19 shows the typical examples comprising a set of 42 girders, including the special ones as well as those with height limit.

The manufacture of P.C. girders will be intended for cast-in-place concrete; the P.C. girders will basically be installed by means of erection girders. As shown in Table 6–5–20, the R.C. girders designed for cast-in-place concrete were adopted for the ground approach line as well as for railway bridge crossing over the road with a short span where temporary detour or closure is practicable because of relatively light traffic. Table 6–5–21 shows the steel girder to be installed near the terminal end of the ground approach line.

1) P.C. Girder

Table 6–5–19

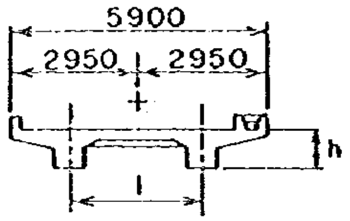


2 Main Girders 4 Main Girders

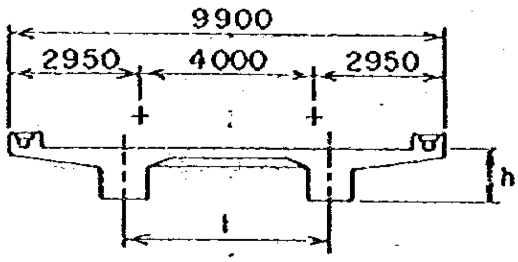
Girder Length	Girder Height (h)	Main Girder Intervals (ℓ)	Number of Main Girders	Remarks
20^m	$1.^{m}80$	$2.^{m}00$	2	Diagonal
25^m	$2.^{m}35$	$2.^{m}00$	2	Curved
25^m	$1.^{m}40$	$1.^{m}20$	4	Height limit
30^m	$1.^{m}80$	$1.^{m}00$	4	Height limit
35^m	$2.^{m}00$	$1.^{m}00$	4	Height limit
40^m	$2.^{m}40$	$1.^{m}00$	4	Diagonal
30^m	$2.^{m}15$	$1.^{m}00$	4	Curved
33^m	$2.^{m}15$	$1.^{m}00$	4	Diagonal
26^m	$2.^{m}35$	$2.^{m}24$	4	2-Line

2) R.C. Girder

Table 6–5–20



Single-track Girder

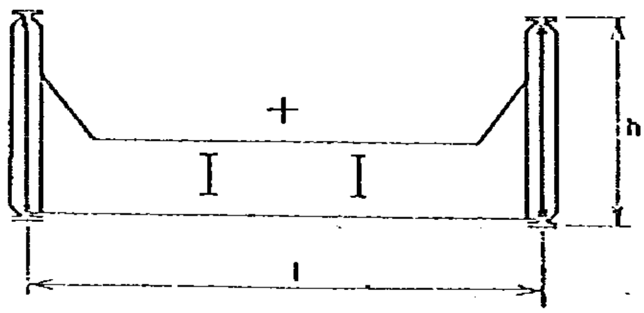


Double-track Girder

Girder Length	Girder Height (h)	Main Girder Intervals (ℓ)	Number of Main Girders	Remarks
10^{m}	0.^{m}90	3.^{m}10	2	Standard single-track girder
16^{m}	1.^{m}50	3.^{m}10	2	Single-track ground approach line (temporary)
10^{m}	1.^{m}20	4.^{m}70	2	Standard double-track girder

3) Steel Girder

Table 6–5–21



Girder Length	Girder Height (h)	Main Girder Intervals (ℓ)	Number of Main Girders	Remarks
17^{m}	1.^{m}60	4.^{m}10	2	Single-track through plate girder

(3) Bridge Substructure

In preparation for future double-track expansion, the bridge substructure was designed to support the girders incorporating two tracks. Therefore, a study of single-track loading is also necessary in the current detailed design. Since the substructure is always subject to eccentric load, attention was paid to prevent piles from being affected by a pull due to eccentric load.

As for the pier accommodating girders of different span, attention was paid to their design from the viewpoint of stability, considering the transfer of its center. In the area where bridges span a road, river, or railway, wall type structure was adopted as shown in Fig. 6–5–7, if there was no particular problem involved. However, as for the piers of a bridge intersecting the Banjir Kanal at an angle of about 45°, 2-column type structure as shown in Fig. 6–5–8 was adopted.

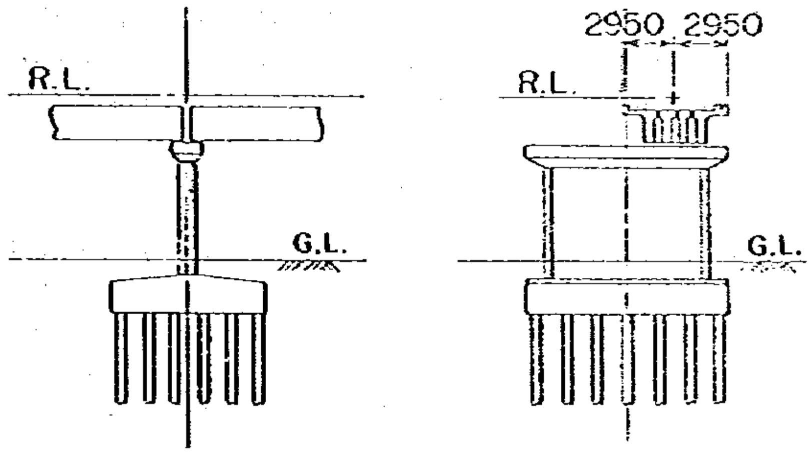


Fig. 6–5–7

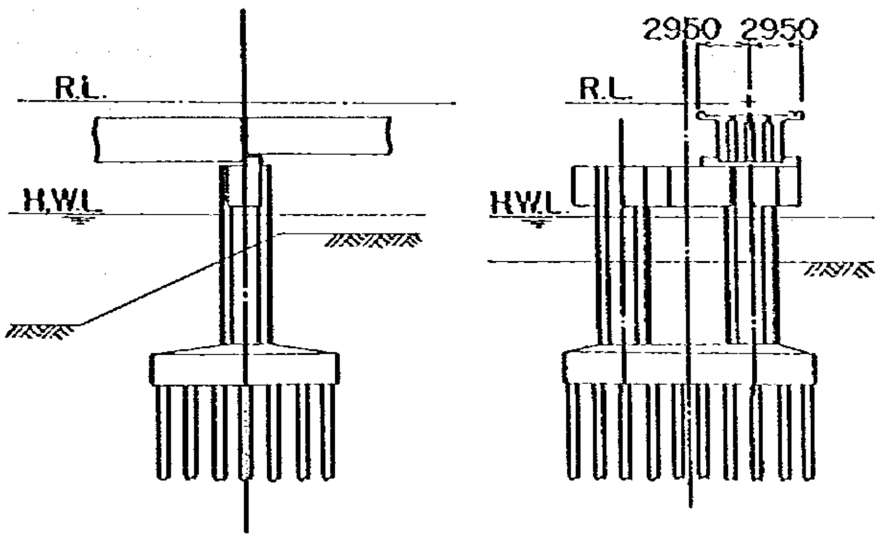


Fig. 6–5–8

(4) Bridge Crossing Over the Gudang Freight Yard

A bridge will be constructed where the Cengkareng Airport Line crosses over a number of lines in the Gudang Freight Yard at the curve radius of R = 500 m. It will be connected with a many turnouts located in the Gudang Freight Yard, which features a multi-level crossing with J.L. Raya Kampung. Girders, 25 m long, were used to flyover the lines where removal of the rails was difficult. It is inevitable to provide piers on the road since a railway is located close to J.L. Raya Kampung. Therefore, by shifting slightly the road, fly over was made with girders of 30 m in length.

(5) Bridge Crossing Over the Kota Depot

The Cengkareng Airport Line crosses over a number of lines at the Kota Depot. The lines located in the depot include the electrified Eastern Line as well as the non-electrified Western and Tanjung Priok Lines. Girders, about 30 m long, were used to span the Eastern Line which is difficult to remove and the lines connected to turnouts. There is an open area between the Kota Depot and J.L. Raya Kampung. Girders of 30 m in length were used to cross over this open area in anticipation of the linkage between the Eastern and Western Lines in the future.

(6) Bridge of the Tentative Ground Approach Area near Jayakarta Station

In case the elevation plan for the Central Line is delayed, the Airport Line will be tentatively brought down to the ground level and connected to the existing Central Line installing a signal facility in Jayakarta. In that case, the ground approach line will be brought out toward the Central Line from near the point $19^{km}050^{m}$, where the Kota Depot is located. Near the point $19^{km}140^{m}$, a 5.70 m space will be provided between the Airport Line and the ground approach line, in anticipation of the Central Line being elevated.

The R.C. structure will be introduced in both substructure and superstructure because the time schedule of elevation work is not definitive. In that case, the span will range between 14 and 16 m, with a pier erected near the center of span of the future structures (Fig. 6-5-9). The ground approach line runs across the Kali Citiwung near its terminal. It is necessary, therefore, to build a through plate girder bridge of 17 m girder length.

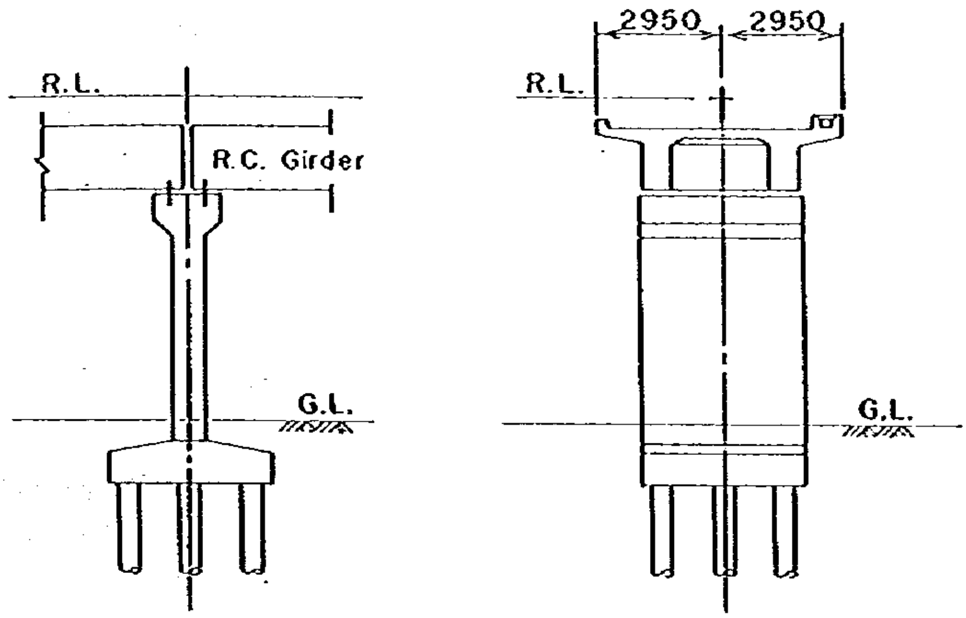


Fig. 6–5–9

6–5–5 Design of Viaduct

(1) Standard Viaduct

According to the past experience, the most economical span length of beam-slab type rigid frame viaduct is 6 to 8 m and the number of spans is 3. A field survey has also proved that this span length features little fluctuation of temperature and seismic coefficient of Kh = 0.1, where it is economically advantageous to apply three or more spans. Therefore, as the standard rigid frame viaduct, a cantilever type of single-track rigid frame viaduct was adopted which features 8 m span length in a series of 4 spans, as shown in Fig. 6–5–10. Also, at the point of connection with bridges, a viaduct equipped with R.C. girders on one side of 2 to 4 spans was used, as shown in Fig. 6–5–11. A viaduct fitted with underground beams was adopted in the elevated area where the supporting layer is situated too deep and the foundation features smaller lateral resistance.

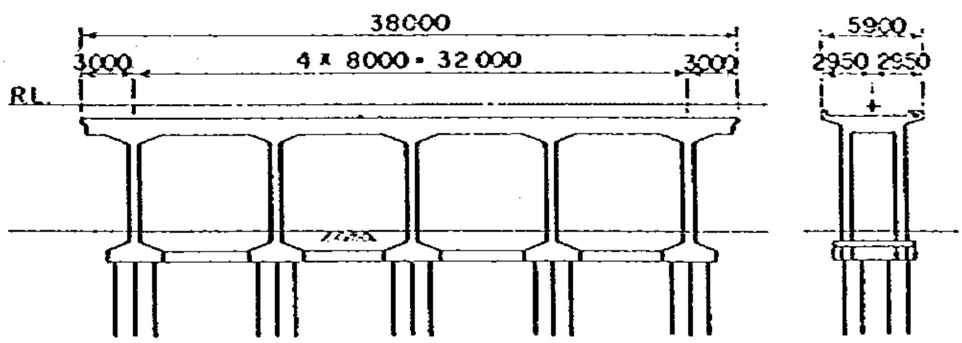


Fig. 6–5–10

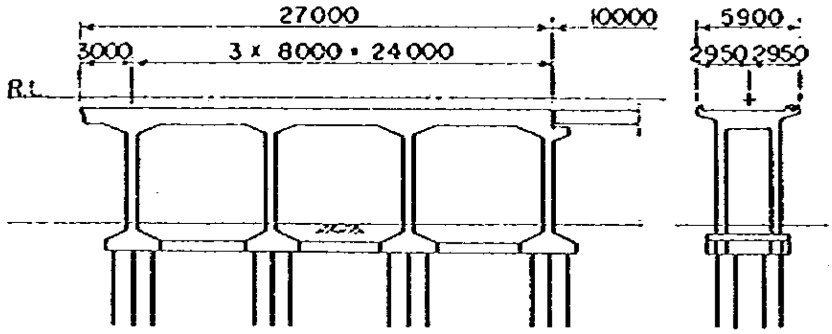


Fig. 6–5–11

(2) Viaduct for the Kota Intan Station

The Kota Intan station is the juncture of the Western and Airport Lines. A dual type of platform was decided upon for this station after studying the convenience of passengers, arrangement of pathways, and conditions of the track layout. According to this detailed design, a platform accommodating a train made up of 4 coaches will be built for both Western and Airport Lines. In the future, however, the Airport Line is expected to require a platform capable of accommodating an 8-coach train. In view of these factors, and after examining the construction of an elevated station, it was concluded that platforms should be separated from the main railway tracks, as shown in Fig. 6–5–12. This is a conclusion reflecting the plan to expand platforms in the future.

The platform of the Western Line features a boxed rigid frame type of structure which also plays its role as a retaining wall against the high embankment of the Western Line. The platform of the Airport Line, on the other hand, features a beam slab type of rigid frame construction.

As for the elevated construction involving the main railway tracks, a double-track rigid frame viaduct is introduced, featuring a dual cantilever with 10 m span length and 3 spans, as shown in Fig. 6–5–13. This is in line with the span conditions of the platform determined by the factors including the pathway, staircase, architectural conditions, etc. Also introduced were underground beams in this construction, because uneven settlement will likely to occur in this area, where the supporting layer under the ground is too deep and the thickness of the layer is not extensive.

The connecting pssageway beneath the Western Line features a boxed rigid frame constitution with a width of 6.0 m and overhead clearance of 2.5 m.

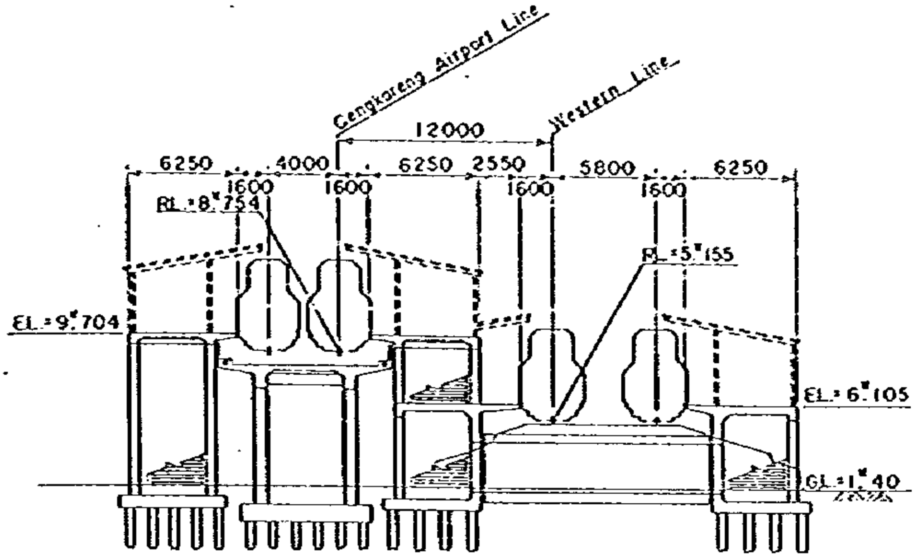


Fig. 6-5-12

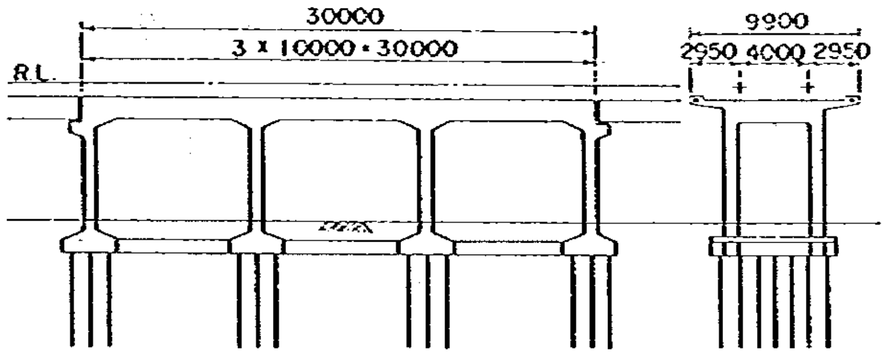


Fig. 6-5-13

(3) Viaduct Crossing Over the Western Line

Since Airport Line will fly over the Western Line at a point of $18^{km}672^{m}50$ in a very skew angle, a part of the Western Line will be relocated temporarily towards the Gudang Freight Yard, and a rigid frame viaduct as shown in Fig. 6-5-14 with two lateral spans, providing a column between the existing Western Line will be constructed.

After completion of the work, the Western Line will be restored to the location beneath the newly constructed viaduct.

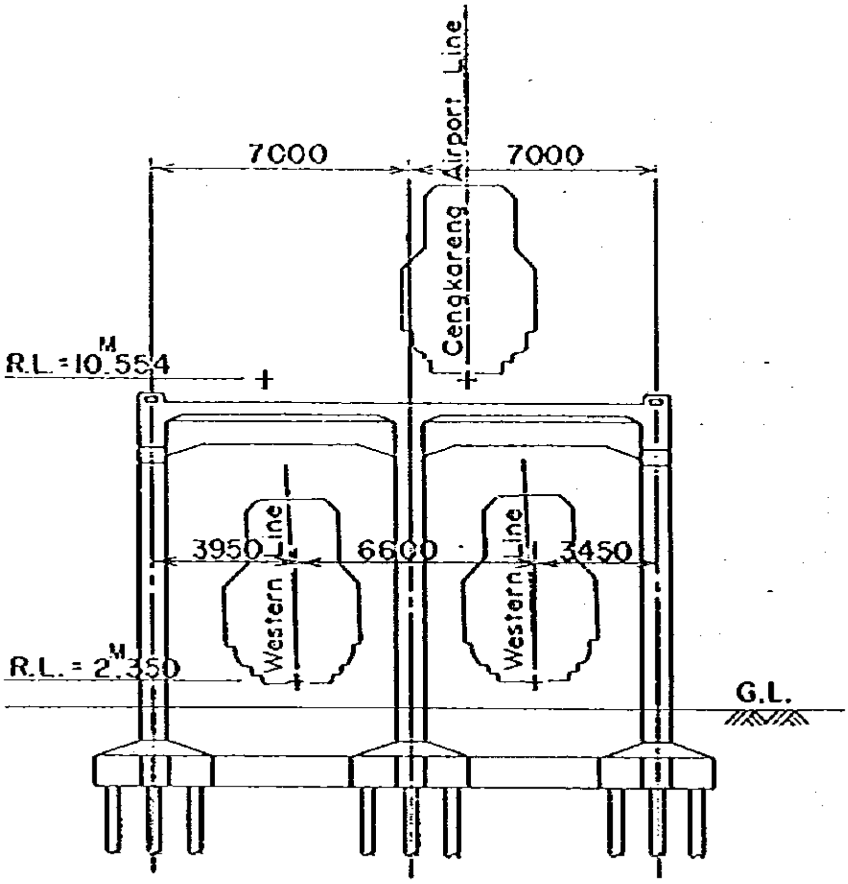


Fig. 6–5–14

(4) Viaduct Crossing Over the Central Line

South-bound line of the Airport Line will fly over the north-bound line of the Central Line at a point adjacent to $19^{km}290^{m}$ where the formation level is the highest throughout the entire length of the Airport Line. A rigid-frame viaduct accommodating both the Central Line (double-track) and the Airport Line (double-track) was adopted. Since this rigid-frame viaduct as shown in Fig. 6–5–15 will partially interfere with the temporary at-grade approach line and will require a split construction method, reinforced concrete steel frame structure therefore was adopted.

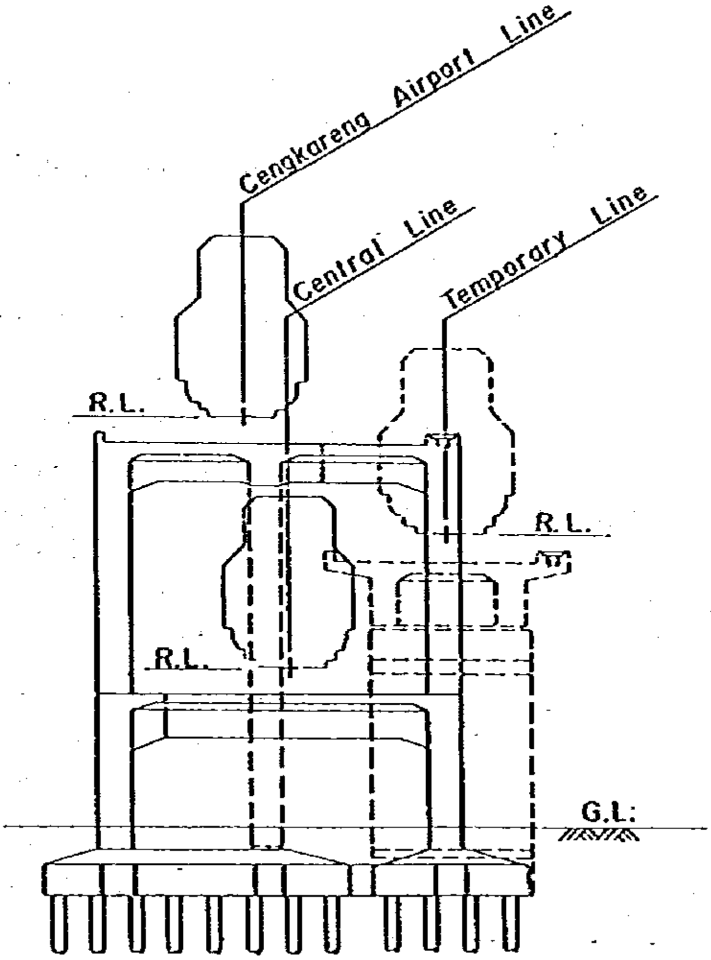

Cengkareng Airport Line
Central Line
Temporary Line
R.L.
R.L.
R.L.
G.L.

Fig. 6-5-15

6-6 Track

6-6-1 Preface

Track is the most fundamental facilities in the railroad which support directly the train load and fulfills its function when laid on the solid roadbed. Track structure should be determined taking into account various factors such as sufficient resistibility in strength against weight and speed of the train, and frequency of the operations, less vibration in movement of rolling stock (car) and less maintenance cost for the track.

In design of track structure for the Cengkareng Airport Line, the following aspects should be taken into account:

As the new Cengkareng Airport line will traverse through the rice field along the beach ridges, occurrence of consolidated settlement and mud-pumping due to heavy annual rainfall would be likely. Since the project location is situated in the tropical area where high ambient temperature throughout the year and heavy rainfall is dominant and less fluctuation in annual and daily temperatures, the construction of the new line and eventual maintenance work would be adversely affected by the environmental conditions.

In recent years, PJKA has made an effort in modernization of track maintenance work by the use of track inspection car and multiple tie-tamper, however, its use has been limited to a certain extent, therefore, efficiency in the construction of the new line and track maintenance work would be encountered in difficulty.

Currently, a number of railway renewal projects have been implemented under "JABOTABEK project". Design criteria for the track structure for this project should be compatible with the said project.

6-6-2 Basic Design Criteria

The basic design criteria are shown below.

(1) Gauge 1,067 mm

(2) Slack

Slack should be provided to allow for smooth-running of the cars on curves. The amount of slack will comply with the following PJKA standards:

Table 6-6-1 Slack Specified by PJKA

Curve Radius (m)	Slack (mm)	Widened Gauge (mm)
500 and more	0	1,067
400	5	1,072
300	5	1,072
250	10	1,077
200	15	1,082
150	20	1,087
100	20	1,087

(3) Horizontal Curve

In selecting the railway route, it is desirable both from the train operation as well as the train maintenance viewpoint that curves be kept at a minimum and that curves be of wide radius. As the degree of curve radius directly affects construction costs, the curve radius was determined in relationship of speed requirements and costs.

In planning the new line the standard for minimum radius of curvature was selected in relation to designed speed as shown in the following table.

Minimum Radius of Curvature

Item	Standard
Main track	600 m (300)
Turnout curve behind frog	320 m (160)
Section along platform	600 m (500)
Side track	160 m (turnout curve behind frog)

Note 1: Indication in parentheses is applicable in unavoidable cases.

In actual design of the rout mainly radius of curvature of 1,000 m was used while 500 m radius used only partially in the densely populated residential areas.

(4) Cant

The PJKA cant standards were applied.

In determining the cant, for trains travelling at speeds faster the designated speed, the outward lateral acceleration must be kept within the limits, and for trains travelling at low speed, the inward lateral acceleration must be kept within the limits.

1) Maximum Cant

Maximum cant must be determined with consideration of such conditions as adequate safety from possible inward overturn of train cars when stopped or travelling at a slow speed on the curved section from winds blowing from outside the curve or discomfort to passengers caused by the tilt of the car body of trains at a standstill or travelling at a slow speed.

The maximum cant according to PJKA standards is 110 mm, which is the same as the maximum cant as used in the countries where narrow gauge is used in the railways.

2) Actual Cant

The PJKA uses the following formula for calculation of actual cant.

$$C = 6\frac{V^2}{R}$$

V : Maximum train speed (km/h)
R : Curvature radius (m)

Table 6–6–2 shows the cant calculated according to the above formula. The above formula shows that the actual cant set is approximately 70% of the equilibrium cant (= 8.86 V^2/R). That is;

$$6\frac{V^2}{R} \div 8.86\frac{V^2}{R} = 0.68 \fallingdotseq 0.7$$

3) Maximum Cant Deficiency

The allowable limit for maximum cant deficiency is determined by conditions such as the riding comfort not affected by the excessive centrifugal force or overturning of the car outwards because of vibration or side wind when the car is passing on the curve. The PJKA standard for maximum cant deficiency is 54 mm.

Table 6-6-2 Cant Specified by PJKA

Curve Radius m	120–101 km/h	100–91 km/h	90–76 km/h	75–66 km/h	65–61 km/h	60–46 km/h	45–31 km/h
110							110
120							100
140							85
150							80
160							75
170							70
195						110	60
200						110	60
230					110	95	55
250					110	85	50
300				110	85	70	40
350				95	70	60	35
400				85	65	50	30
440			110	75	60	50	30
450			105	75	55	45	25
500			95	65	50	40	25
540		110	90	65	45	40	25
550		105	85	60	45	40	20
600		100	80	55	40	35	20
650		90	75	50	40	35	20
700		85	70	50	35	30	20
750		80	65	45	35	30	15
780	110	75	60	45	35	30	15
800	105	75	60	40	30	25	15
850	100	70	55	40	30	25	15
900	95	65	55	35	30	25	15
950	90	60	50	35	25	25	15
1,000	85	60	50	35	25	20	10
1,100	80	55	45	30	25	20	10
1,200	70	50	40	30	20	20	10
1,300	65	45	35	25	20	15	10
1,500	55	40	30	20	15	15	10
1,750	50	35	25	20	15	10	5
2,000	45	30	25	15	15	10	5
2,500	35	25	20	15	10	10	5
3,000	30	20	15	10	10	5	5
4,000	20	15	10	10	5	5	5

The cant values for radius of curve of 1,000 m and 500 m on the new line is shown in the following table.

Curvature Radius and Actual Cant Values

Item	1,000 R	500 R	Limit Value
Train Speed (km/h)	100	82	
Actual Cant (mm)	60	80	< 110
Equilibrium Cant (mm)	87	119	
Deficiency of Cant (mm)	27	39	< 54

Table 6–6–3 shows the cant of all types of curves for the new railway line.

(5) Transition Curve

Transition curves are provided to ease the abrupt change in the unequilibrium centrifugal force and cant between the straight section and the curved section at the beginning and end of a circular curve. Configuration and length of such transition curve should conform to PJKA standards. Its form is a cubic parabola and its length is as follows:

$L = 10\,VC \qquad L \geq 400C$

L : Transition curve length (m)

V : Maximum speed (km/h)

C : Cant (m)

(6) Gradient

Gradients on railway lines have direct and great influence on the hauling power of locomotives and the speed of trains and considerable influence on maintenance costs of railways and operational costs of trains. Consequently, it is desirable to have gradients as gentle as possible. As the new line is exclusively for passenger use, the maximum gradient was fixed at 25 o/oo.

Table 6-6-3 Table of Curves

BTC	ETC	R (m)	I	C (mm)	TCL (m)	Speed (km/h)			Remarks
						Vactual	Veq.	Val.	
km m	km m		° ' "						
0.210.00	0.267.00	500	4.45.49	25	15	100	38	66	
2.257.69	2.697.28	1,000	21.44.51	60	60	100	82	100	
3.703.16	4.182.94	1,000	24.03.01	60	60	100	82	100	
4.665.00	4.722.00	500	4.45.49	25	15	45	38	66	
4.764.31	5.229.80	1,000	23.13.55	60	60	100	82	100	
7.626.23	8.402.93	1,000	41.03.44	60	60	100	82	100	
9.493.52	9.914.27	1,000	20.40.05	60	60	100	82	100	
12.224.00	12.281.00	500	4.45.49	25	15	45	38	66	
13.015.89	13.165.17	1,000	5.06.50	60	60	100	82	100	
13.841.61	14.108.04	1,000	11.49.35	60	60	100	82	100	
14.421.78	14.607.94	1,000	7.13.38	60	60	100	82	100	
14.978.06	15.188.50	1,000	8.37.07	60	60	100	82	100	
16.533.30	16.865.39	1,000	15.35.17	60	60	100	82	100	
17.490.00	17.546.57	500	4.45.49	25	15	45	38	66	
17.850.76	18.281.55	500	42.28.44	80	60	82	67	87	
18.308.93	18.394.00	1,400	2.27.30	30	25	82	69	100	
18.602.56	19.052.18	500	44.38.11	80	60	80	67	87	
19.052.18	19.098.86	300	7.00.22	20	10	40	26	50	
19.098.86	19.145.54	300	7.00.22	20	10	40	26	50	al grade
19.561.79	19.774.66	700	16.36.18	20	10	60	40	76	
20.057.27	20.113.84	500	4.45.49	25	15	45	38	66	West B
19.496.38	19.806.19	600	3.50.00	15	10	40	32	68	East B

$$c = 6 \frac{V^2}{R}$$

$$Veq = 0.336\sqrt{RC}$$

$$Val = 0.336\sqrt{R(c + 54)}$$

(7) Vertical Curve

Wherever there are changes in the gradient and there is doubt in the passenger riding quality suffering or derailment from damaged coupler, vertical curves will be provided to ensure smooth running of trains.

As standard for this line vertical curves (R = 3,000 m) will be provided for straight sections while (R = 4,000 m) vertical curve provided for curved sections with plan radius of curve less than 800 m.

6-6-3 Track Structure Design

(1) Selection of Track Structure

Track is a structure which can fulfill its own function only when it is given proper maintenance on a routine basis. It is composed of rail, rail fastening, sleeper and roadbed, and through the combination of these components various track structures can be conceived. It is only natural that the higher the construction cost of the track structure, the lower, generally, will be the maintenance cost. The track structure which requires the lowest total for construction capital plus maintenance cost is considered the most rational.

The total of construction capital and maintenance cost is calculated according to the following formula:

$$\text{Annual capital cost} = \begin{matrix}\text{Invested capital} \\ \text{x Interest}\end{matrix} + \frac{\text{Invested capital} - \text{Remaining capital}}{\text{Durable service life}}$$

Annual maintenance cost = maintenance cost + material cost

Maintenance cost may be obtained in the following manner. This is to use the method developed by the Japanese National Railways to calculate the required maintenance staff for their operational tracks in 1959. Although this method may have its problems as conditions in Japan are different from those in Indonesia. However, estimates of the effect of track structure on maintenance staff and maintenance costs by category may be obtained by this method.

$Y = 0.730 + 0.125\ PLM + 0.026T$

Y: Maintenance staff for 1 km of converted track length.

P: Coefficient of maintenance arising from differences in track maintenance standards according to priorities of importance given each line. The Cengkareng Airport Line is considered a 2nd Class line according to the JNR classification, and its coefficient would be 0.70.

JNR Classification	1st Class	2nd Class	3rd Class	4th Class
P	1.00	0.704	0.577	0.526

L: Called the load coefficient, which has an effect on track irregularities and is calculated according to the following formula:

L = (Passing tonnage) x (Car coefficient of wheel and axle) x (Car speed)

Car coefficient is determined with particular attention to the effect imparted by the weight of the upper part of the car springs on the ballast.

Type of Car	Coefficient
Locomotive	0.40
Freight Car	0.27
Electric Railcar	0.24
Coach	0.20
High-speed Electric Railcar	0.18

The coefficient of 0.24 is used for the Cengkareng Airport Line.

M: Called the structural coefficient, which expresses track strength.
It is;

$$M = P_b \cdot \ddot{Y} \cdot S$$

Pb: Maximum ballast pressure for a constant value of wheel load, to be explained later.

$\ddot{Y}$: Maximum ballast vibration acceleration for a constant value of wheel impact.

$$\ddot{Y} = \sqrt{K_1} / \sqrt{m}$$

K_1: Sleeper (pad) spring constant

m: Ballast bearing mass

S: Impact coefficient denoting large or small impact of car track structure.

$$S = \frac{1}{EI_x \cdot \beta^3}$$

EI_x: Bending strength of rail

$$\beta = \sqrt[4]{\frac{k}{4\,EI_x}}$$

k: Rail bearing spring constant (sleeper and roadbed)

As a matter of fact, the ratio to the standard as determined from the value M for the specific track structure is called 'structure coefficient' for each track.

T: Passing tonnage for one year

If annual cost of one maintenance staff is C,
Annual maintenance cost = CY + material costs

The annual investment cost and result of comparative calculation of annual investment cost are given below.

R14A, R50 and R54 rails, wooden sleeper and PC sleeper and ballast thickness of 200 mm, 250 mm and 300 mm were selected for the comparative calvalation, and structure coefficient in respective combination were calculated. The result are shown in Table 6-6-4.

The standard track structure for each class as calculated by the PJKA considering annual passing tonnage is given in Table 6-6-5.

The optimum track structure calculated from the condition of the roadbed by the JNR is shown in Table 6-6-6.

Based on the passing tonnage and speed, new Cengkareng Airport Line will correspond to Class 6 of the PJKA and to Class 2 of the JNR. Investment cost and maintenance cost was calculated for the following 4 types of track structures:

Annual maintenance costs

$T = 11{,}000{,}000$ ton/year $= 0.11 \times 10^8$ ton/year

$L = 0.11 \times 0.24 \times 90 = 2.38$

$P = 0.70$

$C =$ Rp 83,561/man month x 12 months = Rp 1,002,700/man year

No.	Track Structure	Maintenance personnel Y per 1 km a year	Annual maintenance cost for total line
1	R50, PC44,250	1,225 man	Rp 24,460 x 10^3
2	R50, PC44,300	1,204	23,982 x 10^3
3	R54, PC44,250	1,200	23,896 x 10^3
4	R54,PC44,300	1,184	23,579 x 10^3

Table 6–6–4 Structure Coefficient M

R50	PC (44/25m)	200mm	1.10
"	"	250	1.00
"	"	300	0.90
R54	"	200	0.97
"	"	250	0.88
"	"	300	0.80
R14A	"	200	1.43
"	"	250	1.27
"	"	300	1.17
R50	Wooden (44/25m)	200mm	1.12
"	"	250	1.05
"	"	300	0.97
R54	"	200	0.98
"	"	250	0.92
"	"	300	0.85
R14A	"	200	1.45
"	"	250	1.36
"	"	300	1.26

Note: Figures show the value of the structure coefficient expressed in the ratio against that of standard track structure using R50, PC 44, 250 mm.

Table 6–6–5 PJKA Standard Track Structure

No.	Class of Track (UIC)		Axle Load (ton)	Train Speed (km/h)	Rail	Fastening	Sleeper		Ballast (cm)
	Class	Passing Tonnage (ton/day)					Quality	Quantity	
1	4	$50{,}000 \geq T > 28{,}000$	18	120	R54 R50	EG	Concrete	1,666	30
2	5	$28{,}000 \geq T > 14{,}000$	15	120	R42	EG	Concrete	1,666	30
3	6	$14{,}000 \geq T > 7{,}000$	15	100	R42	EG ET	Concrete Wood Steel	1,666	25 20
4	7	$7{,}000 \geq T > 3{,}500$	15	80	R42	EG ET	Wood Steel	1,500	20
5	8	$3{,}500 \geq T > 1{,}500$	15	60	R42	EG ET	Wood Steel	1,500	20
6	9	$1{,}500 \geq T$	13	60	R33	K	Wood Steel	1,430	15

Notes:

a. EG = Double Elastic Fastening
ET = Single Elastic Fastening
K = Rigid Fastening

b. Weight of Rail
R54 = 54.43 kg/m
R50 = 50.40 kg/m
R42 = 42.59 kg/m
R33 = 33.40 kg/m

c. Steel sleeper apply to non-electrified section.

Table 6-6-6 Optimum Track Structure (JNR)

Class	Passing Tonnage million ton/year	Roadbed Condition	
		Good Condition	Sinking
1	20 >	60, PC44, 250	60, PC44, 350
2	10 ∿ 20	50, PC44, 250	60, PC44, 300
3	8 ∿ 10 5 ∿ 8	50, PC39, 200 50*, W39, 200	50, PC44, 250 50, PC39, 250
4	3 ∿ 5 >3	50*, W37, 200 50*, W37, 150	50, W39, 200 50*, W39, 200

50* = Secondhand Rail

Annual capital cost

Rail:

$$\text{Annual capital cost difference} = \text{Capital cost difference} \times p + \frac{\text{Capital cost difference} \times (1-\alpha)}{n}$$

p : Interest = 0.035

$1-\alpha$: Residual value ratio = 0.55

n : Durable service life = 40

The difference in capital cost between R50 and R54 (= difference in rail weight) for the whole line is Rp100,000 x 10^3. Hence the annual capital cost difference is:

Rp4,625 x 10^3

Ballast thickness:

The increase in ballast thickness from 250 mm to 300 mm will result in increased ballast volume and increased girder construction cost because of increased dead load. The difference in capital cost will be Rp380,000 x 10^3. The annual capital cost difference, with the ballast service years at n = 40, the girder life at n = 50 and α = 0 for the redisual value ratio, will be:

Rp21,500 x 10^3

Conclusion

Results of tentative calculations on annual maintenance cost and capital cost are given below.

Rail:

The difference in annual maintenance costs between rails of R50 and R54 are, in case of 250 mm ballast thickness, Rp564 x 10^3, and in case of 300 mm ballast thickness, Rp403 x 10^3, so that it will not compensate for the annual increase in capital cost of Rp4,625 x 10^3 which will be incurred if the R54 rail is selected. However, in the selection of the 50 kg/m class of rail special attention was given to consistency with the national future plan and its international compatibility. These were the reasons for the R54, which is of the same class as the international UIC54, being selected rather than the R50 in the 50 kg/m class of rail.

Ballast thickness:

Comparing the annual maintenance costs of the 250 mm ballast thickness proposes and the 300 mm ballast thickness, in the case of R50 rail, the difference will be Rp478 x 10^3 and in the case of the R54, Rp317 x 10^3. These figures will not compensate for the annual capital cost of Rp21,500 x 10^3 and will not have the effect of minimizing the maintenance costs.

The above economic comparisons were made on calculations on track on a normal roadbed.

According to the preceding Table 6–6–6 the JNR proposed the 300 mm ballast thickness for sectors which carry an annual passing tonnage of 1,000 tons to 2,000 tons and sectors with unsatisfactory roadbed foundation. The roadbed of the new Cengkareng Airport railway cannot be considered satisfactory and should more appropriately be classified as unsatisfactory.

Although plans to improve track maintenance operations are now underway, decline in track maintenance improvement work is believed to be unavoidable, given the high humidity, and plentiful rainfall of the tropical area in which the railway is located.

For the above reasons, the 300 mm ballast thickness was selected.
Track structure for the new railway line is shown in Table 6–6–7.

Table 6–6–7 Track Structure for Cengkareng Airport Line

Rail	Fastening	Sleeper		Ballast (cm)
		Quality	Quantity	
R54	Elastic Type	PC Sleeper	1,760/km	30

(2) Partial Track Stress

Stress at each part of the track structure, selected as explained in the foregoing, was studied in detail.

(3) Rail

1) Rail Section

R54 rail section is shown in Fig. 6–6–1.

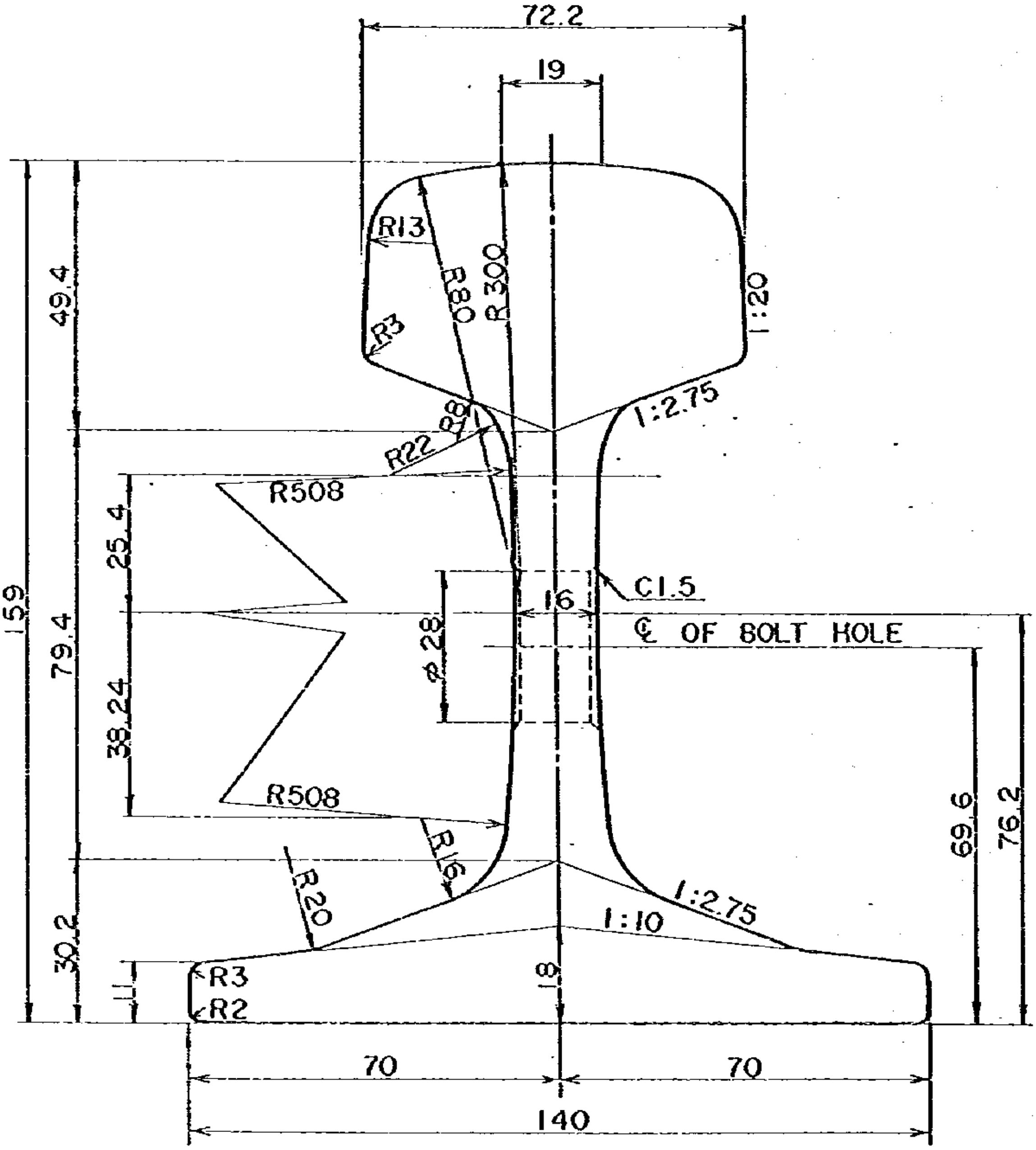


Fig. 6–6–1 R54 Rail Section (54.4 kg/m)

2) Standard Rail Length

In the past, PJKA used as their standard, 17 m long rail. In the case of semi-long rails, rails would be welded into 85 m lengths in the plant and transported to the site. For this project, the standard length of the rails will be 25 m and welded to the length of 100 m at site. This is a preparatory step anticipating the future employment of long rails and is intended to reduce the number of welded joints which is one of the weak points of long rails.

There would be no problem envisaged at loading/unloading facilities at port for the transport of 25 m rails, however, there would be a certain difficulties for the rail transport in the Jakarta City.

3) Rail Strength

In general, steel of the rail would require tensile strength of 70 to 90 kg/mm^2. For this project, rails of 80 kg/mm^2 were selected. In addition, steel for the rail should be resistable to abrasion, fatigue from contact, and weldable. Therefore, manufacturing method and chemical composition should be determined to meet all the above requirements.

(4) Rail Welding

1) Rail Length

PJKA has used 85 m rails (17m x 5) for the track structure consisting of R14 rails and wooden sleepers and it is planned to use 75 m rails (25m x 3) for the track structure with 50N rails and wooden sleepers in the near future. For this project, 100 m rails (25 m x 4) were selected due to the fact that PC sleepers of which ballast resistance is greater than those of wooden sleepers and R54 rails will be used.

2) Rail Joint Welding

Thermit welding will be employed for the rail joints which forms semi-long rails in consideration of welding on site; less expense, and sufficient experiences in PJKA.

3) Rail Expansion and Contraction, and Joint Gap of R54 Rails (100 m)

Joint gaps should properly be determined after giving consideration to the track being free from buckling at the maximum temperature and the joint bolts being free from excessive stress at the minimum temperature.

In order to determine the appropriate joint gap, it is necessary to comprehend the quantitative relation between, rail length, rail temperature variation, joint gap and rail axle force.

Relation (connection) between joint gap and rail temperature when 100 m R54 rails laid is shown in Fig. 6-6-2.

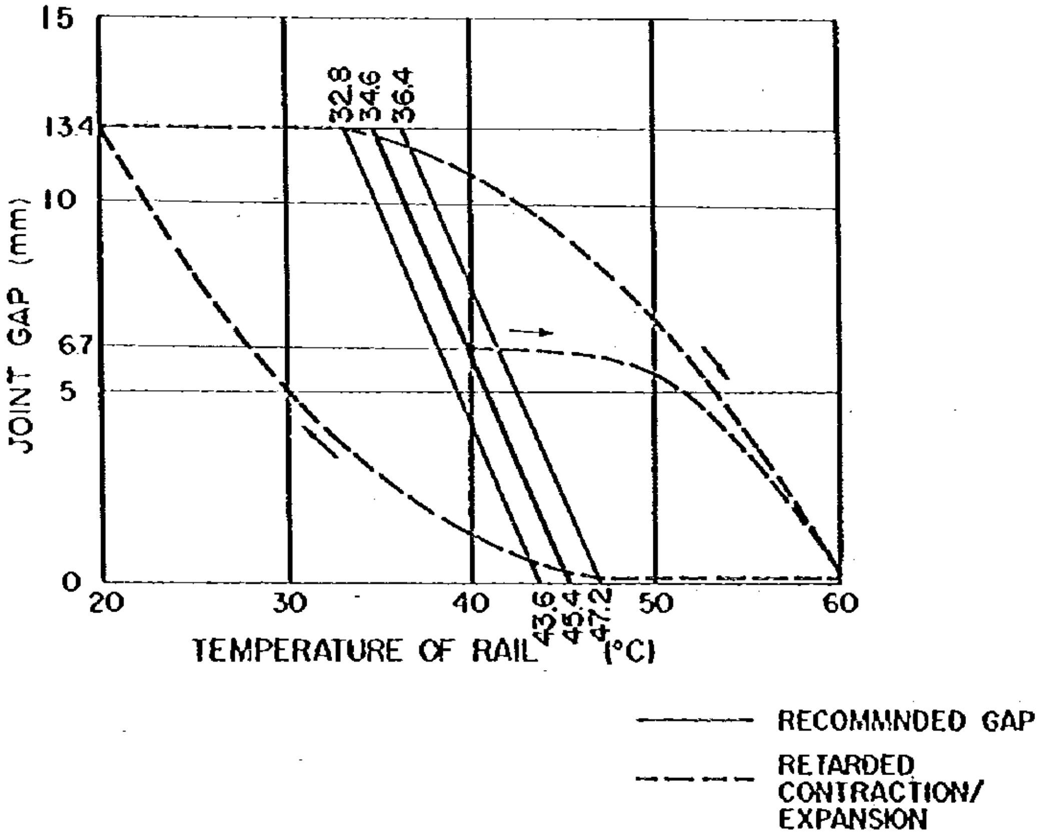


Fig. 6-6-2 t - e LOOP

4) Adaptability of Long Rails

The result of the study on expansion/contraction and joint gap of 100 m rails has suggested adaptability of long rails more than 100 meters length, however, further study should be made through a thorough study and tests on resistance value of ballast and effect of roadbed settlement.

(5) Rail Joint and Insulation Joint

The opposite joint which is conventionally used has been used in this project. There are two kinds of joints, the suspended joint and the supported joint. For this new railway, the common use of the insulation point and the ordinary joint was considered, but since the suspended joint method would provide better insulation joint structure it would avoid insulation troubles of the track circuit than the supported joint method, the former was selected. Consequently, the ordinary joints will also be made in the suspended joint method.

PC sleepers and wooden sleepers were studied for joint sleepers, but PC sleepers do not have proven records for the joints, wooden sleepers were therefore selected for the project.

The joint fastening selected is an elastic type using a plate spring which is also used in the insulation joint.

The number of bolts at each joint and the distance between joint holes will comply with the PJKA standards for R54 rails.

(6) Prestressed Concrete Sleepers

The main role of a sleeper is to hold the rail securely and to support the track alignment accurately, and at the same time to disperse the dynamic load of the train transmitted from rails as widely as possible over the whole ballast surface.

Sleepers used by railways comprise wooden, steel, RC and PC, of which the PC is the most recently developed. It is being manufactured in great numbers and being extensively used.

The PC sleepers were recommended for the following reasons;

- track structure can be strengthened,
- maintenance costs can be saved,
- heavy manual labor for replacing the sleepers can be reduced.

1) Types of PC Sleepers

a) Classification by Manufacturing Method

There are two methods of manufacturing PC sleepers, the pretensioning and posttensioning methods. In the pretensioning method, PC steel wires are preset in the mould and applied the required tensile force prior to placing the concrete into the mould. After the concrete has hardened to the desired strength, the PC steel wires extended out of the mould is cut off. The cohesive strength of the concrete on the PC wires is activated and the prestress is induced into the concrete.

In the posttensioning method, the PC wires are coated with unbonding material before placing in the mould. The concrete is then poured and tensile force is then given to the PC steel and prestress is given to the concrete.

Furthermore, PC steel bars have the advantage that they can be relieved from any strained force because stress is dispersed widely over the full length of the PC steel bar, because no cohesive force is lost even after its service.

b) Classification by Special Properties

As seen in the classification by manufacturing process, there are two types of PC sleepers.

Their special properties are shown in the following Table 6–6–8.

Table 6–6–8 Properties of PC Sleeper

ITEM		UNIT	PROPERTY	
TYPE			PRETENSIONING	POSTTENSIONING
LENGTH		Cm	200	200
WIDTH OF BOTTOM	Max.	Cm	24	24
	Min.	Cm	24	24
WIDTH OF TOP	Max.	Cm	20.24	20.24
	Min.	Cm	18.76	18.76
HEIGHT	Max.	Cm	16.57	16.57
	Min.	Cm	13	13
WEIGHT		Kg	163	163
PC STEEL MATERIALS	Diameter	mm	2.9	10
	Kind		3-stranded steel wires	Steel bar
	Number	PC	12	4
TENSILE FORCE	Initial	t	35.16	29.6
	Effective	t	22.85	23.68
MECHANICAL PROPERTY OF PC STEEL MATERIALS	Limit Load	6/one wire or bar	3.90	10.5
	Load at Yield Point	"	3.45	9.6
	Elongation	%	3.5	5.0
COMPRESSIVE STRENGTH OF CONCRETE (TEST PIECE: ϕ10cm x 20cm)		kg/cm²	500	450

2) Design of PC Sleepers

a) Material strength

– Concrete

Designed standard strength
(Columnar test specimen ϕ 10 x 20 cm)
Pretensioning method 500 kg/cm²
Posttensioning method 450 kg/cm²

Compressive strength at induction of prestress
(Columnar test specimen ϕ10 x 20 cm)

Pretensioning method	400 kg/cm²
Posttensioning method	300 kg/cm²

– Tendon

Pretensioning method – Deformed steel wire ϕ2.9 mm x 3	
Tensile strength	over 3,900 kg
Yield point strength	over 3,350 kg
Posttensioning method – PC steel bar	ϕ10mm
Tensile strength	10,500 kg or more
Yield point strength	9,600 kg or more

b) Load

Rail lateral pressure is taken into account for the curved section of 300 m ≦ R≦ 800 m. Rail pressure and rail lateral pressure are calculated as follows:

Basic data is as follows:

Axle load W	= 16 tons	Dispersion coefficient	D_1 = 0.5
		Extra coefficient	i_1 = 1.0
Lateral load Q	Normal lateral press. 3 tons		
		Dispersion coefficient	D_2 = 0.5
	Casual lateral press. 6 tons		
		Extra coefficient	i_2 = 0.5

From these figures, rail pressure and rail lateral pressure can be obtained.

Rail pressure $P = 16t \times 1/2 \times 0.5 \times (1 + 1.0) = 8.0$ tons

Rail lateral pressure

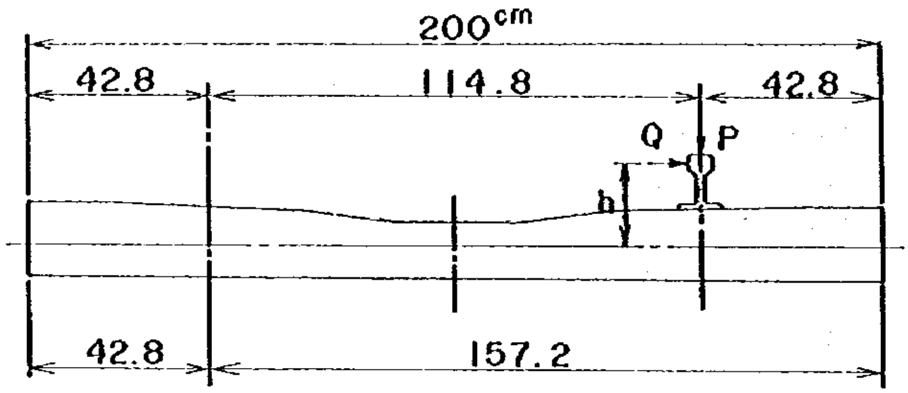
Normal $Q_F = 3t \times 0.5 \times (1 + 0.5) = 2.25$ tons

Casual $Q_S = 6t \times 0.5 \times (1 + 0.5) = 4.5$ tons

Distribution coefficient is meant to be the coefficient expressing the wheel load which is the half of axle load is distributed due to rigidity of the rail and becomes approx. 40% to 50% of the wheel (load) at the location where the maximum load immediately below the wheel. Extra coefficient is meant to be the coefficient considering the extra ordinary great impact distributed by the rail upon passing of the train at high speed or when there is a flat tire on the wheel.

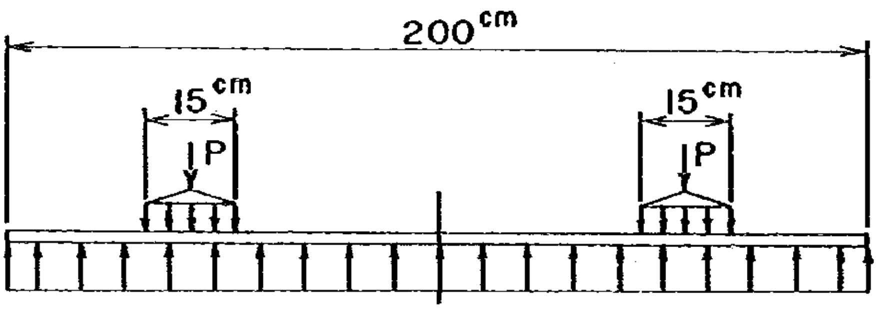
c) Assumed ballast reaction

The distribution pattern of ballast reaction is beleived to vary largely depending on the ballast material used and on the tamping method used. The following loading conditions are used for design calculation.



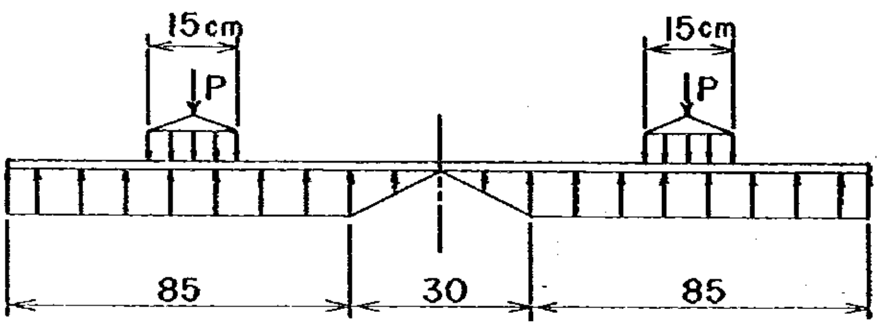
– For only rail pressure.

(Load A)



On assumed condition that ballast reaction is the same for each unit length of sleeper.

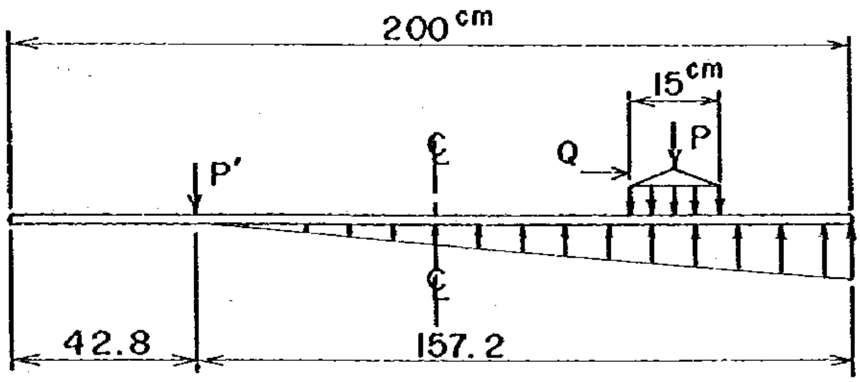
(Load B)



Under the assumed condition immediately after ballast tamping, that ballast reaction at the center of the sleeper would be zero, ballast reaction for each length of 15 cm to both sides from the center would form a pattern of triangular distribution and ballast reaction in any other part would be equalized.

– For rail lateral pressure and rail pressure

(Load C)



P' : Assumed load

P : Rail pressure

Q : Rail lateral pressure

Taking the rail pressure and the rail lateral pressure of only one side and assuming that the reaction to the rail position on the other side to be 0 and that the ballast distribution would be in a triangular pattern.

d) Designed bending moment

Bending moment below the rail and at the center of the rail has been calculated from the three assumed cases mentioned in the foregoing ballast reactions, and the greatest bending moment selected as the designed bending moment. This will be used in the examination of section.

(7) Rail Fastening Devices

1) General Requirements

Fastening devices for PC sleepers will meet the following requirements:

a) In principle, fastening devices will be elastic.

b) Rail section will be of R54 rail.

c) To maintain stability both in vertical and lateral direction to the rails.

d) To be controllable against movement in longitudinal direction.

e) To be absorbable against vibration caused by running wheels.

f) Fastening devices will be of an assembly with minimum number of parts and readily operable for assembly and disassembly.

g) Fastening devices will be capable of being assembled and re-assembled at site and be handled with hand tools by workman.

h) Fastening devices should be electrically insulated between rail and supports.

2) Structure and Performance of Components

a) Rail fastening springs.

- To press the rail against sleepers, to eliminate the space in between and to keep the pad constantly in compressed condition.
- Spring constant should be small.
- The stress of spring caused by train load shall be within the fatigue limit of the steel springs.
- Materials of springs shall be steel spring.

b) Rail pads shall be composed of natural rubber or synthetic resin with molding work.

The following quality tests are required for the rail pads.

- Compression deformation test
- Tension test
- Elastic modulus test
- Bending fatigue test
- Compression permanent strain test
- Oil proof test
- Electric resistance test

3) Performance Tests for Fastening Devices

Tests for fastening devices are as follows:

a) Spring constant of springs

b) Stress of springs

c) Spring constant of rail pads

d) Vertical spring constant of entire device

e) Lateral spring constant of entire device

f) Resistance to rail creepage

g) Amount of lateral movement of rails

h) Allowance for clearance adjustment

i) Lateral pressure strength

(8) Ballast

1) Ballast Characteristics

Generally required conditions for ballast are as follows:

- To be of hard and strong quality especially resistant to abrasion and weathering.
- To be composed of suitable grain size and shape for easy tamping and maintenance work such that trackbed would not be deformed by the passing trains.
- To be available at anywhere in great quantities at low cost.

2) Grain Size

Where there are large voids in the ballast, resistance to settlement will be reduced. Crushed stones of various grain sizes should be appropriately mixed. Fig. 6-6-3 shows the gradation range of ballast.

3) Quarries

Ballast quarries are situated at Suda Manik and Kuari Mas some 70 kilometers southwest of Jakarta. Materials are of andesite, hard and suitable for track ballast.

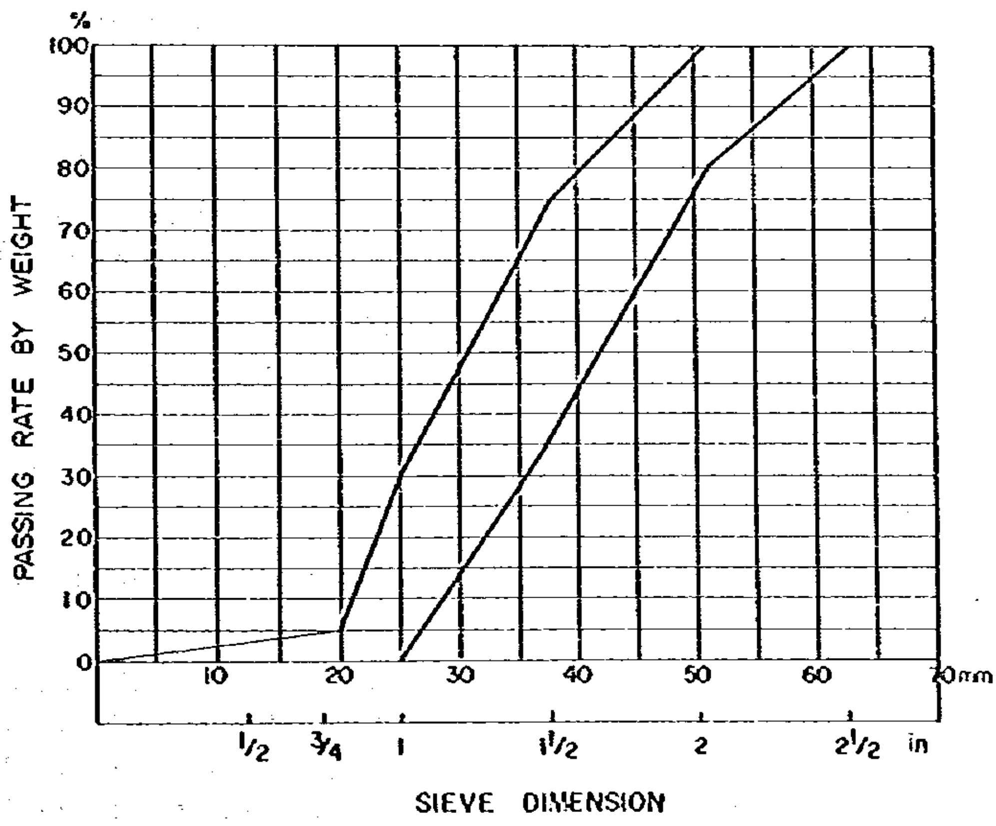


Fig. 6-6-3 Gradation Range of Ballast

(9) Track Structure on Bridges and Safety Sidings

Track structure on through girder was not specifically designed as it consists of one unit of 16 meter span. A proposal to apply the track structure of the general sector (including wooden sleeper, suspended joint structure, tie plates and plate spring type) has been adopted.

Regarding track structure on safety sidings, because of short track length after tuning out, some 20 to 30 meters, it was decided to use R54 rails which are used on the main line with wooden sleepers and track spikes.

(10) Level Crossing

Pavement at level crossing should account for train load and wheel load of vehicles.

There are various types of pavement structure consisted of used wooden sleepers, hard wood materials, stone materials, concrete blocks, asphalt paving, and cast-in-place reinforced concrete.

As considerable traffic volume is expected after opening of the airport continuous track block structure will be used for eleven (11) level crossings where relatively heavy traffic envisaged while hard wood materials will be placed for other level crossings.

The structure of continuous concrete block level crossing is in principle, comprise the wider concrete sleepers being continuously laid applying tension longitudinally and forming a rigid structure. In this project, concrete block in a width of 1.0 m and 2.0 m length has been used for this purpose.

(11) Turnouts

The PJKA has been using turnouts Nos. 9, 10, 11 and 12. As a result of the standardization of track materials in recent years, the turnout numbers have been unified to Nos. 10 and 12.

Turnouts being used may be classified into the following types:

No. 12	Simple turnout
No. 12	Inside curve turnout
No. 10	Simple turnout
No. 10	Runover type turnout

No. 12 Simple turnout: After study of the train operation line diagram, this turnout capable of 45 km/h allowable speed on turnout track was selected.

No. 12 Inside curve turnout: This is the turnout needed for the ground level connection between the new Cengkareng Airport line and the Central line and which will be removed after the completion of the viaduct on the Central line. No point guard will be provided because the train will be operated by trailing only on turnout track for the time being and as there will be no danger of derailment due to worn-out switch end.

No. 10 Simple turnout: This will be used for the emergency connecting track.

No. 10 Runover turnout: This will be used for the branch-off of the safety side track.

(12) Car Stops

Car stops are required to have the strength to stop overrunning cars; they must also have buffering capability to absorb the shock on such occasions.

On this railway, sand drag type and hydraulic damper type were selected; the former will be installed at the end of sidings of signal stations and stations other than the airport station, while the latter will be installed at the ends of platforms of the airport station.

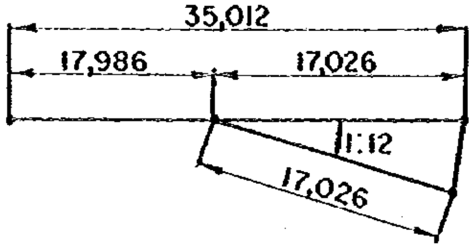
(13) Railroad Signs

Various railroad signs will be provided to indicate necessary operating conditions to train-driver, to provide necessary guidance to track maintenance workers and to caution the general public. They are:

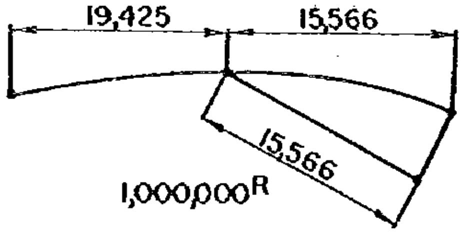
Distance post
Grade post
Curve post
Runoff post
Inspection gang clearance post
Station post
Bridge post
Speed control sign
Speed control-off sign
Clearance post of tracks
Track end indicator
Whistle board
Level crossing warning sign

The form and shape of these markers will be similar to the railroad signs as used by the PJKA.

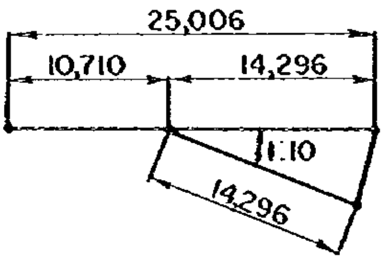
1:12 SIMPLE TURNOUT



1:12 CURVED TRACK TURNOUT FOR INNER DIRECTION



1:10 SIMPLE TURNOUT



1:10 RUN OVER TYPE TURNOUT

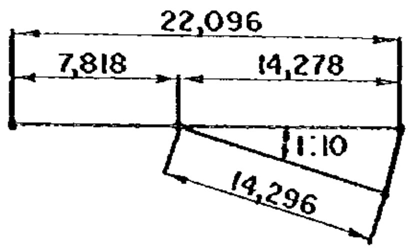


Fig. 6-6-4 Turnout Skeleton

6–6–4 Track Construction Work

(1) Introduction

In railway construction, track work begins when the greater part of the civil work for road-bed has been completed. Consequently, depending on the time of commencement of operations, a rapid construction method may have to be considered. This track work has been planned as part of the process for construction of a new railway.

Track construction has the following characteristics:

1) As stockpile yard for rails will be limited, length of the work of respective party will be long.

2) Accuracy measured in the unit of millimeter will be required of the finished work.

3) The transportation of material plays an important role in track work.

(2) Selection of Track Laying Method

The selection of track laying method depends largely on the local conditions at the project site (such as work section length, period of construction and site environment etc.), so it is important to select the method suitable to the site conditions.

There are two methods; one is to lay a travelling rail and using track crane and another is to lay the track without travelling rails. Generally, there are the following track laying methods.

Methods with the travelling rail.

– to use temporary travelling rails and track panel crane.

Methods without travelling rail.

– Method using track panel laying car
– Temporary track laying method
– Manual laying method

These methods are briefly summarized as below:

1) Method with Travelling Rails and Track Crane

In this method travelling rails are laid on tightly compacted lower ballast and track crane is operated on these rails to lay the track.

Travelling rail is installed first, temporarily at a gauge width of approximately 3 meters, to the end of track laid as shown in Fig. 6–6–5. Track panels are set in place by operation of the lift moving on the rail as shown in Fig. 6–6–6.

Track immediately after being laid, is irregular in alignment, elevation and level, then the lower ballast should be finished 30 to 50 mm lower than the designed level. After spreading the upper ballast by hopper car, the formation level must be raised by multi-tie tamper for final setting of track.

2) Method using Track Panel Car

As shown in Fig. 6–6–7 the track panel laying car is designed for self-running on the finished portion of track and stop near the end of the track. After setting the outriggers in front and back and to right and left, the movable girder is moved to the rear of the car to catch the track panel to be pushed forward on board the cart. When the track panel is lifted up by the rigging, the movable girder is moved forward, and after passing through the car body, lowers the track panel at the designated place. This method does not require a running rail and is the most mechanized method.

3) Temporary Track Method

As shown in Fig. 6–6–8 and Fig. 6–6–9, a temporary track of the same gauge as the existing track is laid at the end of the existing track. The track panel is assembled on this temporary track. The panel is then lifted by a panel lift. The temporary track is then removed. The panel is lowered and the track is now in position. This method requires the least equipment.

4) Labor-intensive Construction Method. (Spreading Method)

After spreading the lower ballast by dump truck and rolling by bulldozer, sleepers are carried to the site by truck and laid at regular intervals on the lower ballast. Rails are then brought to the site by cart and fastened to the sleepers. Upper ballast is sprayed by happer car and track is formed by use of either multi-tie tamper or ordinary tie tamper.

This is the traditional method and does not require large machinery.

For the construction of the Cengkareng Airport Line, this forth method, which depends mainly on manpower, was selected because of track length and construction time.

(3) Track Construction Base

Track bases will be installed for the receiving delivery and storing of construction material, for preparing work on track laying, and for storage of track laying equipment and machinery.

Fig. 6–6–10 shows a standard design for a track work base. In the construction of such a base approval from JABOTABEK will be necessary.

Taking into consideration the transportation of 25 m, R-54 rails, a point $5^{km}700^{m}$ from Cengkareng Airport has been selected as the site for a track work base.

(4) Chronological Sequence of Track Construction

1) Lower Ballast Spreading

Ballast spreading is divided into lower ballast and upper ballast spreading. Lower ballast is carried by dump truck direct to the roadbed, and after being spread over the roadbed is rolled and tamped by bulldozer.

2) Transportation and Alignment of PC Sleepers

After being transported to the base from the PC sleeper manufacturing plant, the sleepers are taken by truck from the depot to the site and stacked alongside the roadbed covered with lower ballast.

Manual laborers using sleeper catches will carry the sleepers to the designated places and align them.

3) Transportation and Laying of Rails

The transportation route of the rails from Kali Deres Station on the Tangerang Line to the Track Work Base is shown on Fig. 6-6-11.

Rails will be loaded and unloaded at the station and at the Work Base by truck crane and transported by long base truck or trailer.

Transportation by road of 25 m rails will require authorization from the Jakarta Municipality.

The rails stocked at the Base will be loaded by truck crane onto carriage cars and pulled or pushed by heavy motor cars on the existing line and unloaded at designated interval. Then, they will be fastened on sleepers at 25 m intervals.

At the same time, temporary rail joint devices shown in Fig. 6-6-12 will be attached to the rails.

4) Upper Ballast Spreading

After stocking at the Work Base, upper ballast will be loaded on happer cars and sprayed over the installed track panel. The track will be compacted by tie tamper.

5) Rail Joint Welding

Rails will be welded to a length of 100 m by thermit welding. Joint gaps will be taken as shown in Fig. 6-6-2.

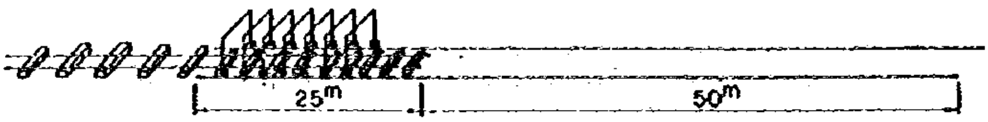


Fig. 6-6-5 Construction Method by Using Temporary Work Rail

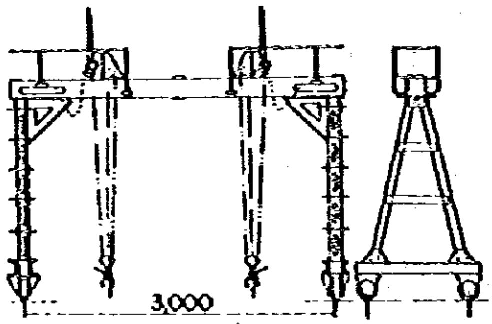


Fig. 6-6-6 Crane

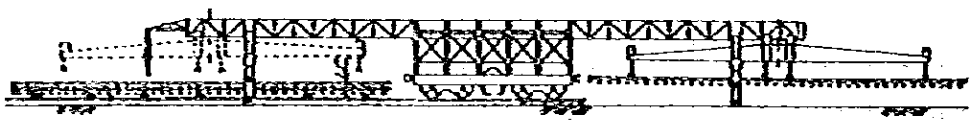


Fig. 6-6-7 Track Skeleton Laying Car

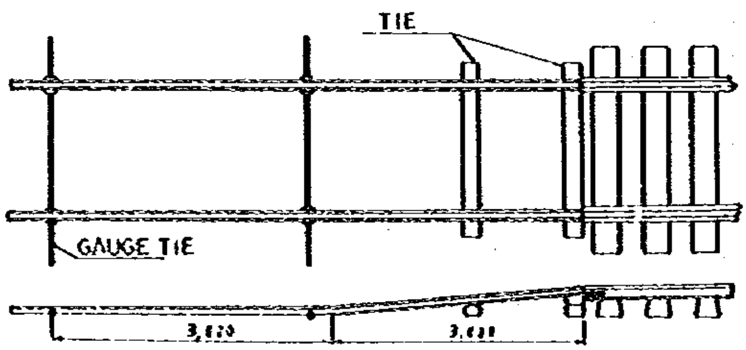


Fig. 6-6-8 Temporary Track

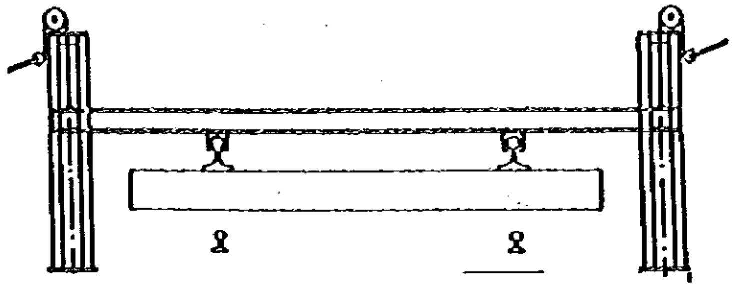


Fig. 6-6-9 Portal Crane

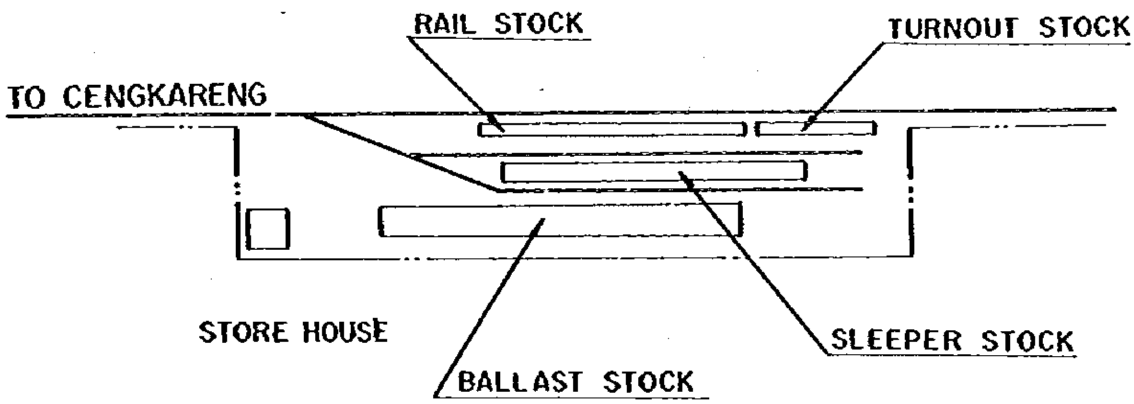


Fig. 6-6-10 Track Work Base

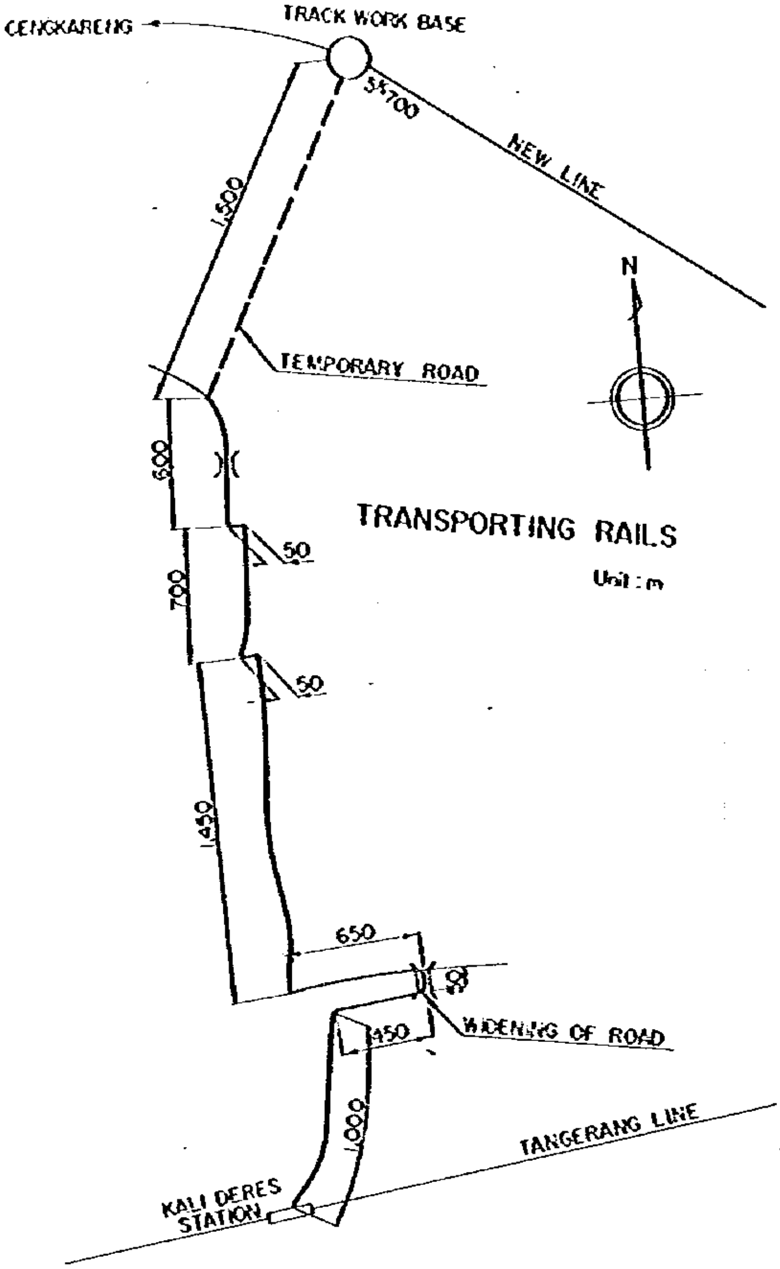


Fig. 6–6–11 Rail Transportation Route

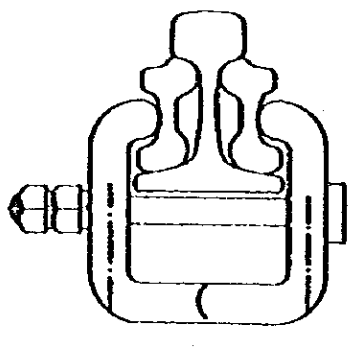


Fig. 6–6–12 Temporary Rail Joint Device

6-7 Station Facilities

6-7-1 General

(1) Architecture

A total of 23 buildings of various kinds are planned, including a terminal building, 2 booking offices, a station building, 4 signal cabins, and 15 crossing-watchman's boxes. The total floor area of the buildings planned in this project is 3,810.15 sq.m. In addition to the above, each station has a platform and a roof, as well as a plaza area. There is also a dump yard. The structure and dimensions of the structures are as follows:

Name of Building	Structure	Storey	Area (approx.) Unit; sq.m
1) Airport Terminal Station			
a) Platform Shelter and Decorative Roof	S		774.00
b) Terminal Building	RC	3	1,005.10
c) Booking Office (2)	RC	1	2 x 227.20
d) Station Plaza and Green Zone	–	–	4,873.00
2) Kota Intan Station			
a) Platform Shelter	S	–	2,466.00
b) Station Building	RCB	2	1,818.21
c) Station Plaza	–	–	6,540.00
3) Signal Cabin			
a) A (2)	RCB	2	2 x 156.72
b) B (2)	RCB	2	2 x 72.00
4) Crossing Watchman's Box (15)	RCB	1	15 x 5.00
5) Dump Yard	–	–	26.46

Note: RC: Reinforced Concrete
RCB: Reinforced Concrete Framing and Brick Wall
S: Steel

(2) Structure

1) Materials

JIS – Japanese Industrial Standards

a) Steel – STK 41, SSC 41, SS41

b) Concrete – FC-210 (Type D)

c) Steel Bar – SD 30, SR 24

d) P.C. Pile – ϕ350 (Type A)

2) Load

a) Earthquake Load: The regulation for earthquake-resistant design of buildings in Indonesia is applicable.

b) Wind Load: Indonesian local code is applicable.

(3) Mechanical

1) Ventilating and Air Conditioning

a) The central single-duct air-conditioning system is of the air-cooled packaged type. The staff rooms have a window-type air-conditioning units.

b) The automatic control of the air-conditioning system senses the temperature of the return air in the package type air-conditioning unit.

c) Areas which are not air-conditioned have a forced-air ventilation system.

2) Plumbing and Drainage Systems

a) The domestic water supply is connected by the city water main and is stored in a reservoir. The reservoir water is pumped to the rooftop storage tank by a lift pump from where it is distributed throughout the building water supply system by gravity.

b) The soil and waste piping installed is of cast iron pipes and materials, and is connected to the main pipe of the City Sewer System.

c) Each plumbing fixture will be vented.

d) Soil and waste sewage from Kota Intan Station is disposed of in a septic tank or percolation pipe in accordance with local regulations.

e) The irrigation system for landscaping draws water directly from the water supply system and distributes it through hoses. Watering should be avoided during peak hours.

(4) Electrical

1) Light Switches

a) Each room has a switch to control the lighting in that room.

b) Areas with high ceilings (i.e. Concourse, Platform, Office) have distribution board from which the lighting can be directly controlled.

c) Outdoor lighting is automatically controlled through the use of built-in photoelectric cells.

2) Grounding System

Power for the indoor electrical system is drawn from the main electrical system for the train line (package 3 electrification work) and is grounded through the main grounding wire. Outdoor lighting fixtures are grounded through grounding rods.

3) Illumination

Levels of illumination are determined according to JIS Z 9110 (Levels of Illumination) Class B (Illumination for Stations).

4) Alarm System (Push Button Station)

Each floor in each building is provided with a push-button station for the alarm system. In this system, each station is individually set off when the button is pushed at that station.

5) Interface with Air Conditioning and Sanitary Work

Electric outlets and isolater switches are provided at all ventilating and air conditioning equipment locations as well as in locations where required in relation to sanitary work.

6–7–2 Airport Terminal Station

(1) General

The Airport Terminal Station has been designed in traditional Indonesian style to provide an appropriate gateway to the country. The style of the buildings and the sweep of the roofs harmonizes with the surroundings and local materials will be used to the maximum extent. The large roofs connecting the platform area with the terminal building will provide a traditional appearance while sheltering the modern facilities of an important railroad station. The design of this station provides returning travellers and foreign visitors to Indonesia with a warm welcome on their arrival in the country. Design particulars are indicated below.

(2) Terminal Building

The Terminal Building is located at the head of the platform area, facing the drop-off area and the green zone. Design particulars are as follows:

– Structure:	Reinforced Concrete
– Number of Storeys:	Three (3)
– Building Area:	461.12 sq.m.
– Total Floor Area:	1,005.10 sq.m.
– Area Per Floor	
1st Floor:	461.12 sq.m.
2nd Floor:	461.12 sq.m.
3rd Floor:	82.86 sq.m.

– Room Areas

Room Name	Area
Concourse:	120.18 sq.m.
Locker Space	34.02 sq.m.
Information:	7.40 sq.m.
Passenger Waiting Room & Cafeteria:	31.05 sq.m.
V.I.P. Waiting Room & Lavatory:	27.75 sq.m.
Station Master's Room:	18.00 sq.m.
Station Office I and Pantry:	47.85 sq.m.
Ticket Sales I:	6.90 sq.m.
Ticket Check:	24.12 sq.m.
Staff Lavatory:	13.68 sq.m.
Mechanical Room:	24.30 sq.m.
Power Room:	24.30 sq.m.
Maintenance & Janitor Room:	17.40 sq.m.
Meeting Room:	49.29 sq.m.
Power Inspection Office:	39.75 sq.m.
Signal Telecom Office:	37.50 sq.m.
Staff Room:	49.50 sq.m.
Dining Room:	29.88 sq.m.
Kitchen:	18.00 sq.m.
Staff Lavatory:	13.68 sq.m.
Ablution Room:	17.33 sq.m.
Musholla:	39.69 sq.m.

– Maximum Height: 11.20 m

(3) Booking Office

Each booking office is located in the central area of one of the two platforms, for a total of two booking offices. The design particulars are as follows:

– Structure: Reinforced Concrete

– Number of Storeys: One (1)

– Building Area: 241.00 sq.m

– Total Floor Area: 227.20 sq.m.

– Room Areas

Room Name	Area
Men's Lavatory 4:	28.40 sq.m.
Women's Lavatory 3:	21.30 sq.m.
Men's Lavatory 2:	17.50 sq.m.

Women's Lavatory 1:	15.00 sq.m.
Storage 1:	7.35 sq.m.
Storage 2:	6.30 sq.m.
Porter:	17.75 sq.m.
Ticket Sales 2:	42.60 sq.m.
Station Office 2:	17.75 sq.m.
Train Control Office:	17.75 sq.m.
Waiting Room:	10.65 sq.m.
Bus Ticket Sales:	12.43 sq.m.
Security:	12.43 sq.m.
– Maximum Height:	3.50 m

(4) Station Plaza and Green Zones

The Station Plaza and Green Zone are designed to continue the traditional feeling of welcome presented by the Station Building and to harmonize with the surroundings. The Green Zone provided between the Station Building and the bus parking lot is intended not only for alighting passengers, but also as a relaxing area for local people. Trash baskets and smoking stands, as well as benches, are provided in this area.

6–7–3 Kota Intan Station

(1) General

Kota Intan Station is an important transfer point between the Cengkareng Line and the Western Line, the two lines being connected by a passageway under the platforms. In consideration of layout, the Station Plaza will be located on the Western Line side. The Plaza, facing on Jl. Nelayan Barat, also includes the pick-up and drop-off areas and bus stops for passengers transferring to and from other made of transportation. The design particulars are as follows:

(2) Station Building

The Station Building at Kota Intan faces out on the Station Plaza. The design particulars are as follows:

– Structure:	Reinforced Concrete Framing and Brick Wall
– Number of Storeys:	Two (2)
– Building Area:	1,578.70 sq.m
– Total Floor Area:	1,818.21 sq.m.
– Area Per Floor	
1st Floor:	1,578.70 sq.m.
2nd Floor:	239.51 sq.m.

– Room Areas

Room Name	Area
Concourse:	109.74 sq.m.
Passengers' Waiting Room & Cafeteria	27.41 sq.m.
Women's Lavatory:	24.48 sq.m.
Men's Lavatory:	24.48 sq.m.
Porter:	23.74 sq.m.
Maintenance and Janitor Room:	44.41 sq.m.
Station Office:	75.56 sq.m.
Ticket Check:	4.00 sq.m.
Station Master's Room:	23.62 sq.m.
Meeting Room:	26.04 sq.m.
Security:	18.63 sq.m.
Staff Lavatory:	22.00 sq.m.
Staff Locker Room:	22.00 sq.m.
Storage Room 1:	20.25 sq.m.
Storage Room 2:	41.88 sq.m.
Power Room:	23.65 sq.m.
Mechanical Room:	41.88 sq.m.
Covered Service Area 1:	35.74 sq.m.
Covered Service Area 2:	35.74 sq.m.
Dining Room:	37.10 sq.m.
Kitchen:	10.80 sq.m.
Ablution Room:	14.69 sq.m.
Musholla:	37.83 sq.m.
Staff Room:	34.05 sq.m.
Lavatory:	10.80 sq.m.

– Maximum Height: 7.20 m

(3) Station Plaza

The Station Plaza is designed to provide easy transfers between buses and trains for passengers using this station. Landscaping is included so as to provide shade, wind breaks noise control and aesthetic qualities.

6-7-4 Signal Cabin

(1) Signal Cabin A

One Signal Cabin A building is located at the foot of the existing platform near Road CI and the other is located along the rail line near Jayakarta Station. The design particulars are as follows:

- Structure: Reinforced Concrete Framing and Brick Wall
- Number of Storeys: Two (2)
- Building Area: 60.00 sq.m
- Total Floor Area: 156.72 sq.m
- Area Per Floor

1st Floor:	60.00 sq.m
2nd Floor:	96.72 sq.m

- Room Areas

Room Name	Area
Lavatory:	7.00 sq.m
Power Room:	11.52 sq.m
Signal Device Room:	32.00 sq.m
Inspector's Room:	30.00 sq.m
Dressing Room:	4.64 sq.m
Staff Room:	7.50 sq.m
Pantry:	5.50 sq.m
Signal Control:	36.72 sq.m

- Maximum Height: 10.15 m

(2) Signal Cabin B

The two Signal Cabin B buildings are located at intervals along the rail line.

- Structure: Reinforced Concrete Framing and Brick Wall
- Number of Storeys: Two (2)
- Building Area: 36.00 sq.m
- Total Floor Area: 72.00 sq.m.
- Area Per Floor

1st Floor:	36.00 sq.m
2nd Floor:	36.00 sq.m

- Room Areas

Room Name	Area
Relay Equipment Room:	28.00 sq.m

Waterhouse: 2.20 sq.m
Toilet: 2.65 sq.m
Signal Handling Staff Room: 16.00 sq.m
Staff Room: 12.00 sq.m

– Maximum Height: 9.55 m

6–7–5 Crossing Watchman's Box

The 15 Crossing-Watchman's Boxes are one-storey, one-room structures set at 15 grade level crossing locations along the rail line. The design particulars are as follows:

– Structure: Reinforced Concrete Framing and Brick Wall
– Number of Storeys: One (1)
– Building Area: 5.00 sq.m
– Total Floor Area: 5.00 sq.m
– Room Area: 5.00 sq.m.
– Maximum Height: 2.90 m

6–7–6 Dump Yard

The Dump Yard consist of an area enclosed by the dump yard wall and includes a dust collecting, self-contained smoke-consuming, general-waste-handling incinerator. The Dump Yard and incinerator are located at the foot of the existing platform near the signal cabin and Road Cl. The design particulars are as follows:

– Incinerator Capacity: 84 kg/h
– Wall Structure: Brick Masonry
– Incinerator Yard: 18.06 sq.m
– Trash Room: 5.90 sq.m
– Ash Room: 2.50 sq.m
– Total Area: 26.46 sq.m
– Maximum Wall Height: 1.20 m

6-8 Airport Station

6-8-1 Track Equipment

(1) Track Layout

The Cengkareng Airport Station is the terminal station where the New Airport Railway Line starts.

The track layout in the station yard will be prepared for future operation of trains consist of 8 coaches. The track layout was designed to cope with the departure and arrival of trains during rush hours as well as to facilitate their berthing for the night. This can be accomplished by connection through the #12 turnout to Track 1 (for passenger service), Track 2 (for train detention and daily inspection), and Track 3 (for passenger service), whose effective track length is 314, 210, and 210 m respectively.

The railroad track extends over $2^{km}080^{m}$ within the airport area. According to the operational scale of the airport terminal, the railway line outside the station yard will be single track to cope with the traffic demand for the time being.

(2) Roadbed

Construction of Airport Access Roads P1, P2, C1, and C2 is already under way on both sides of the tracks in the station and airport area. Because of the close relationship with these roads, efforts were made to keep the rail level and the road surface on the same level.

(3) Track Drainage

The drain ditch for the railway tracks within the station area will be constructed with the retaining wall for the platform. A side ditch without lining will be provided for the area where the platform will be extended in the future.

From $0^{km}200^{m}$ to $2^{km}000^{m}$, the railway track will be laid between the Airport Access Roads (C1 and C2). Within the right of way, therefore, a drain ditch will be provided almost in parallel to these roads, and the area not affecting the roadbed for future double track formation. The ditch will be of U-shaped reinforced concrete structure to resist against the load of automobiles and trains.

Since its total distance is very long, the drainageway runs across the railway track and Airport Road (C1) by a culvert near point $0^{km}700^{m}$, where it runs out to the waterway of Channel 500. This outlet covers the drainage for the track extending over $1^{km}300^{m}$ from the station area. The drainage water between points $1^{km}300^{m}$ and $2^{km}000^{m}$ flows out to the river Rawa Bokor which crosses the railway track at point $2^{km}021^{m}$.

The capacity of the above drainageway reaches at least 0.15% of the hydraulic gradient, with the sectional area of discharge covering 0.9 m^2. The capability is sufficient to cope with the rainfall of 90mm per hour, which is the largest volume of rainfall during the last 10 years.

(4) Level Crossing

The railway track in the airport area runs across the airport road at two points, i.e., at $1^{km}574^{m}$ and $2^{km}044^{m}$. At point $2^{km}044^{m}$ where a level crossing is provided, rail level is about 33 cm higher than that of road surface. It is necessary to raise the road surface by asphalt concrete paving.

6-8-2 Passenger Facilities

(1) Platform

At the airport station, passengers getting on and off the train are mainly air travel passengers carring large suitcases and hand-carry bags. A shuttle bus service which provides a link between airport and station is available.

In the station, platforms will be built for both trains and buses in order to reduce the passengers' walking distance.

In the initial stage, two platforms with a length of 100m each will accommodate 5 buses and a train composed of 4 coaches. In the future, these platforms will be capable of accommodating 10 buses and a train of 8 coaches. The platform has a total width of 16 m, one half (8m) of which will be for trains and the other half (8m) is for buses.

Concrete will be used as pavement as it is expected that small motorized vehicles will be used for conveying baggages on the platform. A modern image of the platform can be achieved by finishing the surface with color tiles.

A ticket counter and a room for personnel in charge of passenger service will be built in the center of the platform, where a fence will be set up to separate the bus and train sectors. Also, wickets will be provided at two places on the platform to speed up the examination of tickets. In addition, the entire platform will be provided with shelter to protect passengers from the intensive heat from the sun and rainfall.

(2) Roads within Station Area

The roads within station area are primarily intended for use by the shuttle bus. As the airport road is a one-way traffic system, the entry to the station will be made through Road C2 and the exit through Road C1. In line with these regulations, it would be appropriate to adopt the one-way traffic system in the station area.

Two exits will be built for each gate to anticipate traffic congestion caused by unexpected accidents. Also, two bus berths will be built alongside the train platforms. To facilitate the entire bus traffic, an auxiliary road will be constructed to provide a detour for buses, which will then be allowed to arrive and depart in one-way traffic by means of these two berths.

Only 5 buses at a time can stay at the berth located alongside the bus platform. This is not enough to accommodate all passengers getting off a train composed of 4 coaches. Therefore, a parking lot capable of accommodating 26 buses will be built in order to facilitate a speedy and continuous bus operation.

The road in the station area features an asphalt concrete finish designed to cope with the passage of about 2,800 shuttle buses a day estimated for the future. The pavement has a thickness of 60 cm in the main road and 40cm in the auxiliary road and parking lot. The road is provided with 1% crossfall to prevent water standing on the road surface.

To ensure traffic safety, the roads within station area incorporate various roadway markers including a divisional strip line, stop line, bus berth line, pedestrian walkway line, and direction indicator mark, as well as a traffic control sign and speed limit sign. For the convenience of drivers, there is a guide sign, installed at two spots, indicating the entrances to the station. Concrete blocks (200 x 300 x 600 mm) are established at the boundary between the road and bus platform, footpath and greenbelt.

(3) Drainage Facilities

To drain the waste water derived from the station building and staff room on the platform, a 150 mm cast-iron pipe will be connected to the drainpipe designated by the airport authorities.

The main drainage channel will be provided by connecting the reinforced concrete side ditch (0.9 m^2 sectional area and at least 0.18% hydraulic gradient) to the track drainageway at a point $0^{km}200^{m}$, along the Roads C1 and C2, extending from the side ditch to be installed in the rotary section at the point $-0^{km}130^{m}$. This channel is intended to drain the rainwater collected in the platform housing, parking zone, and greenbelt, as well as on the road of the railway area surrounded by Airport Roads C1 and C2.

Also, a reinforced concrete pipe, 300 mm in diameter, will be laid alongside the road and platform. This pipe will constitute a branch drainage channel, linked with the main channel from the terminal of the road and platform housing located in the station area. As an inlet for the rainwater, a catch basin will be placed in this branch channel at intervals of about 20 m.

(4) Green Zone

In the station area, there are various facilities such as station building, platform housing, signal cabin, roads within station area, etc. All unoccupied spaces excluding these facilities shall be used as a green zone, where tropical trees, promenades, and garden benches will be laid out. The green zone shall function as a rest area to be used by the passengers while they are waiting for the arrival of their buses and trains. Hydrants will be installed in the green zone to keep trees healthy.

(5) Water Supply System and Other Equipment

Water will be supplied for the station building, staff room, signal cabin, and green zone, through the branch pipes connected with the water main of the airport authorities. For fire protection, all these facilities will be equipped with fire extinguishers. Sodium lamps will be used for street lighting, as well as in the above facilities. An incinerator will be provided to dispose of the rubbish collected from trains, waiting rooms, and other facilities.

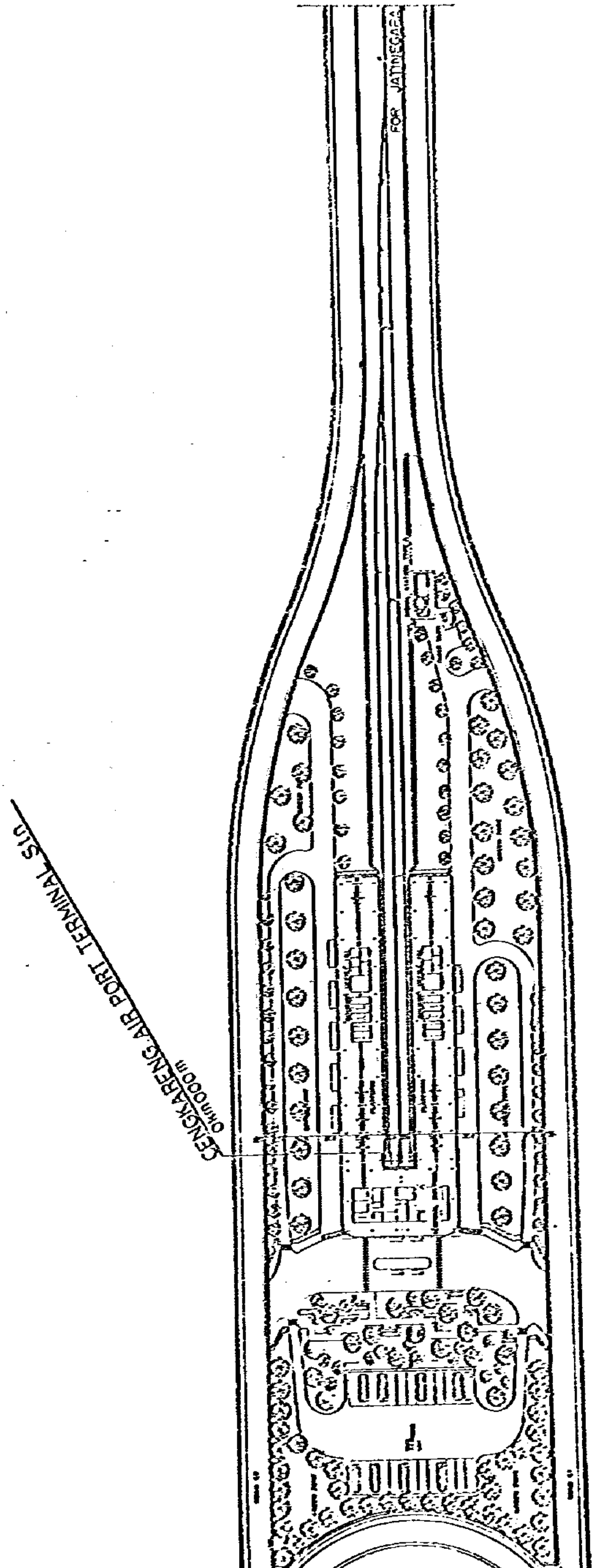


Fig. 6-8-1 Plan

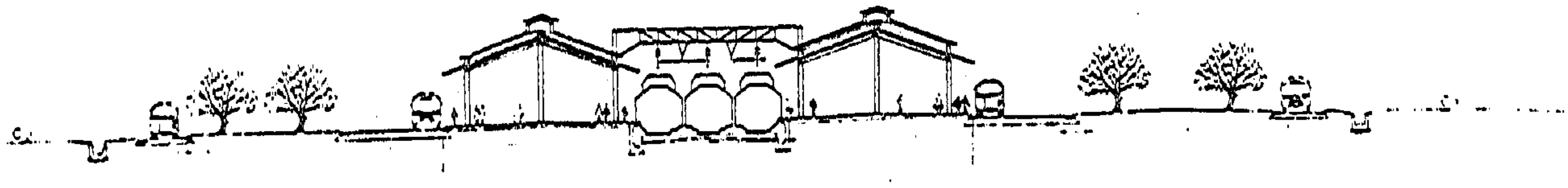


Fig. 6–8–2 Cross Section

6-9 Substations

The substation facilities in the new railway line for Cengkareng Airport, will conform to the specification of the facilities in Western Line already designed, from the point of view of the operation and the maintenance, and will be designed as follows.

6-9-1 Fundamental Conception

(1) Electric System

The electreic system of the new line will be DC 1,500 V considering the through operation with the existing Central Line.

(2) Composition of Train and Headway

The composition of the train and the headway is esteemed as shown in Table 6-9-1 according to the feasibility study.

Table 6-9-1

Year	Number of track	Composition	Number of air-conditioned cars in one train	Headway (min.)
~ 1997	Single	4 cars (2M2T)	1	20
1998 ~ 2006	Single	8 cars (4M4T)	2	20
2007 ~	Double	8 cars (4M4T)	2	10

(3) Location of Substation and Feeding System

The locations of the substations and the feeding system will be as shown in Fig. 6-9-1 and Fig. 6-9-2. The number of the substations will be three as shown in Table 6-9-2.

Table 6-9-2

Distance from JIAC	Name of Substation	Note
$2^{km}960^{m}$	Cengkareng	Installation in this project
$11^{km}100^{m}$	Kapuk	ditto
$19^{km}130^{m}$	Jakarta Kota	Joined to the existing substation

(4) Capacity of Substation

The installation capacity of the substations will be as shown in Table 6-9-3.

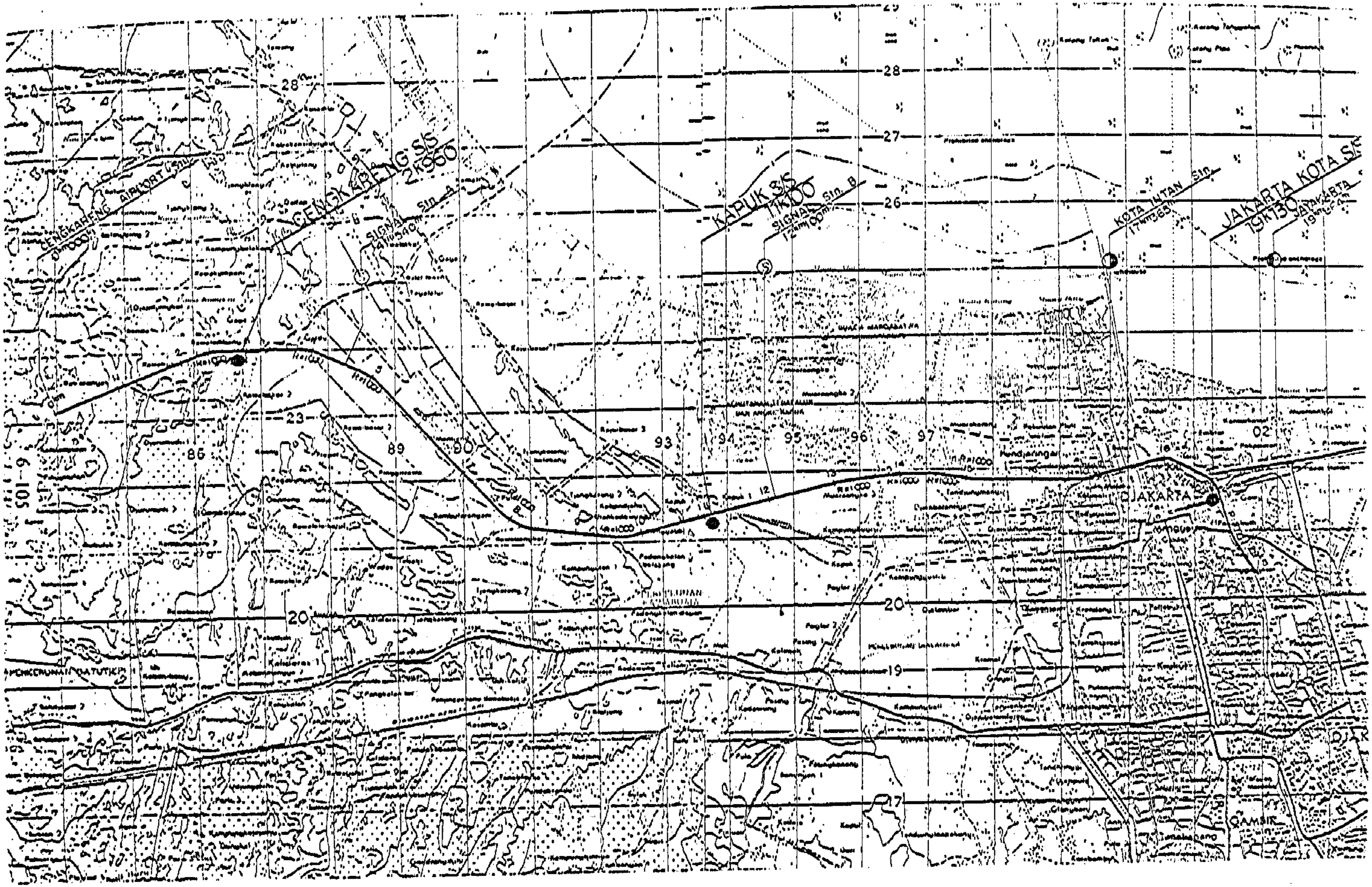


Fig. 6-9-1 Location of New Substation

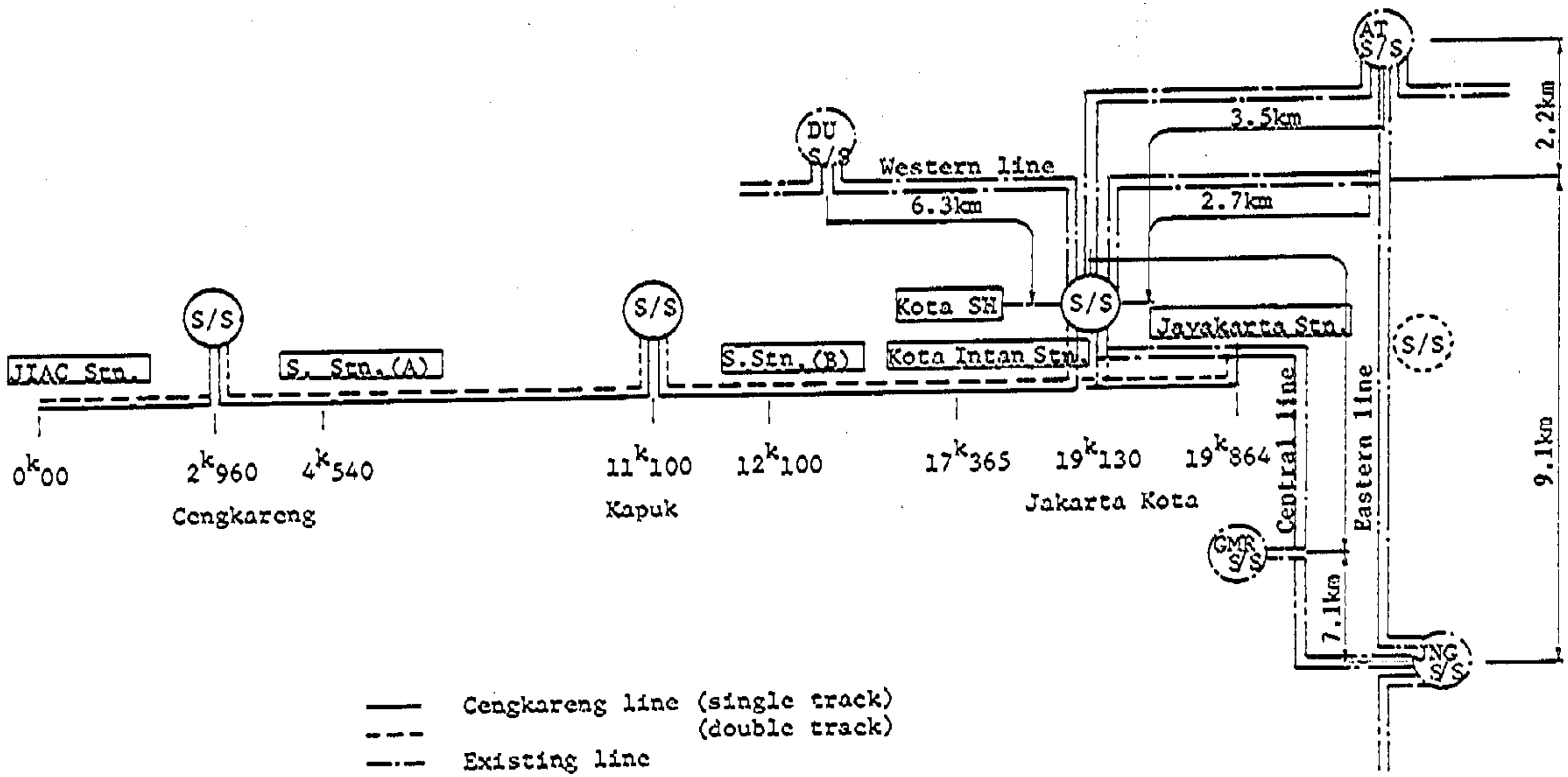


Fig. 6-9-2 Feeding Network

Table 6-9-3

Name of substation	Number and capacity of rectifier	Number and Capacity of distribution transformer
Cengkareng	3,000 kW x 2	300 kVA x 1
Kapuk	3,000 kW x 1	–
Jakarta Kota	3,000 kW x 1	500 kVA x 1

Note: The rectifier in Jakarta Kota substation means the added one.

(5) Power Receiving System

1) In Cengkareng substation two circuits of distribution lines from PLN will be received, one of them will be standby. The system will be 20 kV common bus system.

2) In Kapuk substation, the system is the unit substation system as adopted in Western Line.

3) In Jakarta Kota substation considering of its important position, the system will be 20 kV common bus system with two circuits of lead-in distribution line, one of which will be standby, reforming the existing facilities of Jakarta Kota substation for Western Line.

(6) Protection of DC Feeding Circuits

For the protection of DC feeding circuits, a Delta I fault selecting device (hereinafter called 50F) and a linked breaking device will be adopted for firm detecting of fault current.

(7) Remote Supervisory Control System

The remote supervisory control system for the new line will be 1:1xN system, the same type as that of Western Line, considering of the level-up of the system and the convenience of maintenance.

(8) Type of Substations

The type of substations will be outdoor cubicle type, enclosing the energized parts, preventing the maintenance staff from touching, resulting small space and maintenance free.

(9) Site of Substations

In the site of substations, the spare space for the site in the future double track stage will be prepared. The height of banking of the substation site will be the same height as the track, considering of floods. Jakarta Kota substation will be joined to Jakarta Kota substation for Western Line.

(10) Foundation of Substation

According to the boring servey the soil bearing strength is very low. Therefore, for the foundation of the substation, the pile foundation will be adopted preventing the differential subsides. The type of pile will be the top bearing pile, and the foundation will be strong enough to bear the vertical load of the equipment and foundation, as well as the horizontal load of 0.1 G in an earthquake.

6–9–2 Location of the Substations

(1) Items to be Considered in the Determination of the Location of the Substations

The detemination of the location of the substations is the most important item in the electrification design, and the following items will be taken into consideration:

1) The estimation study of the load increase in the future must be performed. As the location of substations cannot be changed easily, it should be determined after full studies of estimated loads in the future.

2) The location of substations should be near the substations of the State Electricity Public Corporation (hereinafter called PLN), the power capacities of which should be large enough for traction loads. On this condition, the high reliability for the power source will be achieved, and at the same time, the bad influence to the PLN transmission line network by the fluctuated loads will be decreased.

(2) Installation Intervals of Substations

The installation intervals of the substations will be determined by the voltage at the pantographs of the train, which should be high enough to operate the train. The maximum line voltage drop will be arised when the train in the utmost distance takes the maximum load, and will be limited to 400 V.

From the above condition, the result of the calculation tells that the maximum installation intervals of the substations will be 9.6 km in parallel feedings, and 3.1 km in one direction feedings. (Refer to the volume of calculations)

(3) Determination of the Substation Location

The location of the substations will be totally determined considering the maximum installation intervals of the substations by calculation, the power transmission line network of PLN, the route of the transmission lines, the topographical features, the land use, the access road for construction machines and etc.

In this serveys the location of the new substation will be around $2^{km}960^{m}$ (Cengkareng substation) and $11^{km}110^{m}$ (Kapuk substation) from JIAC station. In Jakarta Kota substation for Western Line, the new equipment will be installed for the new line, and the reformation for the existing equipment will be performed.

6–9–3 Capacity of Rectifiers

(1) Rating of Rectifiers

The electric traction loads fluctuate widely according to the operating condition of trains and the overlap of the power runnings in each train. Therefore, as the operation rating of rectifiers, the heavy duty nominal rating, S grade rating (100%: continuous, 150%: 2 hours, 200%: 5 minutes, 300%: 1 minute) will be required for the rectifiers which withstand a wide load fluctuation.

(2) Capacity of the Rectifiers in each Substation

The capacity of the substations will be determined considering the rate of electric power consumption of the existing train running in JABOTABEK area and the operation condition of the new line. On the new line, air-conditioned cars are expected to be operated. Therefore the capacity for them will be added to the traction load. (Refer to the volume of calculation)

As described in Master Plan, the unit capacity of the rectifiers will be unified in 3,000 kW considering the mutual exchangeability. Because Cengkareng substation will be the terminal substation, two sets of 3,000 kW rectifiers will be installed. One of them will be standby.

As for Kapuk substation, one set of 3,000 kW rectifier will be installed. Because in the failure of Kapuk substation, the extended feeding from both of Cengkareng and Jakarta Kota substation will be possible.

In Jakarta Kota substation, one set of 3,000 kW rectifier will be added for the new line, for 2 sets of 1,500 kW rectifiers will be already installed for Western Line.

But as indicated in the volume of calculation, the re-examination will be required, when these train operating conditions should vary widely, although in the calculation, the loads of Jakarta Kota substation are esteemed to include Western Line, Eastern Line, Tanjung Priok Line, and Central Line.

(3) Cooling System of Rectifiers

The rectifies will be three-phase bridge connection silicone rectifies which are most commonly used, and the cooling system will be oil-immerced self-cooling system. This system is commonly used now that the reliability of silicone rectifier elements are remarkably improved, and the maintenance will be very easy due to the sealed type structure the same as the transformer.

(4) Time Schedule Operation

These substation equipment will be operated by the time schedule operation, the same system as in Western Line, considering the reduction of the labour of the maintenance staff.

6-9-4 Power Receiving System

(1) Conditions on PLN Substations

Railways take a charge of transportation in very wide area, accordingly the train stop on the way by accident, made a congestion all over the lines. Therefore, PJKA's traction substations will require to procure the power source of the most stable and best quality. Moreover, the flactuations of the electric traction loads are very wide, and give bad influences to the power transmission system of PLN.

Therefore, to PLN substations, the power source of 20 kV, 50 Hz, about 200 MVA will be required.

(2) Power Receiving System

1) Exclusive Distribution Line

Power receiving system of PJKA's substation will be made directly from PLN substation with the distribution line of exclusive use. If the power receiving should be made from the general distribution line of common use with ordinal customer, the traction load will give a bad influence on the ordinal user, and at the same time, the reliability of the power supply in PJKA's substation will be lowered.

2) Unit Substation System

The unit substation system is as shown in Fig. 6-9-3. This system is adopted in Western Line, and has a merit that the specifications of equipment are all the same from the power receiving cubicle to the rectifier. But to think of the installation of three sets or more of rectifiers, or the easiness of the operation of two sets of rectifiers, this system is not recommendable.

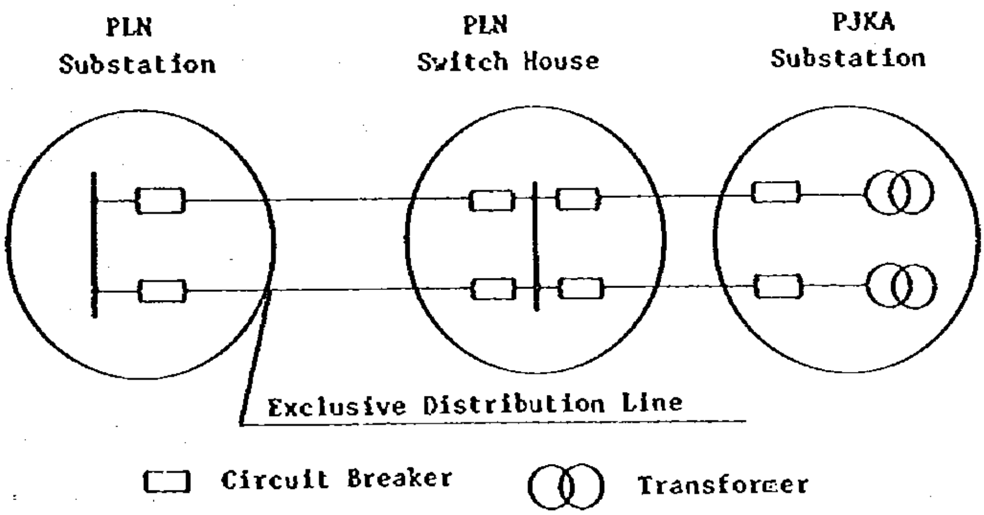


Fig. 6-9-3

3) Common Bus System

The common bus system is, as shown in Fig. 6-9-4, the system that the common bus is installed on the primary side of rectifier equipment and one circuit of two is standby. The merits of this system are the easiness of the addition of equipment, and that the management of rectifier equipment is possible only on PJKA side. But the demerits are the increase of construction cost, and that much cares must be taken at the maintenance work because the common bus is always energized.

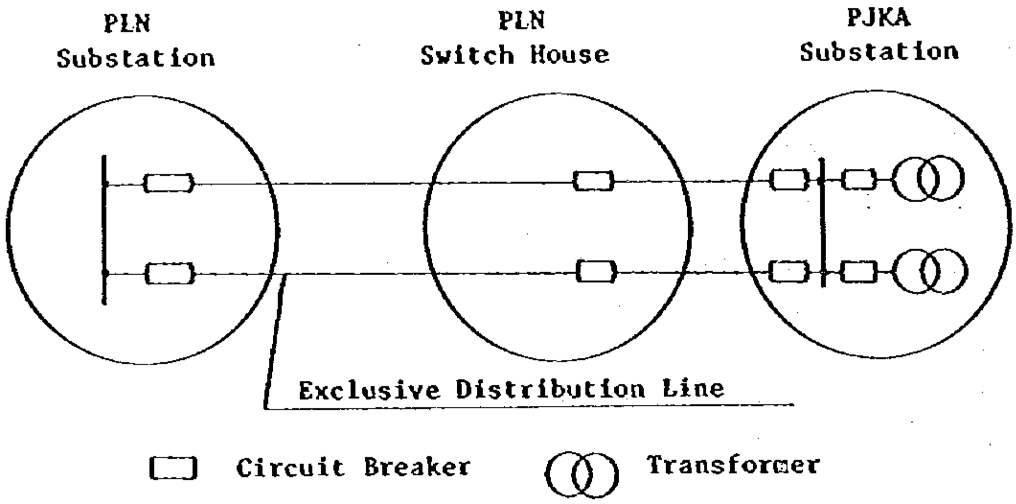


Fig. 6-9-4

4) Power Receiving System in each Substation

At the discussion with PLN, it was required that the number of power receiving circuits will be upto two circuits for each substation.

Considering that condition and the study on the system described in the former sections, the power receiving system in Cengkareng substation will be common bus system with two sets of rectifier equipment and one set of distribution transformer.

In Kapuk substation, one set of rectifier equipment is planned to be installed, and it will be enough for the increase of load in the future. Therefore, the unit substation system will be adopted for Kapuk substation.

In Jakarta Kota substation, the amount of equipment will be three sets of rectifier equipment (existing two and added one) and one set of distribution transformer. Therefore, the reformation to the common bus system must be performed.

(3) The Study on the Short Circuit Current and Voltage Regulation in Each Substation

PLN substations from which PJKA substations will receive power, will be as shown in Table 6-9-4, according to the discussion with PLN, and the PLN power map around the new line is as shown in Fig. 6-9-5.

Table 6-9-4

Name of PJKA Substation	Name of PLN Substation	Distance between PLN and PJKA substation
Cengkareng	Cengkareng	10 km
Kepuk	Duri Kosambi	8 km
Jakarta Kota	Ancol	3 km

The results of the calculation of the short circuit current, voltage regulation, rating of 20 kV CV cable are as shown in Table 6–9–5.

Table 6–9–5

Name of Substation		Cengkareng Substation	Kapuk Substation	Jakarta Kota Substation
3-phase short circuit capacity	Max.	198 MVA	223 MVA	380 MVA
	Min.	194 MVA	219 MVA	376 MVA
Voltage regulation		3.7%	2.8%	2.2%
Rated short circuit breaking current of 20 kV circuit breaker		25 KA	25 KA	25 KA
Required size of 22 kV cable		CV 1-core 150 mm²	CV 1-core 150 mm²	CV 1-core 150 mm²

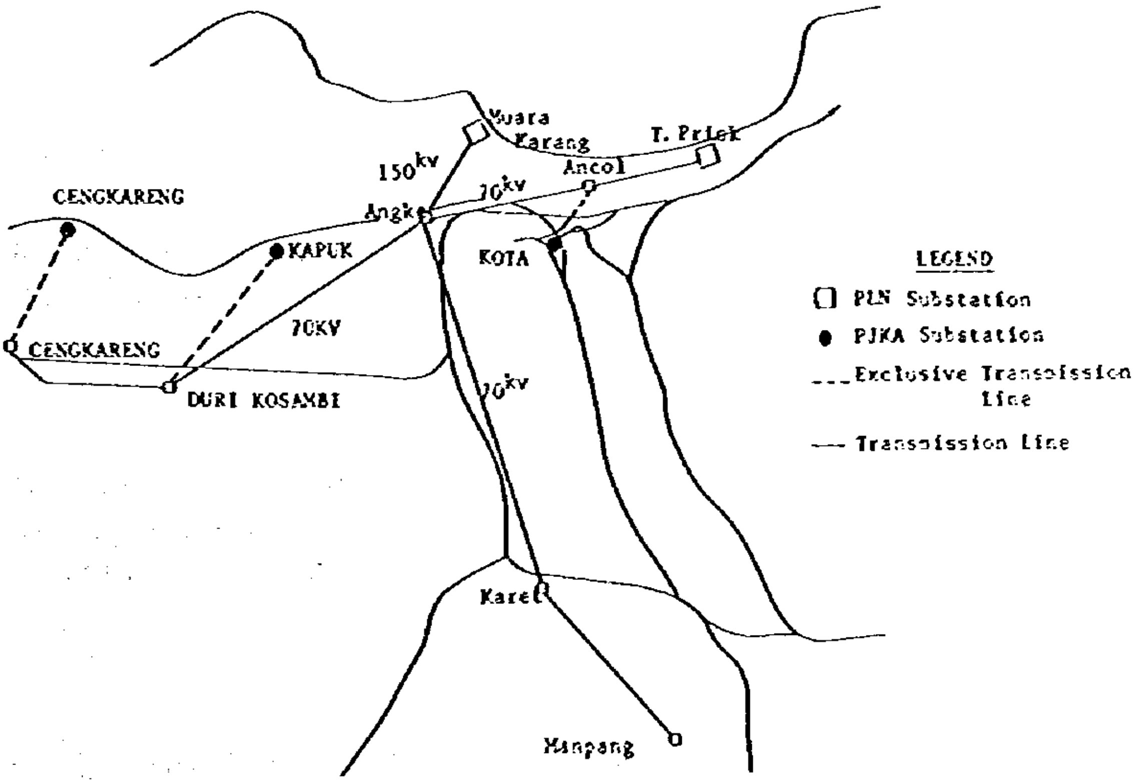


Fig. 6–9–5 PLN Power Map

As three-phase short circuit capacity of each substation is about 200 MVA, there is no problem. The voltage regulation is not necessarily required to be taken into consideration in DC electrification and the upper limit of that value is not determined. The calculated value of the voltage regulation is 3.7% at the maximum.

The 3-phase short circuit capacity of the circuit breaker is determined on the base of that of Jakarta Kota substation and the circuit breaker of the same capacity as that, will be adopted in other two substations considering exchangeability. The type of the circuit breaker will be vacuum type considering the performance and the point of economy.

As for 20 kV cables, the size of which is determined on Jakarta Kota substation will be used the same size in these three.

(4) Coordination with PLN

The protection system of power receiving system will be shown in the single line diagram in the drawing volume. In the leveling of the protective relays, a coordination with PLN will be required lest PLN circuit breaker should break at 250% load of the installation capacity, because the traction load is fluctuating lead in wide scale.

As for the period of the power receiving from PLN will be required before 6 months of the completion of the construction.

The PLN power delivery equipment for Jakarta Kota substation at the stage of Western Line electrification, is to be installed considering the future increased load, caused by Cengkareng Line and increased train operation, avoiding the future reconstruction.

6–9–5 DC Feeding Circuits

(1) Parallel Feeding

The standard feeding system in DC feeding circuits is parallel feeding and sections will be installed in front of substation for the separation of circuits.

As JIAC side of Cengkareng substation is dead-end, one direction feeding will be adopted. In the stage of the double track construction, the study will be required as to the connection of both feeders of up line and down line.

(2) Installation of Standby High Speed Circuit Braker

The standby high speed circuit breaker (hereinafter called HSCB) will be installed for each substation considering the convenience of inspectors of HSCB, and the shortening of power outage time in feeding circuit, by manually changing the fault HSCB to the standby HSCB at the site.

(3) The Section of Feeding Circuits around Jakarta Kota Substation

The feeding to Jayakarta direction will be made from Central Line, due to the arrangement of signals as shown in Fig. 6–9–6.

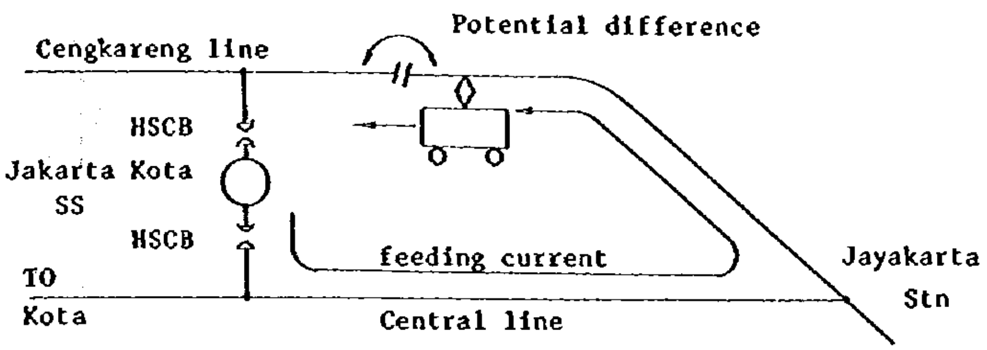


Fig. 6–9–6

In this case, when a train passes through the section potential difference arises at the section. This is no good. Therefore, as the countermeasure for this phenomenon, a connecting wire will be installed between the secondary side of the feeding HSCB for Central Line and the Jayakarta station side of the section as shown in Fig. 6–9–7.

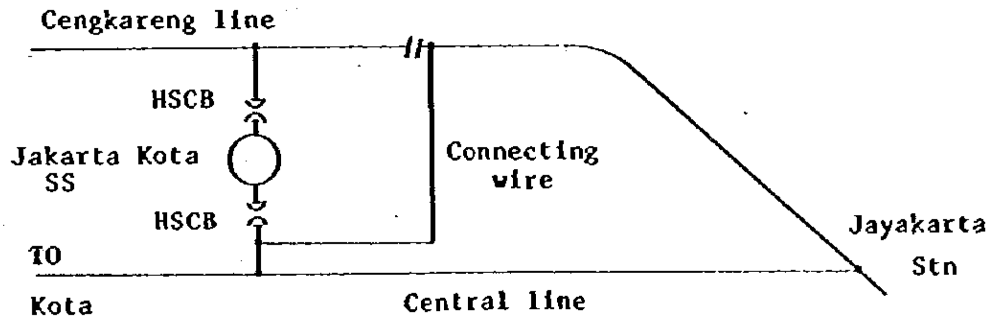


Fig. 6–9–7

(4) Protection of Feeding Circuits

1) Protection of Feeding Circuits

The protection of the feeding circuits will be made with self-detecting type 50F and linked breaking devices (hereinafter called LBD) for higher reliability. But LBD cannot be adopted theoretically for a one direction feeding circuits. The power source equipment for LBD must withstand AC 5,000 V. Without this measures, the fault of a substation will be extended to the telecom line.

LBD will be also installed between Duri and Jakarta Kota substation and between Gambir and Jakarta Kota substation, to make sure of detection of faults.

The calculation is made for the possibility of the protection of the feeding circuits in both cases of with LBD between Cengkareng and Kapuk substation, and without LBD (only 50F) between Cengkareng substation and JIAC station. The schematic diagram of LBD is as shown in Fig. 6–9–8. (Refer to the volume of calculation)

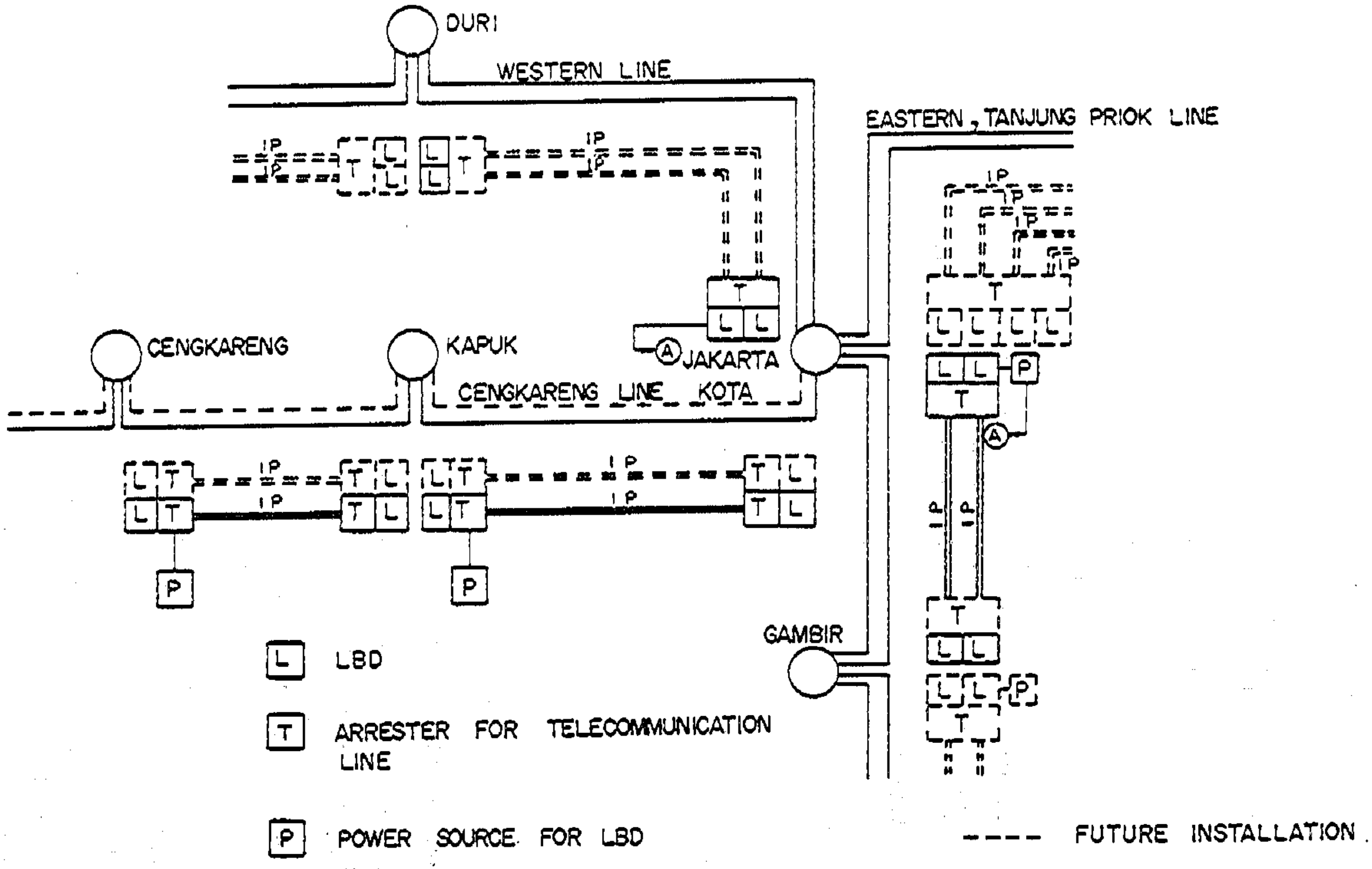


Fig. 6–9–8 Linked Breaking System

2) Protection of DC Buses

The 64P will be installed between the negative DC buses and the ground for the dielectric breakdown in substations.

This 64P is a indispensable relay for a DC substation. There are some examples that a fault accident in a substation extends to a fire, due to a failure of an early detection of a fault without 64P.

6-9-6 Power Filters

In the stage of transferring 3-phase AC 20 KV to DC 1,500 V, higher harmonic waves arise, higher harmonic waves give bad influences to the telecom and signal cables.

To restrict these higher harmonic waves the power filters (series reactor and filter) will be installed in the DC side of each rectifier equipment. As series reactors generate much heat, they will be installed out of cubicle.

6-9-7 Distribution Transformers

For the power distribution to the auxiliary equipment, installed along the railway, signals, alarming devices in level crossing, lighting facilities in the stations and telecom facilities, the distribution transformers will be installed in Cengkareng and Jakarta Kota substation.

6-9-8 Remote Supervisary Control System and Control Center

The power dispatch center in JABOTABEK area is planned to be installed in Manggarai. Therefore, Cengkareng and Kapuk substation will be remotely controlled from Manggarai Center.

The remote supervisary control system will be 1:1xN system, the same as in Western Line. The items of controls and indications will be as shown in Table 6-9-6, 6-9-7, and in Jakarta Kota substation, a reformation of the control panel to be changed to the new items as shown in Table 6-9-8, will be required.

The required number of pairs of telecom cables will be as shown in Fig. 6-9-9. But the cable installation design between Jakarta Kota and Manggarai is planned in other project. Therefore, some coordination with the staff of that project will be required.

Table 6-9-6 Cengkareng Substation

CH	Item	Control	Indication	Flicker	Bell	Buzzer
1	Receiver CB ($52R_1$)	ON, OFF	ON, OFF	O		
2	Receiving CB ($52R_2$)	ON, OFF	ON, OFF	O		
3	Rectifier CB (52-1)	ON, OFF	ON, OFF	O		
44	Rectifier HSCB (54-1)	ON, OFF	ON, OFF	O		
5	Rectifier CB (52-2)	ON, OFF	ON, OFF	O		
6	Rectifier HSCB (54-2)	ON, OFF	ON, OFF	O		
7	Feeder HSCB (54F 1)	ON, OFF	ON, OFF	O		
8	Feeder HSCB (54F 2)	ON, OFF	ON, OFF	O		
9	Distribution CB (52D)	ON, OFF	ON, OFF	O		
10	Distribution CB (52L)	ON, OFF	ON, OFF	O		
11	Remote Control Test					
12	Heavy Fault		ON	O	O	
13	Light Fault		ON	O		O
14	Remote Control (43R)		ON	O		O
15	Door Open		ON	O	O	
16	Linked Breaking Receive		ON	O	O	
17	Ground Fault (64P)		ON	O	O	
18	Power Source Trouble		ON	O	O	
19	Emergency Stop	ON	ON	O	O	
20	Spare					
21	Spare					
22	Spare					

Table 6-9-7 Kapuk Substation

CH	Item	Control	Indication	Flicker	Bell	Buzzer
1	Receiving CB (52)	ON, OFF	ON, OFF	O		
2	Rectifier HSCB (54)	ON, OFF	ON, OFF	O		
3	Feeder HSCB (54F-1)	ON, OFF	ON, OFF	O		
4	Feeder HSCB (54F-2)	ON, OFF	ON, OFF	O		
5	Air Switch (AS)	ON, OFF	ON, OFF	O		
6	Remote Control Test					
7	Heavy Fault		ON	O	O	
8	Light Fault		ON	O		O
9	Remote Control (43R)		ON	O		O
10	Door Open		ON	O	O	
11	Linked Breaking Receive		ON	O	O	
12	Ground Fault (64P)		ON	O	O	
13	Power Source Trouble		ON	O	O	
14	Emergency Stop	ON	ON	O	O	
15	Spare					
16	Spare					

Table 6-9-8 Jakarta Kota Substation

CH	Item	Control	Indication	Flicker	Bell	Buzzer
1	Receiving CB ($52R_1$)	ON, OFF	ON, OFF	O		
2	Receiving CB ($52R_2$)	ON, OFF	ON, OFF	O		
3	Rectifier CB (52-1)	ON, OFF	ON, OFF	O		
4	Rectifier HSCB (54-1)	ON, OFF	ON, OFF	O		
5	Rectifier CB (52-2)	ON, OFF	ON, OFF	O		
6	Rectifier HSCB (54-2)	ON, OFF	ON, OFF	O		
7	Rectifier CB (52-3)	ON, OFF	ON, OFF	O		
8	Rectifier HSCB (54-3)	ON, OFF	ON, OFF	O		
9	Feeder HSCB (54F 1)	ON, OFF	ON, OFF	O		
10	Feeder HSCB (54F 2)	ON, OFF	ON, OFF	O		
11	Feeder HSCB (54F 3)	ON, OFF	ON, OFF	O		
12	Feeder HSCB (54F 4)	ON, OFF	ON, OFF	O		
13	Feeder HSCB (54F 5)	ON, OFF	ON, OFF	O		
14	Feeder HSCB (54F 6)	ON, OFF	ON, OFF	O		
15	Feeder HSCB (54F 7)	ON, OFF	ON, OFF	O		
16	Feeder HSCB (54F 8)	ON, OFF	ON, OFF	O		
17	Feeder HSCB (54F 9)	ON, OFF	ON, OFF	O		
18	Feeder HSCB (54F 10)	ON, OFF	ON, OFF	O		
19	Distribution CB (52D)	ON, OFF	ON, OFF	O		
20	Distribution CB ($52L_1$)	ON, OFF	ON, OFF	O		
21	Remote Control Test					
22	Heavy Fault		ON	O	O	
23	Light Fault		ON	O		O
24	Remote Control (43R)		ON	O		O
25	Door Open		ON	O	O	
26	Linked Breaking Receive		ON	O	O	
27	Ground Fault (64P)		ON	O	O	
28	Power Source Trouble		ON	O	O	
29	Emergency Stop	ON	ON	O	O	
30	Spare					
31	Spare					
32	Spare					
33	Spare					
34	Spare					
35	Spare					
36	Spare					
37	Spare					
38	Spare					

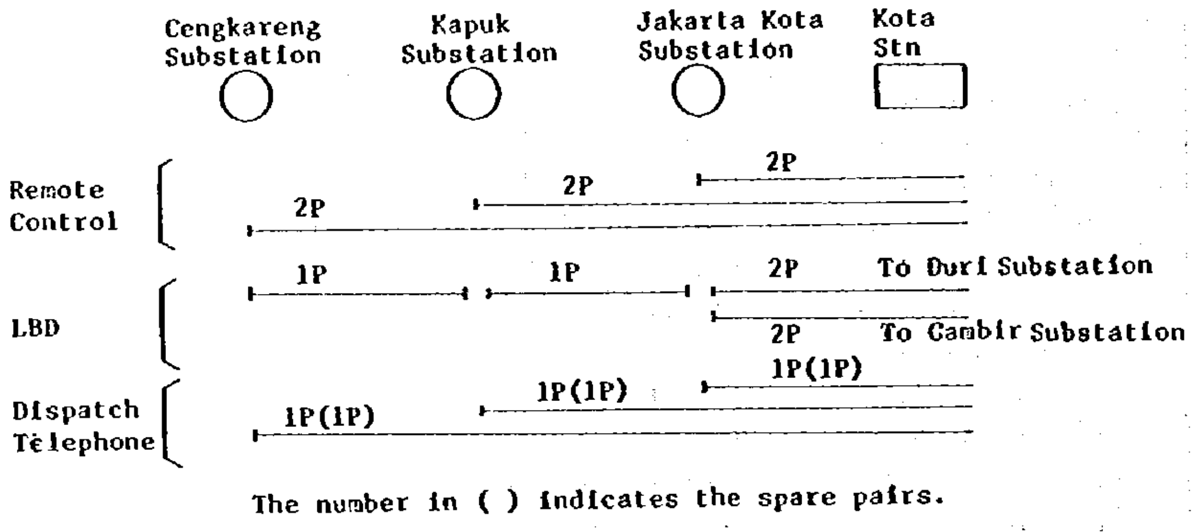


Fig. 6-9-9

In Manggarai Center, a direct telephone to PLN must be installed to make a close connection with PLN. And a establishment of a new maintenance office near Jakarta Kota station will be required, because the quick arrangements in an emergency in the substations are hardly made due to the far distance from Manggarai.

6-9-9 DC Power Source Equipment

DC 100 V alkali batteries and battery control boards will be installed for a power source of circuit breaker operations and control circuits.

6–10 Overhead Contact System

6–10–1 General

These standards are to provide rules for the design of the overhead contact system of the new line for Cengkareng Airport in accordance with that of Western line.

6–10–2 Electrification System

The electric system will be direct current, and the voltage will be as follows:

Standard voltage	1,500 volt
Minimum voltage	1,100 volt

6–10–3 Insulation Coordination and Insulation Level

Lightning arresters will be installed on the feeder wires, making the insulation coordination with the substation equipment. The basic impulse insulation level in the overhead contact lines will be 50,000 volt or more.

6–10–4 Composition of Feeding Circuits

The feeding circuits will be composed with circuits devided in each substation, for minimizing the power outage area in faults and maintenance works, and making easy breaking of short circuit currents.

6–10–5 Crearances of Overhead Contact System

(1) The clearance between the energized parts and the grounded parts in the overhead contact system will be as shown in Table 6–10–1.

Table 6–10–1

Classification	Clearance (mm)
General	250 or more
Minimum in an unevitable case	70 or more
Minimum in an momentary access	30 or more

(2) The clearance between mutual feeders belonging to different circuits will be 600 mm or more.

(3) The messenger wires, pull offs, steady braces, installed under overbridges or structures of platforms, will not be energized in case of close access to these structures.

6-10-6 Design Conditions

(1) Temperature

The standard, maximum, minimum temperatures to be used in the overhead contact system design, will be as shown in Table 6-10-2.

Table 6-10-2

Standard	Maximum	Minimum
30°C	40°C	20°C

(2) Wind Velocity

The maximum wind velocity to be used in design will be 20 m/sec.

6-10-7 Safety Factor

(1) For the overhead contact system facilities the following safety factor will be required to the assumed wind pressure load and tensil load.

Table 6-10-3

Sort	Item	Condition	Safety factor
Wires	Hard-drown copper	To tensil load	2.2 or more
	Other wires	ditto	2.5 or more
Structures	Steel	To yield strength	1.5 or more
	Concrete poles	To breaking load	2.0 or more
	Guys	To tensil load	2.5 or more
Insulators	Stem insulators	To bending breaking load	2.5 or more
		To tensil breaking load	2.5 or more
	Suspension insulators	To breaking load in energized condition	3.0 or more
etc.		To breaking load	2.0 or more

(2) The overhead contact system facilities will be installed so that the train operation will be possible in the monetary maximum wind velocity, 20 m/sec.

6-10-8 Dielectric Strength and Insulation Resistance

(1) The overhead contact line circuits must withstand the applied AC voltage, 1.5 times the operation voltage between the lines and the ground, for 10 minutes continuously.

(2) The insulation resistance between the lines and the ground must be such a value as the leakage current in the operation voltage is 10 mmA/km or less.

6–11 Power Distribution Lines

6–11–1 General

Generally speaking with the adoption of the electric interlocking devices in signaling, the power distribution lines will be required for power supply to the signaling devices and the other railway auxiliary equipment along the tracks for the more reliable power source. In this new line for Cengkareng Airport, the power distribution lines will be installed.

6–11–2 Power Distribution System

(1) Classification

The power distribution system for the railway auxilliary equipment, signaling devices, level crossing facilities, telecom devices, lighting facilities in stations, signal cabins and watchman's sheds, will be classified as shown in Table 6–11–1. Without distribution lines, the electric power will be delivered by PLN directly at each site in low voltage or medium voltage.

Table 6–11–1 Classification of Power Distribution System

Track	Electric System			No. of Lines	Loads	Management
	Phase	Wire	Voltage			
Single	Without distribution lines					
	1	2	20 kV or 6 kV	1	Signaling & Lighting	
	3	3		1	Signaling, Lighting & Motor Loads	
Double	Without distribution lines					
	1	2	20 kV or 6 kV	2	Signaling & Lighting	Mutual changeover
	1	2		1	Signaling Lighting & Motor Loads	Mutual changeover without motor loads
	3	3		2	Signaling Lighting & Motor Loads	Mutual changeover

The principle in the selection of the system is that the more reliable system should be adopted for the more important line. The importance of the lines will be evaluated by single or double track, electrified or not, short or long headway, the composition of train, namely 4–car or 8–car train, mechanical or electric signaling and etc.

(2) Electric System

1) Phase

There are many kinds of electric facilities in railways, and most of them are available with two-phase power except three-phase motor loads. Signaling devices are also available with two-phase. The main purpose of the distribution lines is the power supply for the signaling devices, therefore, the phase of the distribution lines is enough for two-phase from the point of economy.

If there are no three-phase motor loads in stations or other sites, it is no problem. But if any, three-phase power will be required. Especially if the amount of them are over the limit of the low voltage supply, the medium voltage supply will be required. And like this new line, if there are no low voltage distribution lines along the track, the three-phase power supply will be impossible. Especially in the airport a big three-phase power supply cannot be exepcted by PLN.

In the near future, in Jakarta most of buildings will be equipped with air conditioners. Therefore in each working offices in the new line, much of three-phase loads are installed. Therefore, as the phase of the distribution line, three-phase will be adopted for the convenience of three-phase loads.

2) Voltage

Two sorts of voltages can be considered for the distribution lines. They are 6kV and 20kV, and the latter is standard voltage of PLN distribution lines. But the capacity of the electric facilities in railway is small enough with 6kV supply. Therefore, 6kV will be adopted for the voltage of the power distribution lines in PJKA from the point of economy.

3) Ground System

A grounded system and a non-grounded system can be considered. The former is easy in protection relay system. But from the following reasons, the non-grounded system will be adopted. First the non-grounded system gives few inductive interferences for a telecom and signal lines. Next, even in the light ground fault the distribution lines can continue to sypply power with this system. The demerit of this system is the difficulty of ground fault detection in case of the cable installation along all line length. But in the railways, the distribution lines are usually installed in the overhead system on the pole for the overhead contact system. Therefore, the ground fault detection is possible.

(3) Number of the Lines

The number of the distribution lines is usually one for the single track and two for the double tracks. The mounting of two distribution lines to the same pole is not economical compared with the reliability. And the cable installation of second line is too expensive. To think of the importance of the single track line, one distribution line will be enough for the new line. The two lines, two powers system will be completed in the stage of the double track, adding one more line.

In conclusion, the power distribution system for the new line will be three-phase 3 wires 6,000V 50Hz non-grounded system.

6–11–3 Power Distribution Line Network

The network of the distribution lines for the new line will be as shown in Fig. 6–11–1. In this system, an intermediate load break switch normally open will be installed in Kapuk substation for the separation of the line and the changeover of the power supply direction, and remotely controlled from Manggrai Center.

And some pole air switches shall be inserted also into the line at the each station and signal station, and the joints of branches, for the separation of the fault section. Using these switches, the loads between Cengkareng substation and Jakarta Kota substation can expect the power supplies from both directions. But JIAC side of Cengkareng substation and Jayakarta side of Jakarta Kota substation will be obliged to get power only from one direction.

As for Jayakarta station, the power supply will be made from the future distribution lines in Central line. In that stage, the distribution line of Jayakarta side of Jakarta Kota will be removed.

6–11–4 Allowable Voltage Drop

The allowable voltage drop of the distribution lines will be within 6%.

6–11–5 Power Distribution Equipment at Station

The single line diagram of the power distribution equipment at JIAC and Kota Intan Station will be as shown in Fig. 6–11–2. At Kota Intan station where the both direction power supply can be expected, two banks of transformers will be installed, one bank will be standby. At Cengkareng station where only one direction power supply can be expected, one bank of transformer will be installed.

6–11–6 Transformer Stations Outdoor Installation

The transformer stations will be installed on the poles for the wayside electric facilities. For the signaling load in A and B signal station, where the both direction power supply can be expected, two banks of transformers will be installed.

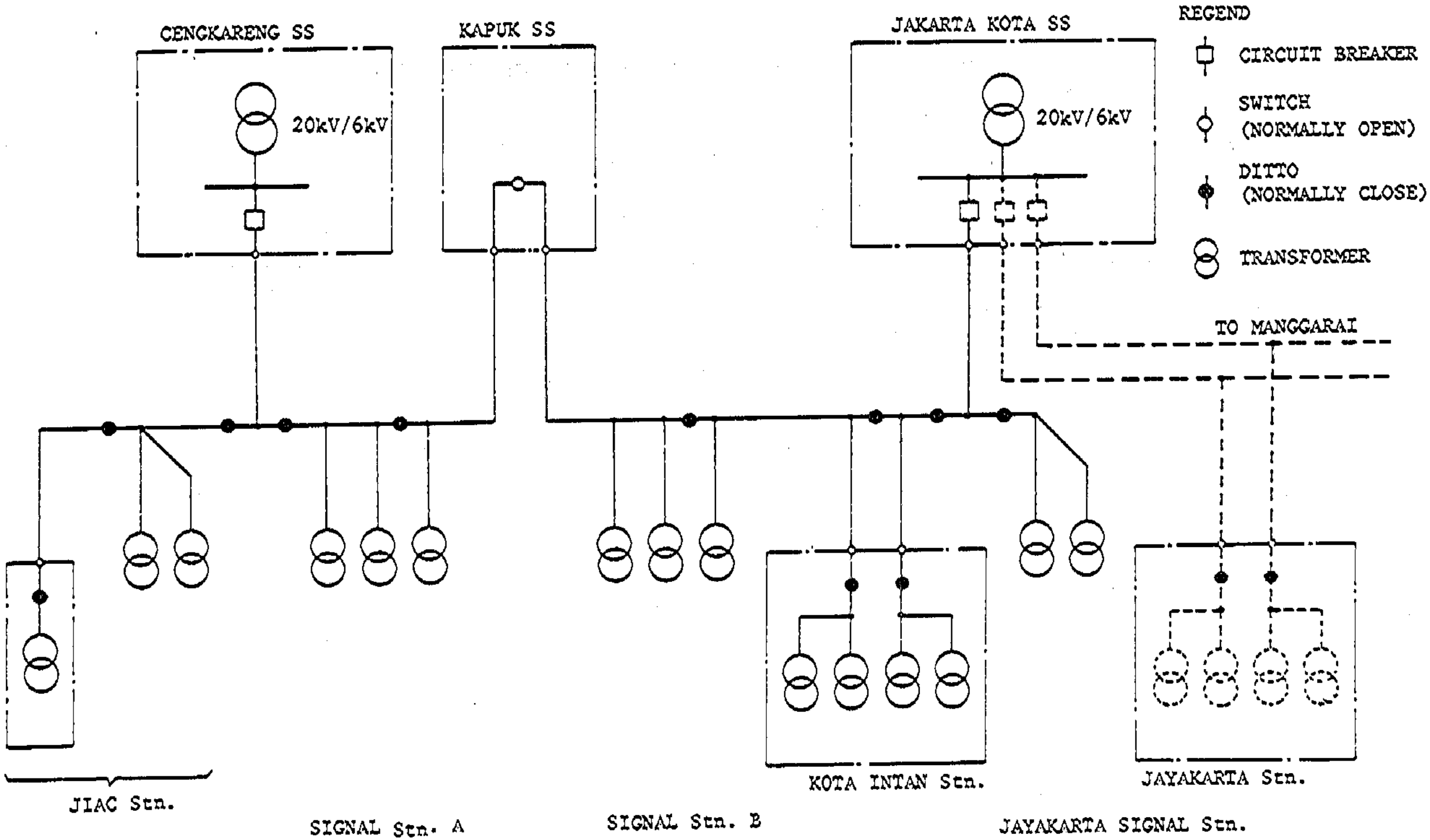


Fig. 6–11–1 Utility Power Distribution Network Diagram

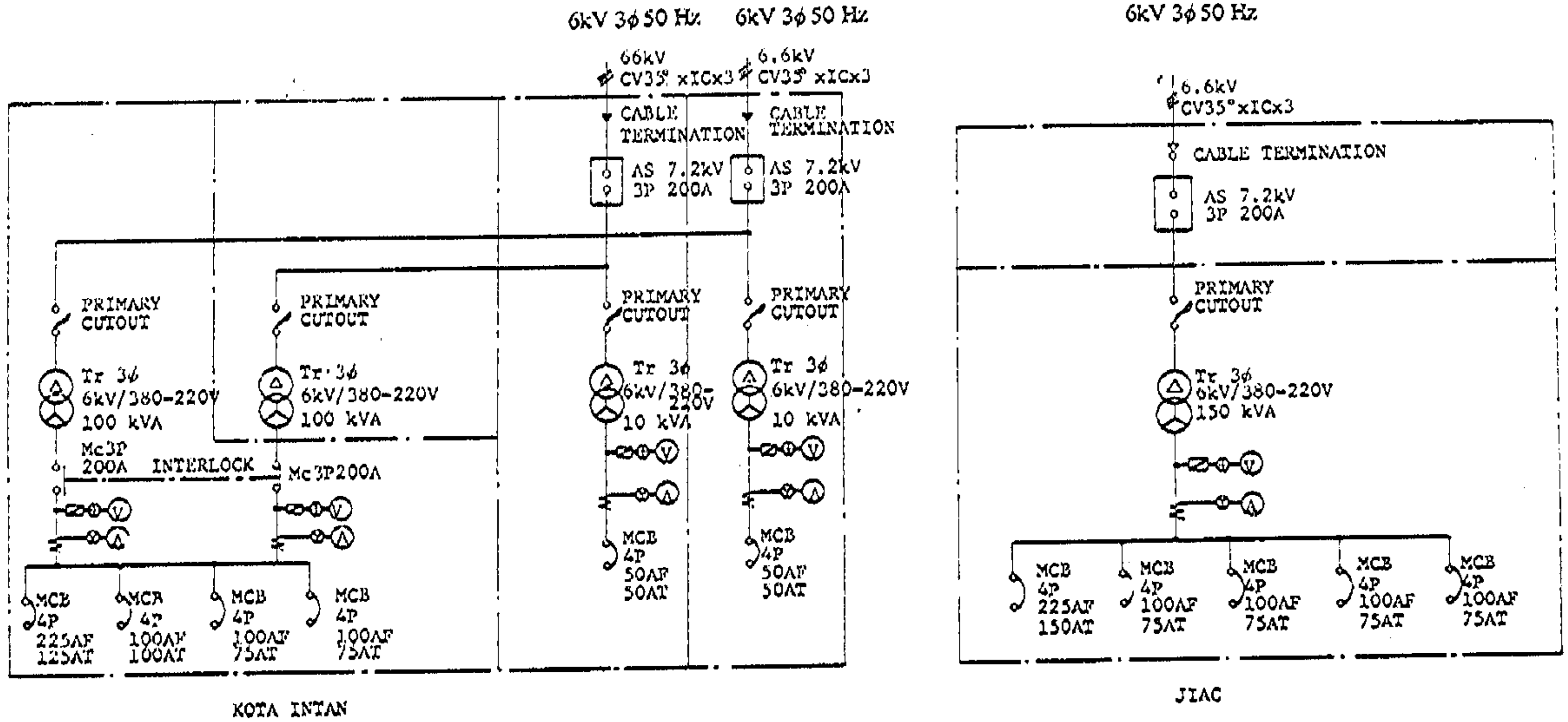


Fig. 6-11-2 Single Line Diagram in Station

6–11–7 Installation Capacities of Electric Facilities

The installation capacities of the electric facilities in each sites will be as shown in Table 6–11–2. The number of the transformers will be also shown.

6–11–8 Capacities of Distribution Transformers in Substation

The capacities of the distribution transformers will be calculated from the installation capacity of the auxiliary electric facilities in the new line adapting demand factor (about 0.7).

In conclusion, the capacity of the distribution transformer in Cengkareng substation will be 300 kVA, and in Jakarta Kota substation will be 500 kVA considering the increase of the service area in the future.

6–11–9 Overhead Distribution Lines

The one line of distribution line will be installed on the poles of the overhead contact system, by the use of 6.6kV grade polyethylene insulated wires and suspension insulators for the higher reliability. The size of wires will be 38 mm^2, which is enough size to keep the voltage drop within the required value. Lightning arresters will be installed on the lines at the required positions.

6–11–10 Overhead Ground Wires

The overhead ground wires will be installed on the top of the poles covering the distribution lines and the overhead contact system against lightning, by the use of galvanized steel strands 55 mm^2 and spliced-arms.

6–11–11 Salt Contamination Proof

Every electric device in outdoor installation will be salt contamination proof type.

Table 6-11-2 Installation Capacity of Electric Facilities

Sort of load	Site			Transformer	
	Name	No.	Installation capacity in each site (KVA)	No.	Capacity (KVA)
Lighting Motor Telecom	JIAC Stn	1	26.5 + 67 + 34 + 34 = 161.5	1	150
	Kota Intan Stn	1	37 + 58 + 42 = 137	(1) 1	100
	Signal Cabin A	2	20	2	20
	Signal Cabin B	2	15	2	20
	Watchman's Shed	15	0.3	13	5
Signaling	Kota Intan Stn	1	10	(1) 1	10
	Signal Cabin	4	10	(2) 4	10
	Watchman's Shed	15	1	13	3
Total			438		484

Note: The number in ( ) indicates standby ones.

6–12 Signalling System

6–12–1 General

Signalling system will be provided to ensure efficient control of train operations and safe operation of trains at high speed. The system will comprise the following devices in such a pattern as designed to cope with the future operational plan for the JABOTABEK area.

(1) Block devices will provide automatic block system for single track.

(2) Signalling devices will be of speed control system which is designed to display the running speed for train operation with the colour light signal.

(3) Electric switch machines will be installed to switch and lock turnouts in the relay interlocking section.

(4) Relay interlocking devices will be installed so as to provide interlocking relations among signals and switch machines and to operate electrically them.

(5) Track circuits will be installed to detect the occupancy of trains at each station and between the stations.

(6) Level crossing facilities will be provided with alarm signals and barriers designed for both automatic and manual control to prevent any accidents at level crossings.

(7) Ground devices of automatic train stop system (ATS) will be provided to compensate any failure to be caused by the train driver.

(8) Signal cables will be installed to transmit necessary informations and data for indication and control of signal equipment.

(9) Electric power will be received from the exclusive distribution line because the power source must ensure stabilized supply with good quality. The Stand-by generator will be installed wherever deemed necessary.

Entire signalling system for the New Railway Line will be as shown on the attached Fig. 6-12-1.

6-12-2 Train Operation System

The signalling system for train operation on the New Railway Line, as the transport means for airport passengers and workers, is planned as mentioned hereunder.

(1) Route Setting

Signal cabin at each station and signal station will be provided with a control console of relay interlocking device. Since the whole section is of single track, only one train should be operated in the section between the two adjacent stations. To comply with this need, a couple of traffic levers will be provided for both of the neighboring stations. Prior to departure or arrival of the train, signal operators at the two stations will notify each other through the Direct Line Telephone. Firstly, the lever will be handled toward the arriving side at the arrival station and then the other lever at the departure station will be handled toward the departing side. After handling of those levers, the system can secure its directional setting. The proceeding route for the train of arrival or departure can be cleared by depressing the starting point button at each corresponding signal on the track diagram of control console and the arriving point button at the point of entering and leaving, thus the turnouts on the desired route can be switched to clear the route so as to enable the signals to indicate the clear aspect.

(2) Train Operation

If the desired route for the train is cleared as referred to in (1), the clear aspect is indicated on the starting signal and the home signal at the next station, the train can be driven to its destination safely without fail if operated by the driver at such a speed as meant by its signal indication.

(3) Shunting Operation

At JIAC station, it is required that shunting operation of trains mutually between the arrival/departure track and the stabling track, because of having two arrival/departure tracks and one stabling track. After simultaneous depressing both shunting and starting point buttons on the track diagram of the control console at JIAC station, the clear aspect can be indicated on the shunting signal by depressing of the arriving point button.

6-12-3 Control and Operation of Level Crossing Equipment

The New Railway Line constitutes the high speed operating section designed at a train speed of 100 km per hour. Therefore, all the level crossings (at 15 points) will be provided with alarm signals and barriers for safety protection of road vehicles and pedestrians. The control system is so designed as to automatically detect the approaching train and start up the alarm signal through the train detectors or the track circuits provided within station yards. Level crossing equipment will be equipped with the lever switch to select control modes of automatic, semi-automatic and manual controls. Manual operations of the equipment are performed by depressing a push button.

6-12-4 Signalling Facilities

(1) Relay Interlocking Device

Signalling equipment and switch machines will be installed to ensure safe and efficient operation of each leaving or arriving train and shunting cars at each station. To provide overall control over those equipment, the relay interlocking device will be installed, comprising control console, relay board, terminal board, instrument board, equipment rack, and power distribution board. Control consoles provided at each signal cabine will be of mosaic type, and rute setting will be made by two push buttons. Indication of the console will be as follows: several indication lamps are lit white on a rute to indicate the rute clearance when the rute is set up for arrival or departure of a train. If the train enter the rute, the indication lamp is turned to red by proceeding of the train. After the train passing through a section on the rute, the indication lamp is turned off and returned to standby position in order. Block system for the section of Jakarta Kota-Jayakarta-Sawahbesar stations will be connected to cooperate with existing S & H Type Hand-Operated Lock-and-Block System for the Central Line. Interface device will be provided at the Jayakarta signal station to convert signals supplied from the Lock-and-Block System of the Central Line and the Relay Interlocking Device of the New Railway Line to each other. Jayakarta signal station has two train operation routes for Jakarta Kota and Airport, therefore, the direction of a train operation will be made sure by an operation staff at Gambir station through the Direct Line Telephones. Numbering systems for signals and switch machines will be shown on the attached Fig. 6-12-2.

(2) Signals

Instructions will be given as to the running conditions prevailing ahead of the train by indication of signals.

1) Signal Indication System

Signal indication system is devised as a speed signal system signifying restricted speed for train operation with signal indication of colour light signals installed on the wayside.

a) Speed Indication Steps:

Speed indication steps are classified into five (5) categories represented basically by "Green" (proceed at max. permissive speed for the section), "Yellow" (proceed with care at 45 km/h) and "Red" (stop): including "Yellow" - "Green" (proceed at reduced speed of 60 km/h) and "Yellow" - "Yellow" (proceed with caution at 25 km/h).

(b) "Yellow" - "Green" and "Yellow" - "Yellow" Aspects:

Although these signal aspects are not adopted for the proposed New Railway Line, the aspect of "Yellow" - "Green" may be used in such events that the breakable distance to the signal ahead is not sufficient; for instance, insufficiency of the required distance to reduce speed from "Green" (100 km/h) to "Yellow" (45 km/h), shortage of the visual distance to the signals ahead or "Yellow" - "Yellow" aspect are indicated on the signal ahead. In the meantime, "Yellow" aspect will be used in the event of insufficiency in the safety distance for overrun at "Red" indication on the signal ahead or in the case of inability to use the "Yellow" signal (45 km/h) because of the low restricted speed allowable for passage over the turnout.

2) Colour Light Signals

Colour light signals will form up the structure of either 2 aspects or 3 aspects by fabricating on each signal unit for separate colour identification of "Green", "Yellow" and "Red". Colour light signals will be categorized as follows:

a) Home Signals:

Signals will be installed at both ends of a station, giving instruction as to acceptability or unacceptability of the incoming train in approach to the station. The protection coverage under the signal is limited up to the arrival track.

b) Starting Signals:

Signal will be installed on the departure track at a station, having the function to issue permission of departure to the outgoing train from the station. The protection coverage under the signal is extended to the home signal at the neighbouring stations.

c) Distant Signals:

Signals will be installed about 500 m in advance of home signals to serve as the annunciators of the indicated signal on the home signals and also to give instructions to the train as to the safety speed applicable to its inward access.

d) Repeating Signals:

Signal will represent the signal indication appearing on its main signal, covering any shortage of the visual distance to home, starting and block signals.

3) Shunting Signals

Shunting signals will be of a position light type to indicate "Proceed" aspect by low white lamps and "Stop" aspect by a "Red" light. The shunting signal assembled with the starting signal will work only for clear indication by two white lamps.

4) Emergency Signals

Emergency signals will be provided with the home and starting signals. It is installed so as to accept the incoming train inward from the signal after confirming indication, by communication with and consent of the operating staff, only in the event that "Stop" or no light is indicated on the main signal.

5) Markers

Markers will be installed, wherever deemed necessary, to identify respricted speed releasing, shunting limit and car stop.

(3) Switch Machines

Switch machine will be provided to switch the trunout in the desired direction as may be required for setting up the clear route for the train. Power for such switching will be supplied by the electric motor. The switch machine is of a trailable type to be capable of throw over the turnout automatically in the opposite direction so as to prevent derailment and to protect switching mechanisms thereof or turnout if it should be pressurized beyond a certain limit against access of any train from the direction of the route not as yet cleared for traffic. In this case, warning indicator provided on the control console is flashed.

(4) Track Circuits

Track circuits installed for train detection within station yards are of a commercial frequency type and are designed for centralized system. The divided frequency track circuit will be installed inter-stations. However, both divided frequency and commercial frequency long track circuits will be installed between the A and B signal stations; the two stations are separated more than 5 km apart from each other. Each station will be equipped with the approach relay connected to the track circuit in order that approach of any train to the point about 1.2 km in advance of the home signal can be detected. The track circuit constitutes power receiving and transmitting equipment, track relays and approach relays.

(5) Level Crossing Facilities

Level crossing facilities will consist of the following items to be installed for safety and protection of road vehicles and pedestrians and for prevention of traffic accidents at the crossing.

1) Level Crossing Signals:

Signals will be provided to notify approach of a train to crossing vehicle drivers and pedestrians by means of warning alarm and flashing lights.

2) Level Crossing Barriers:

Barriers will be installed to separate physically all the vehicles and pedestrians from the railway after lapse of certain time length with approach of the train to a level crossing. Each rod of the barrier will be provided with two type of warning lamps to be flashing and continuously lighting while working of the barriers.

3) X-mark Indicators:

Indicators will serve as the annunciator to the train driver to confirm that the crossing barriers has completely descended by normal performance of the level crossing equipment.

4) Control Devices:

Control devices will be installed near the crossings to automatically control the crossing signals and barriers. Control device consists of relay as the main unit, rectifier, arrester and alarm sound oscillator which are installed in a apparatus case.

5) Train Detectors:

Train detectors will be installed respectively at both points of alarm starting and ending, so that adequate time of alarming can be ensured at each crossing. The train detectors are provided for open and close circuit system, and will be installed in tis own box.

(6) Automatic Train Stop System (ATS)

ATS will be installed for automatic brake control over the train to stop it before the danger zone by alarm indication against the approaching train if the incoming train after entry into the access section exceeds the speed limit indicated on the signal. ATS will be devided into ground and on-board equipment. Out of those two categories, the ground device comprising the wayside coil and its control relays will be installed. ATS control diagram and block diagram of the system will be shown on the attached Fig. 6–12–3 & 6–12–4. ATS is designed continuous speed check system with speed pattern memory and consist of:

1) Ground Devices

Multi-frequency shift type wayside coil will be installed to instruct the restricted speed to the pick-up coil on board.

2) On-board Devices

Devices will consist of pick-up coil, speed detector, speed check mechanism, brake control mechanism, alarm indicator and buzzer and operational switch. It works to stop the train before the stop indicating signal by automatically energizing the normal or emergency brake if the train speed exceeds the limited speed by instruction from the ground control system.

(7) Signal Cables

Signal cables will be used for electrical connection between components of the signalling system. Multicore cables are used to form up the circuit in centralization of equipment.

(8) Power Source

Power for the signalling system will be supplied from the exclusive power distribution line for the railway system, since it must be of good quality on a stabilized supply basis. Stand-by power equipment will be installed at JIAC station and Jayakarta signal station to supply electricity to signal equipment in case of a failure on the exclusive distribution line and will consist of a diesel engine driven alternator, rectifier, batteries DC--AC inverter and control panel.

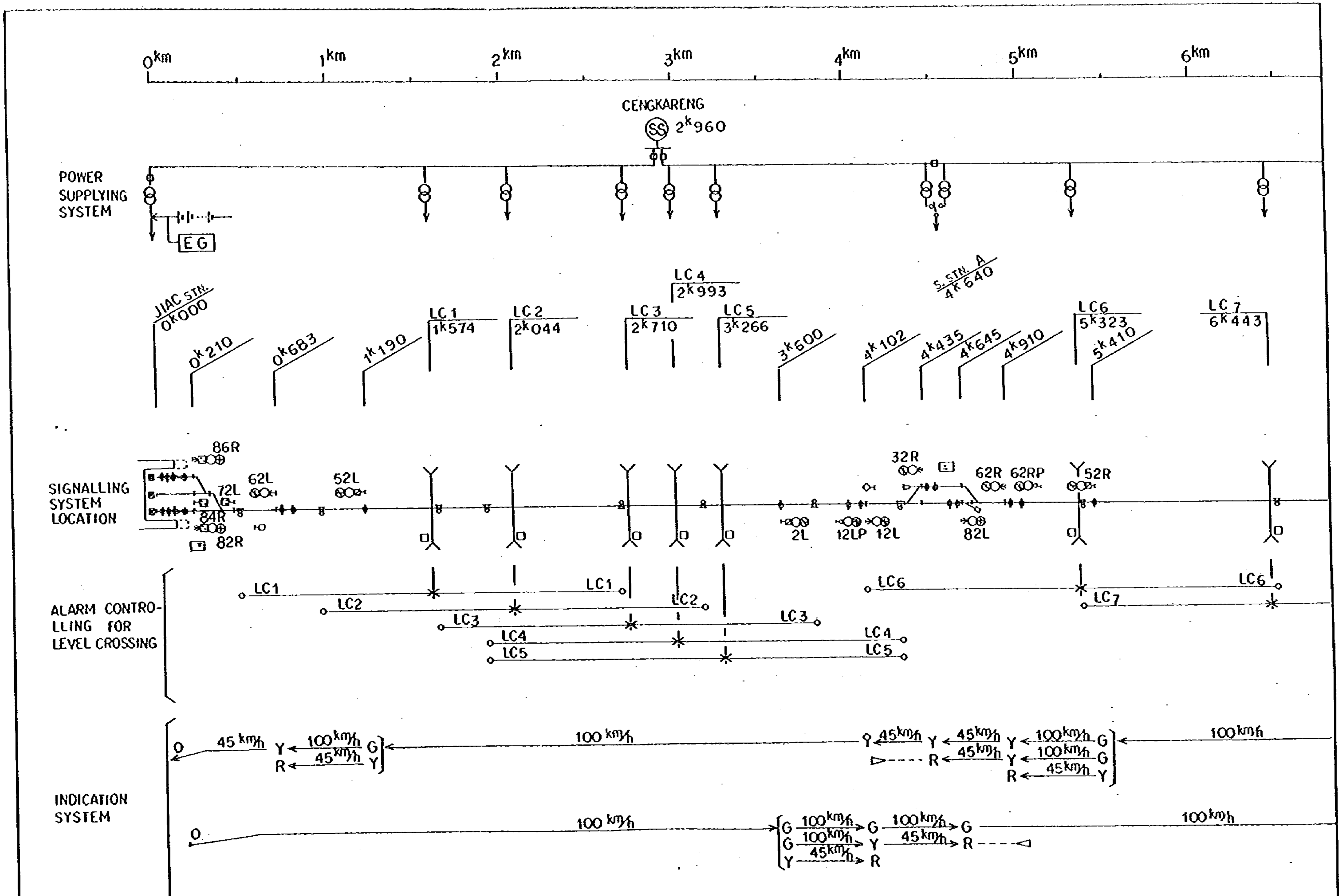


Fig. 6-12-1 Entire Signal System Plan (1)

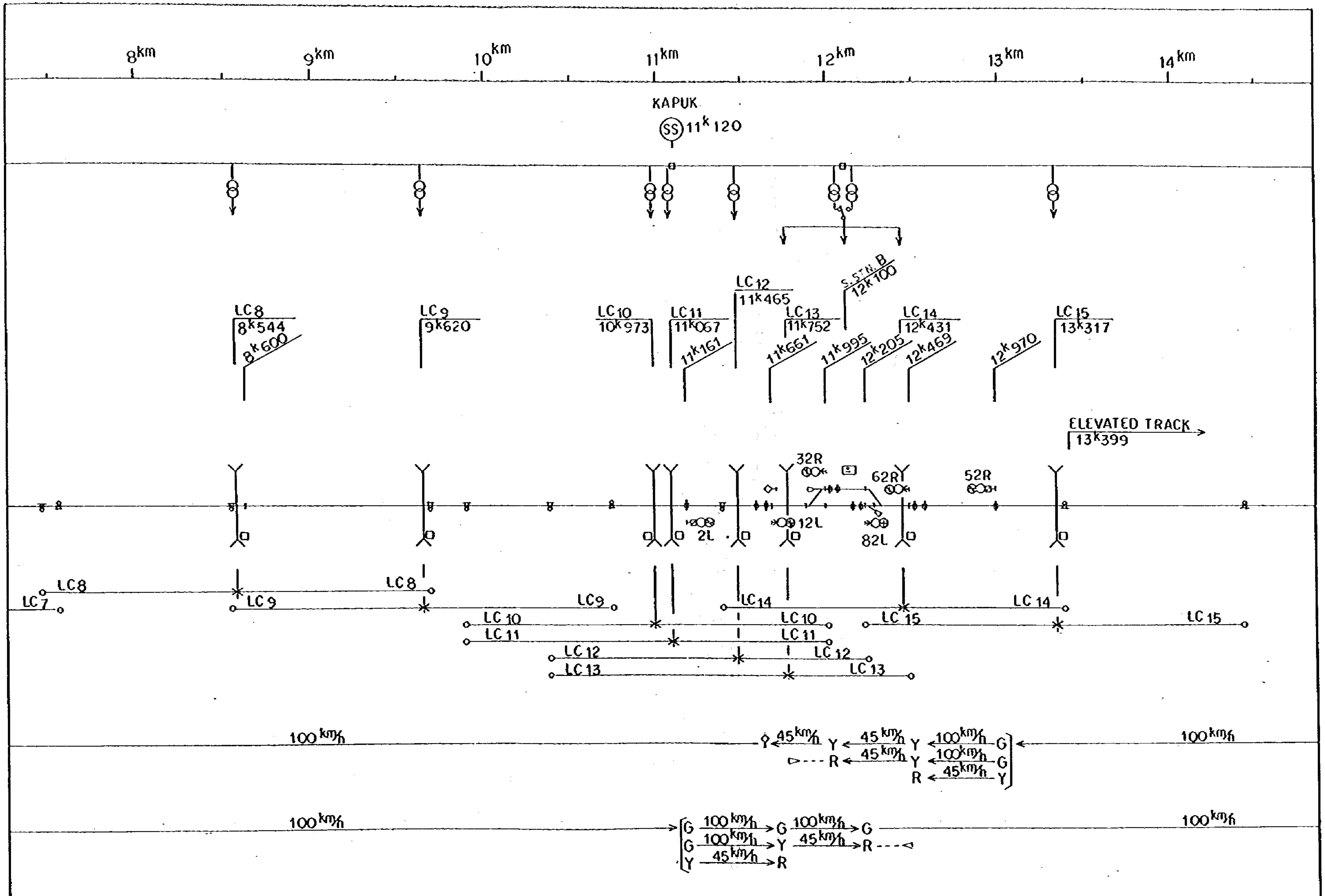
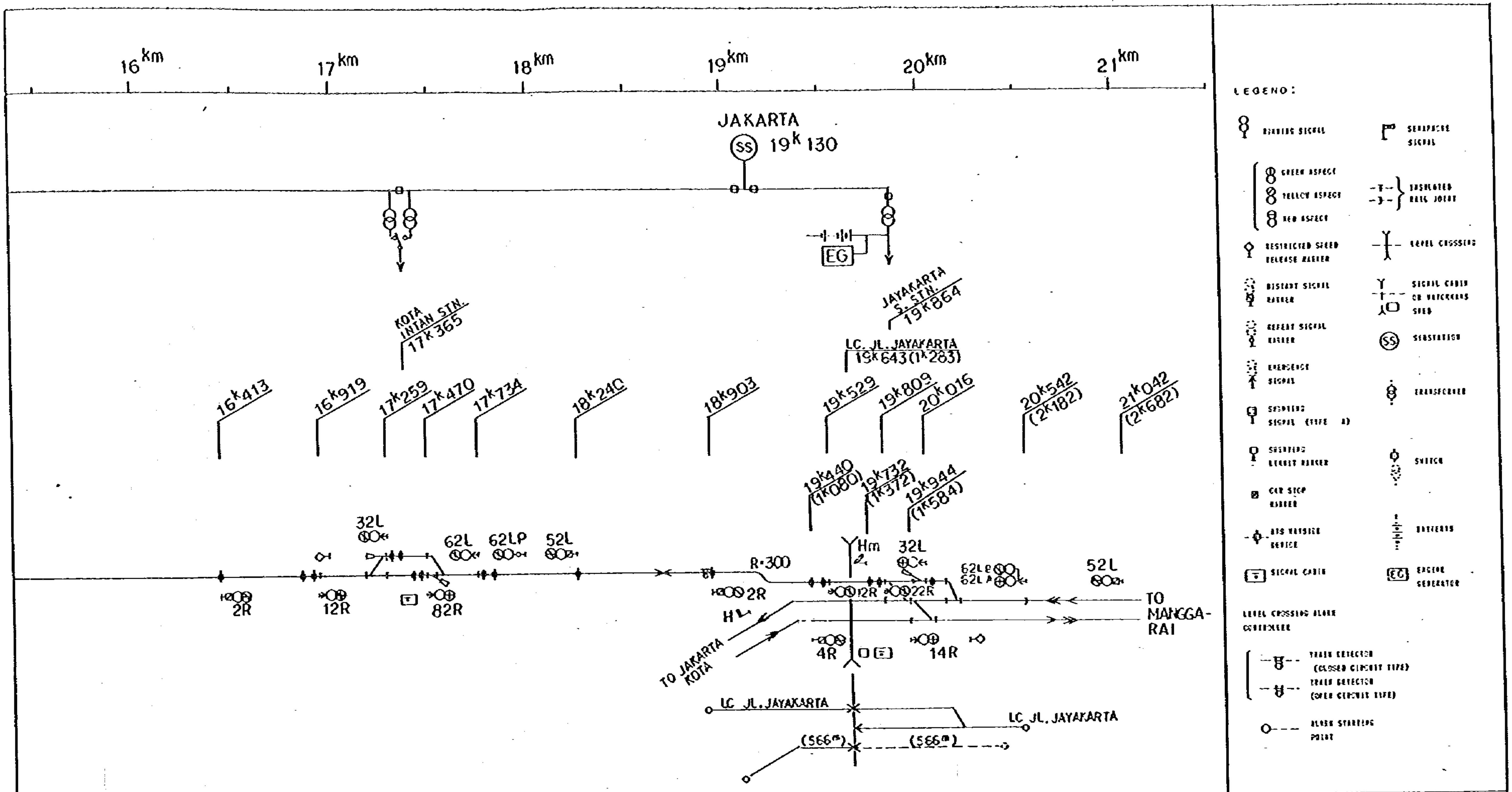


Fig. 6-12-1 Entire Signal System Plan (2)



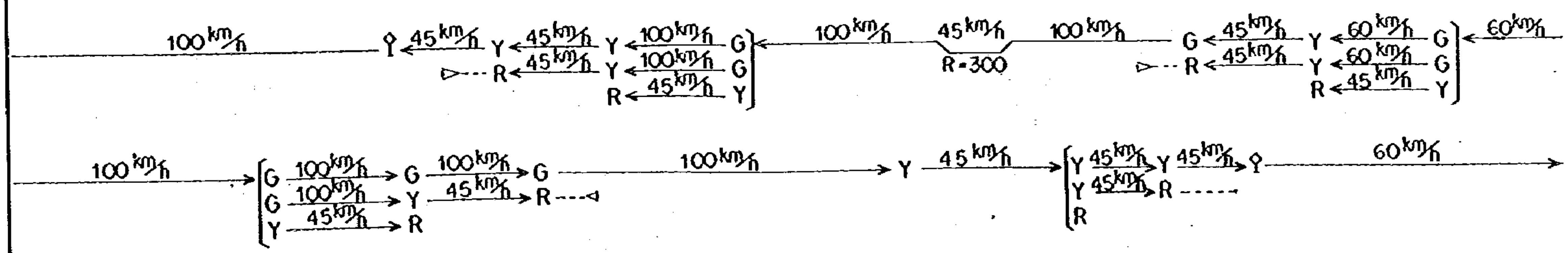


Fig. 6-12-1 Entire Signal System Plan (3)

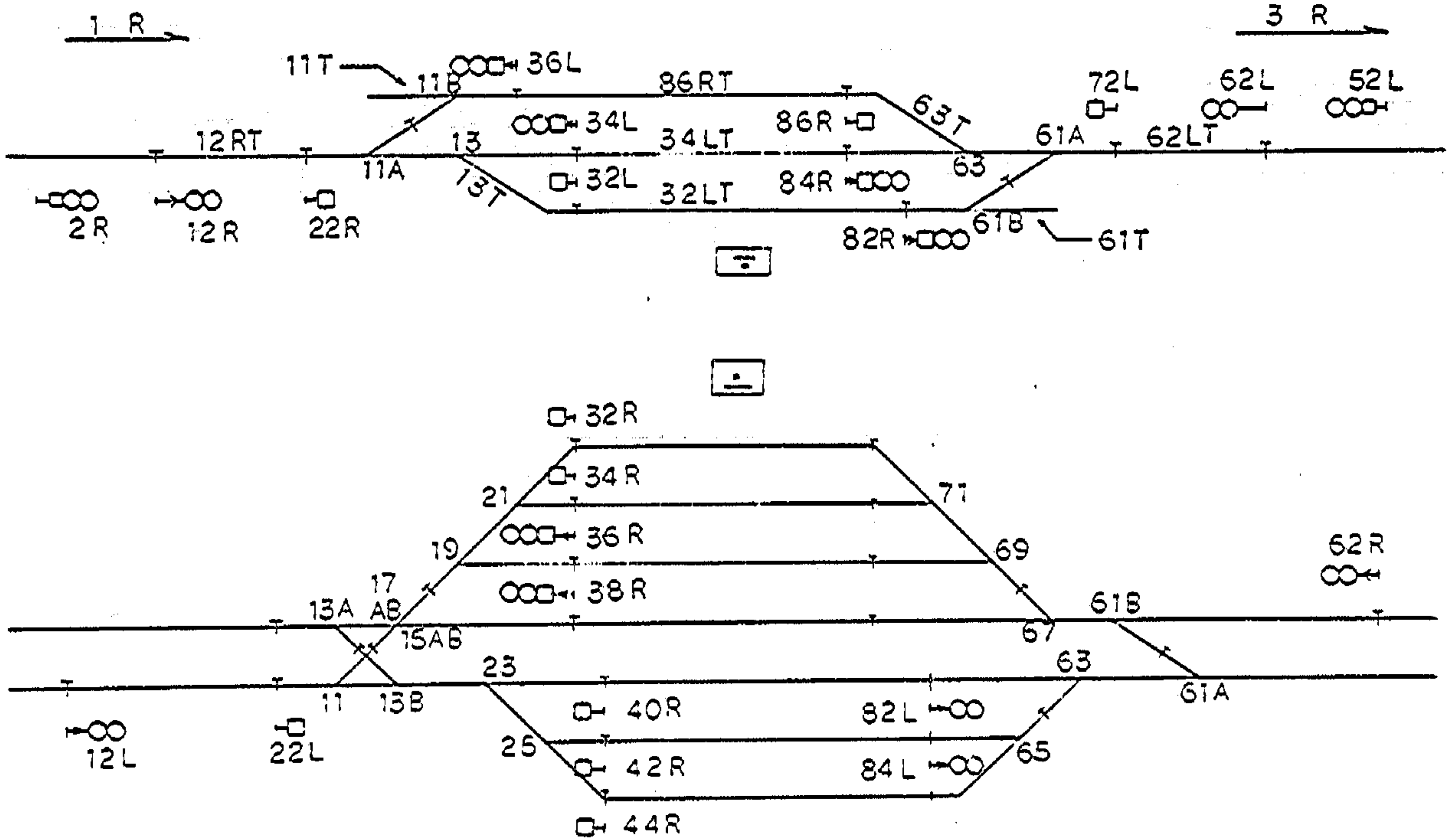


Fig. 6-12-2 Typical Numbering of Traffic-Levers, Switches, Signals and Track-Circuits

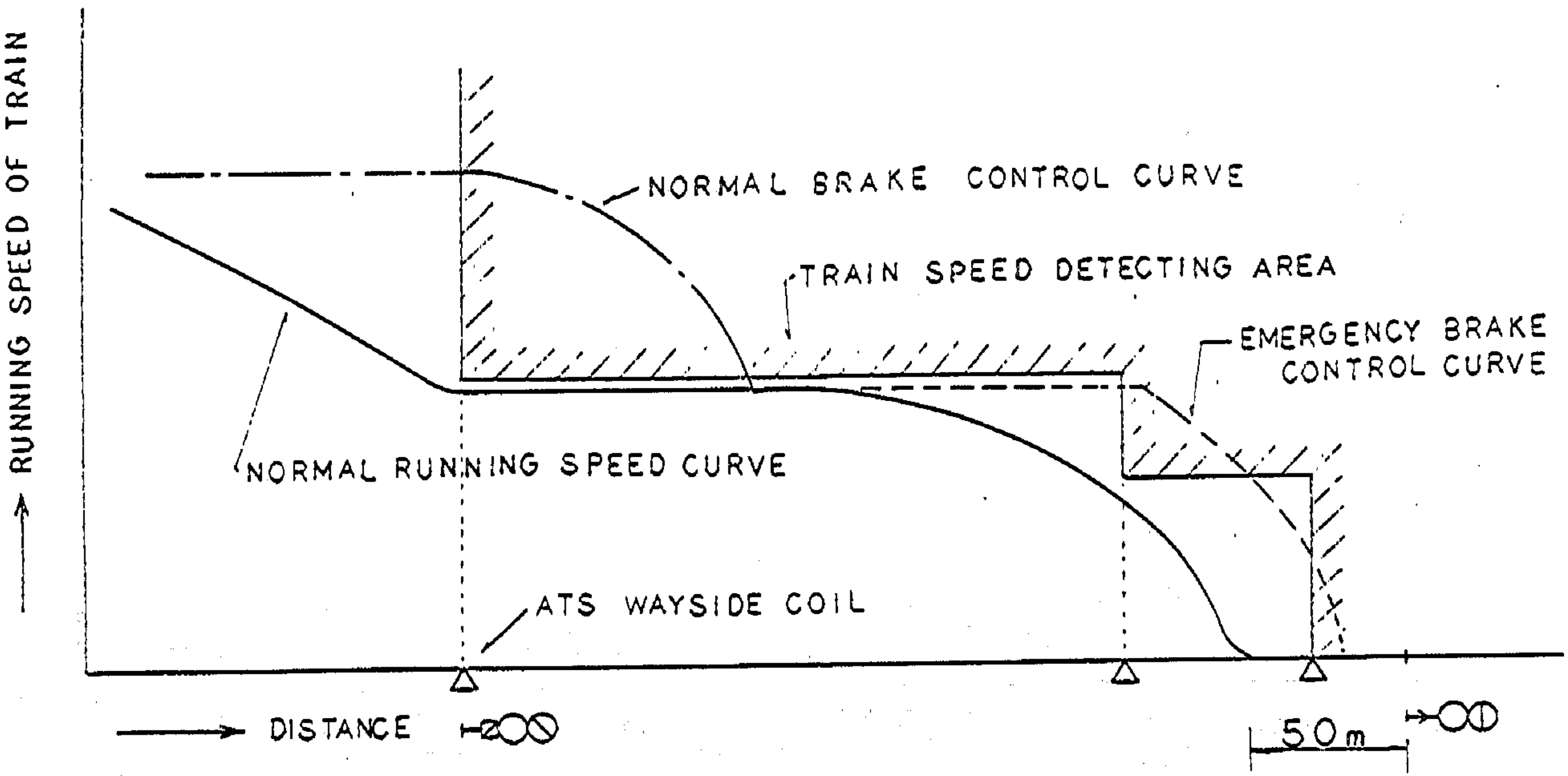


Fig. 6–12–3 ATS Control Diagram

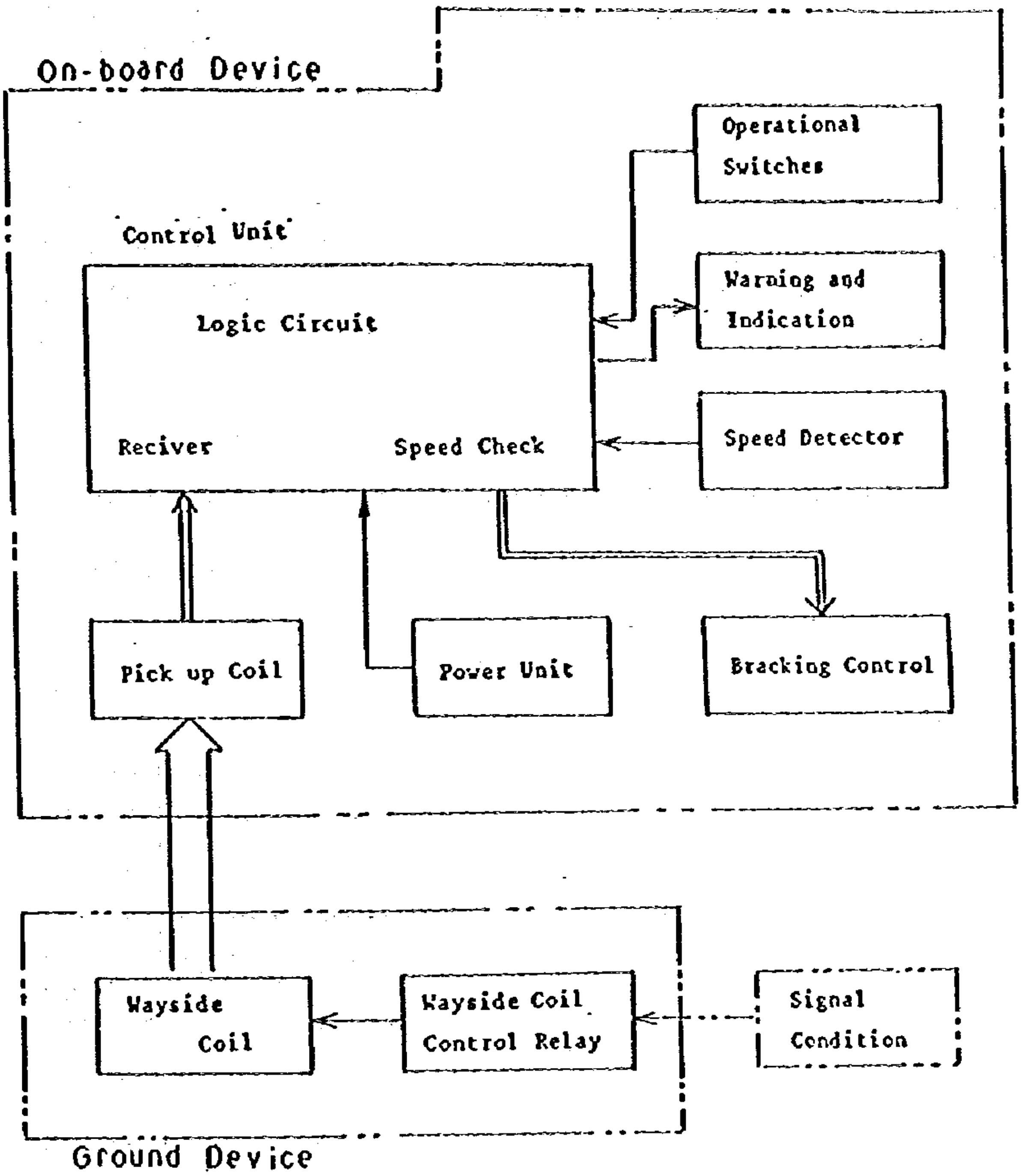


Fig. 6-12-4 Block Diagram of ATS System

6–13 Telecommunication System

6–13–1 General

The New Railway Line should employ the latest technology for its new telecom system. However coordination with existing facilities in the JABOTABEK area, and uniformity with equipment proposed in the Further Study Report (Telecom System) for Jakarta Metropolitan Transportation, issued by PCI/JTC in February 1983 must also be taken into this system. With the above points in mind, telecom system were proposed for easy maintenance and operation, and increasing safely operation and efficiency of the railway and passenger service.

6–13–2 Telephone System

A telephone system composed of automatic telephones, dispatching telephones, direct line telephones, and local yard telephones will be installed for administration of the railway systems.

(1) Automatic Telephones

Subscriber telephones will be used for general communications, and will be connected with the existing PABX (Philips UH–200) installed at Jakarta Kota station. On the PABX, the subscriber line relay units have been provided for 200 lines the capacity, and have about 38 open lines at the present time. Since connection of new subscriber lines to this PABX will be capable. Subscriber telephones will be of the automatic telephone type, with a dial speed of 10 pps.

(2) Dispatching Telephones

Train operation and power dispatching telephones will be provided for dispatchers to communicate with local offices. Selective call type train operation dispatching telephones will be installed in each station, and train dispatch control center to dispatch and communicate for train operations. The units in each station and control center will be capable of station-to-station calls, station-to-control center calls, and control center-to-station or all station calls. Selective call power-dispatching telephones will be installed in each substation and power dispatching control center, and will be used for power dispatch commands and maintenance communications. Capabilities will be the same as for the train operation dispatching telephones.

(3) Direct Line Telephones

Magneto-type direct line telephones will be provided to communicate between neighboring stations for rute setting of a train, and will be capable of Substitute blocking (Telephone blocking) if the rute setting can not be made by down of signalling devices including a relay interlocking device.

This telephone will be provided with a tape recorder to make records of communication on only substitute blocking and not to be used on usual rute setting.

(4) Local Yard Telephones

Magneto-type local yard telephones will be provided at the signal cabin of a station and 50 meters ahead of the home signal of the station for a train driver to contact with a signal operator at the signal cabin in case of home signal down.

6-13-3 Public Address System

The Public Address System is made up of an input device, an amplifier, and an output device, which may be of various types depending on the specific capabilities desired. The simplest public address system is composed of a microphone, an amplifier, and a speaker. Railway public address systems are primarily used for passenger service and directions to station staff, including announcements of train approaching, arrivals and departures.

Equipment for this system on the New Railway Line will include master public address equipment for automatic broadcast of train approaching and departure announcements worked by receiving the signal of a train approaching or departure button pushing. It will also have operation panels with microphone select switch, speakers, and microphone boxes to broadcast at platforms. The three broadcast areas will be the two platforms and the concourse, and the operating panel will be capable of individual or multiple broadcast area selection. The microphone boxes will also have broadcast area selection control for platforms. There will be an alternate amplifier with a select switch in the event of amplifier failure to ensure smooth operation.

6-13-4. Electric Clock System

An electric clock system will be installed at stations and signal cabins to ensure accuracy of train operations, and to increase passenger service. The electric clock system has either digital or analog in type, an analog type with a relatively long visual recognition distance will be adopted. The analog electric clock system has, in turn, 2 types of independent clock types and master/slave types. master-type clock system providing easy maintenance and no time differences indicating on slave clocks will be employed and will composed of a master clock and slave clocks. The master clock is installed in the JIAC station, and the slave clocks at each station. The master clock will provide a crystal oscillator, will demultiply the high-stability high-accuracy oscillations and will supply 30-second clock pulses to drive the slave clocks. In addition, the master clock will be provided with monitor slave clocks on each circuit to ensure identical times for the entire system, or for each circuit separately, as desired.

6-13-5 PCM-type Cable Carrier System

The cable carrier system will be installed between JIAC station and Jakarta-Kota station to save transmission loss and will be provided for increasing of the future communication.

On the cable carrier system, Frequency Division Multiplex (FDM) system or Pulse Code Modulation (PCM) system will be available. As a result of total cost evaluation, construction costs are almost the same for both the systems; and optical fiber PCM system is planed for JABOTABEK area, so that the PCM system would be easier for future interfacing. By these reasons, PCM cable carrier system will be adopted.

The PCM-type cable carrier terminal equipment will be installed at JIAC station and at Jakarta Kota station, and metalic telecom cables will be installed for the transmission line. Repeaters will be provided at intervals of aout 2 km to control transmission loss. One system (30 channels) of the PCM cable carrier terminal equipment will be installed for automatic subscriber telephones and substation control system.

6–13–6 Telecommunication Cable System

The telecommunication cable system is composed of the main cable, which will have communication circuits for train operations, administration and maintenance; the local cable for portable and wayside telephones, wayside telephone boxes and distribution boxes. Cabling methods in aerial, duct and direct burial system will be available. Although the aerial method is the cheapest; for maintenance, it is not recommended for the permanent line. As about 2/3 of the railway will be embanked, the direct burial system is adopted.. It will be effected only little by the surroundings, and should be maintenance-free. The direct-burial system may use either armored type cable or corrugated type cable. Corrugated type cable is superior in flexibility, and is superior from the maintenance point of view as the interior seal can be maintained. Therefore, corrugated type cable will be adopted for the main telecom cable, which will be directly buried in the shoulder of the embankment sections and will be installed within cable ducts provided under the civil work in the elevated sections. Wayside telephone terminal boxes will be located at 500 meters intervals along the track to communicate with adjacent stations or maintenance offices as needed by connecting portable telephones. The distribution boxes will connect main and local cables, and will be provided with arresters to interface with telephones or other telecom equipment.

6–13–7 Train Boarding Information System

This information system will consist of indication panels and a operation panel. Indication panels will be installed at gates of a station to inform departure times and destinations of drains for passenger service. The information system has manual control type and automatic control type which indicates a departure time and destination following a train operation diagram. The automatic type is for large station. For a middle scale station such as JIAC station, semi-automatic system having economy and easy operation will be adopted. The semi-automatic information system provides a micro-computer to operate easily, and will indicate the time and destination on the panels through the operation panel.
Train operation diagram will be programmed on memories of the microcomputer in advance. The indication panel has sheet rolling type and flap revolution type. Flap revolution type indication panels will be employed with advantage of maintenance.

7 TECHNICAL SPECIFICATIONS AND BILL OF QUANTITIES

7. TECHNICAL SPECIFICATIONS AND BILL OF QUANTITIES

7–1 Technical Specifications

Technical specifications have been prepared for three (3) Contract Packages. Contract packages shall comprise the following:

Package I for Civil Work and Architectural Work
Package II for Track Work
Package III for Electrical Work

Package I shall consist of earthwork including but not be limited to excavation (general and structural), grading, filling, clearing and grubbing, construction of embankment, subgrade preparation, concrete structures (reinforced concrete and/or prestressed concrete) for bridges and viaducts, box culverts, slope protection, various architectural work as required at the locations at Airport Terminal Area and Kota Intan Station including but not be limited to pavement work for platform and adjacent area, landscaping and related work.

Package II shall consist of furnishing and delivering of necessary track materials, i.e. R-54 rails, turnouts, fishplates, bolts, nuts, washers, buffer stops in the types as indicated and related accessories; and including track laying work.

Package III shall consist of furnishing and delivering and installation of necessary equipment devices and facilities for substations, power distribution, overhead contact lines, level crossing warning devices, signalling and telecommunications.

Emphasis has been made to the necessity of procurement of local materials and products such as aggregates, soil material and cement to the maximum extent for the Project in the requirements of technical specifications taking into account nation's demand on this particular issue.

For quality assurance of the products and materials, it has been intended to incorporate internationally recognized various standards including but not be necessarily limited to ASTM, AASHTO, ACI, AWS, JIS, AREA, UIC or equivalent standards insofar as the products and materials to be used for the Project can be assured.

Consideration has also been made to incorporation of local standards wherever applicable, provided that equivalent degree of quality of the products can be guaranteed.

Format of technical specifications for Civil Work Package and Electrical Work Package have been prepared using CSI (Construction Specification Institute) Format compiling the contents divided into three (3) parts, i.e. Part I for description of the work required, references, submittals, product handling and other items deemed necessary; Part II for products and materials requirements; and Part III for execution of the work, including fabrication, installation and testing where applicable, except for Track Work Package for which technical specification have been prepared in the format identical to the Contract Document of the similar projects previously executed in the Republic of Indonesia.

7–2 Bill of Quantities

Bill of quantities have been prepared to such an extent that evaluation of tender can be made, based on detailed design drawings as a result of the study made mainly on the similar type of work in road construction and architectural work previously executed in the Republic of Indonesia.

Bill of quantities have been prepared for three (3) Contract Packages I, II and III respectively.

8 BID DOCUMENTS

8. BID DOCUMENTS

8–1 Instructions to Bidders

After thorough study on the collected data and information related to bids under projects identical to this project, Instructions to Bidders have been prepared for Packages I, II and III, which comprise the following:

(1) Outline of the Work

(2) Composition of Bid Documents

(3) General Provisions

(4) Preparation and Submission of Bid

(5) Opening of Bids

(6) Evaluation of Bids

(7) Validity of Bid

(8) Award of Contract

Appendix

Form 1 Form of Bid

Form 2 List of Constructional Plant

Form 3 Price List of Materials Required for the Works

Form 4 Wage Rates for Labour

Form 5 Detail Price Analysis

Form 6 Detail Progress Schedule

Form 7 List of Contractor's Staff

Form 8 Curriculum Vitae of Contractor's Senior Staff

Form 9 Form of Bid Bond

8–2 Conditions of Contract

Conditions of Contract have been prepared for Packages I, II and III based mainly on the Conditions of Contract (3rd edition) published by the FEDERATION INTERNATIONALE DES INGENIEURS-CONSEILS (FIDIC) as well as on conditions of contracts for the projects identical to this project. Form of Contract Agreement and Form of Performance Bond have been also prepared as Appendix.

9 CONSTRUCTION COST AND SCHEDULE

9. CONSTRUCTION COST AND SCHEDULE

9–1 Basic Principles governing Estimation of Construction Costs

Construction costs are believed to fluctuate considerably with the economic condition of Indonesia, the timing of the award of contract and other factors. In this report, the construction costs were estimated according to the following principles:

(1) The construction costs were estimated on the basis of laws, regulations, labor wages, and prices of materials and equipment, as of October 1983.

(2) The construction costs are calculated on the presumption of international tender, and estimated in 3 packages, i.e. for civil engineering/ architectural work, track work and electric work.

(3) The construction costs are estimated for the domestic currency portion and the foreign currency portion according to the following divisions;

Domestic currency portion

- Equipment and materials acquired in Indonesia
- Wages and salaries for Indonesian workers and staff
- Expenses and profit of domestic contractors
- Taxes

Foreign currency portion

- Imported equipment and materials
- Wages and salaries for expatriate workers and staff
- Expenses and profit of foreign contractors

(4) Assumption was made that tax exemption would be applied to all the materials, tools and equipment to be imported from the foreign countries for the construction work as well as any income of all the engineers, personnel and workers, and firms of foreign enterprises, who would participate in this project.

(5) All workers engaged in the work are assumed to be Indonesian, and their wages are assessed on the basis of basic wage for actual working hours of 7 hours per day plus social security and other allowances.

(6) Materials required for the work will be of Indonesian origin whenever possible, and foreign products will be imported only when Indonesian products are not available.

Prices of locally procured materials are assessed on the basis of information issued by the Ministry of Public Works of Indonesia and the market price prevailing in Jakarta.

(7) Prices of construction machinery and tools required for the work are based on the prices of these equipment brought in by the contractors and taken back upon completion of the work; these prices were used after then were compared with the domestic market prices of the same equipment (imported goods) and found to be lower.

(8) In addition to the construction costs for the 3 packages which are subject to tender, the budget for the following items, which are also required for the work, was appropriated:

1) Cost of Land Acquisition and Compensation for Removal and Relocation of Obstacles

The client will be responsible for acquiring land required for the work and compensating for relocation of obstacles from the right-of-way. Land cost and compensation cost for relocating buildings are assessed on the basis of DKI information on records of land acquisition for the airport access road.

2) Cost for Relocating Airport Access Road

The Airport Line will intersect the Airport Access Road at the location apart approx. 2.5 km from the airport. Following discussions with Bina Marga, it was decided that the road be relocated to cross over the railroad. Bina Marga will carry out the design and relocation work, while the project will bear the cost for the design and work.

3) Cost for Test Run

The work will be completed almost 6 months before the opening of the Airport Line so that test runs may be conducted for that period. The cost for the test runs, including labor costs for drivers, conductors, station employees and facility maintenance personnel, and electricity cost, is appropriated.

4) Electricity Charges and Deposit

Power will be supplied by the Indonesia Electric Corporation (PLN), and the client will pay the charges and deposit to the Electric Corporation. The cost for such expenses is appropriated.

5) Construction Supervision Facility Cost

The cost of facilities required for supervision of the work, including offices (newly constructed, including facilities and fixtures) and automobiles (purchased), as well as maintenance/administration cost of facilities for supervision, is appropriated.

6) Cost for Supervision

The cost of supervisers and foreign consultants required for supervision of the work, including salaries, travel cost, living costs and other expenses is appropriated.

7) Contingency Fund

As contingency fund for design modification, 10% of the cost is appropriated for civil engineering/architectural work and electric work, and 5% for track work.

As contingency for inflation, an annual increase rate of 10% is appropriated for the domestic currency portion and 5% for the foreign currency portion.

(9) Exchange rate of foreign currency is set at RP 980 = US$ 1.00 (= ¥235).

9–2 Construction Cost

A summary of the construction cost, which was estimated in accordance with the basic principles of the cost estimation, is estimated for the construction of a temporary track at grade and for the track elevating work thereafter.

9–3 Construction Schedule

As shown in Table 9–3–1 construction schedule, it would require three (3) years from commencement of the Civil Work, Track Work and Electrical Work until completion, and entire work period including acquisition of right-of-way and test run until commissioning will be four (4) years.

Table 9-3-1 Construction Schedule

Work Item		1st Year (months)	2nd Year (months)	3rd Year (months)	4th Year (months)
Surveying	Right-of-Way Stake	9–10			3–4
Geological Survey	Boring	9–10			
Civil Work	Earthworks	7–12	1–12	1–11	
	Bridges and Viaducts	10–12	1–12	1–12	1–5
	Road Construction Works		4–10	8–11	
Track Work	Track Laying Work		2–12	1–12	1–6
	Track Shifting Work		3–4, 9–11		
Architectural Work	Airport Station		1–12	1–2	
	Kota Intan Station			1–12	
	Signal Station			1–10	
	Crossing Watchman's Box			9–12	
Electrical Work	Substations		4–12	1–12	1–6
	Overhead Contact System		3–12	1–12	1–6
	Power Distribution Lines		7–12	1–12	1–6
	Signalling System		3–12	1–12	1–6
	Telecommunication System		7–12	1–12	1–6
Land Acquisition and Removal of Obstacles		1–12	1–12	1–6	
Shifting of Airport Access Road		1–12			
Test Run					7–12 (Commencement of Operation at end of 12)
Construction Supervision Facilities		2–6			

APPENDIX

LIST OF DATA COLLECTED IN INDONESIA

The collected data and information from relevant sources are described below.

(1) Directorate General of Air Communication

- o Drawings for airport plan and bridge structures in airport area
- o Drawings for various structures in airport area
- o General arrangement of airport facilities
- o Pavement detail of road in airport area
- o Drawings and information on plantation in airport area

(2) Directorate General of Highways

- o Manual for design of road
- o Feasibility study on Jakarta harbour road
- o Standards and codes on road
- o Drawings on airport access road
- o Drawings for future plan of Jalan Jembatan Tiga
- o Set of tender documetn for Jakarta - Intra urban tollway
- o Jakarta - Merak highway project bid schedule

(3) DKI Jakarta

- o Materials for land acquisition of airport access road
- o Drawings for river and water channels in proposed railway line area
- o Land use map for Jakarta
- o A set of drawings for Jalan Jayakarta
- o Map of Jakarta (scale 1 : 5,000)
- o Drawings and information on roads in Jakarta
- o Drawings for various underground structures/facilities

(4) Indonesian State Railways

- o Yard operation diagram (Jakarta and Gudang Station)
- o Train diagram in JABOTABEK area
- o Materials for design of Railway structures
- o Materials for cost estimate
- o Profile of western line
- o Drawings for bridge structures located in western line
- o Materials for land acquisition of central line
- o Feeding network in JABOTABEK area
- o Signal line diagram in Gambir substation
- o Standard for buried cable under live line
- o Standard for materials of electric car line
- o Peta hubungan telekomunikasi PJKA
- o Standard for catenary
- o PJKA train dispatching system
- o Track design criteria
- o Material list for track
- o Comparison on fastenings
- o Class of railway
- o Roadway diagraph
- o Specification for PC sleeper
- o Drawing of Pandrol
- o Bid and contract documents
- o Tender document for track

(5) Other Relevant Sources

- o Meteorological data in Jakarta area (1973 - 1982)
- o Data on rainfall and rainy days (1961 - 1980)

- Record of earthquakes
- Unit cost of construction materials
- Monthly statistical bulletin
- Traffic volume of main road in Jakarta area
- Tariff of power
- Tariff of city water
- Masterplan for drainage and flood control of Jakarta
- Final report on Cengkareng drain system study
- Data on rainfall in Jakarta area
- Unit cost of architectural materials
- Catalogue of various architectural materials
- Laws for fire fighting
- Standard specification for highway construction
- Instalasi tegangan tinggi 6 kv, 20 kv
- Price list of various cables
- Price list of power supply from PLN
- Location map for 20 kv cable in Jakarta area
- Single line diagram of PLN switch house
- General regulation for electrical installation
- The regulation for earthquake resistant design of building in Indonesia
- Contract documents & B/Q for Bumi Putera building

RECORD OF DISCUSSION

FOR

INCEPTION REPORT

ON

DETAILED DESIGN

OF

NEW RAILWAY LINE FOR CENGKARENG AIRPORT

The joint meetings for the above mentioned study were held on 19th and 20th of July 1983 at Directorate General of Land Transport and Inland Waterways (PHBD) Ministry of Transport.

Attendants from both sides were shown in this record as attached.

The Indonesian side was represented by. Ir. Giri S. Hadiharjono MSE, chairman of Indonesian Steering Committee and the Japanese side was represented by Mr. H. Takashima, Chairman of Supervisory Committee for the Study Team.

JICA Study Team, headed by Mr. H. Koyama submitted thirty (30) copies of the Inception Report on the above mentioned study to PHBD and also made explanation on the Report.

The following is the Record of Discussions during the Joint meetings.

The Inception Report submitted by JICA Study Team was accepted with the following clarifications :

1. Problem Areas

   (1) Interface between New Railway Line and Central Line.
   It was suggested by Indonesian side to cope with a considerable and certain time gap between the project schedules for

"Cengkareng Airport Railway Line" and Elevated Track for the Central Line" that the most cautious study be made by JICA Study Team for the alternatives in connection with the future plans as mentioned by Indonesian side.

JICA Study Team stated that the study would be made to the possible extent in direction of incorporating the recommendation to the suggestion made by Indonesian side into the Report.

(2) Interface with Jakarta Harbour Road.

JICA Study Team presented schematic drawings showing the location where shifting of the Harbour Road by approximately 15 m towards north from the proposed alignment and to the extent of approximately 3 km required from the location adjacent to Jalan Jembatan.

Close coordinating through PHBD with BINAMARGA and other relevant authorities should be immediately made.

(3) Crossing with Airport Access Road at the Exit of Airport.

Due to the fact that the design of access road was completed by BINAMARGA, coordination through PHBD with BINAMARGA and other relevant authorities should be immediately made.

(4) Crossing with JEMBATAN Road

In view of future vehicular traffic volume on the Jembatan Road, grade-separation will be essential, close coordination through PHBD with BINAMARGA and other relevant authorities should be immediately made with regard to determination of the type of grade-separation.

(5) Crossing with Airport Acces Road.

This is an identical problem to the precedings, therefore close coordination through PHBD with all relevant authorities should be immediately made.

(6) Gradient.

Indonesian side stated that a grade of 35‰ as used in Japan would not be practical in Indonesia as the existing rolling stock of PJKA cannot cope with the grade in question.
For example, existing diesel raicars' tractive power has been designed for a grade of 15‰.

(7) Design Train Load.

Despite JICA Study Team proposed to adopt design train load lighter than KS-16, Indonesian side suggested an alternative of an axle load of 18 t for bridge structure and 15 t for track structure.
Discrepancy was discovered in the meaning of a term " KS " between two parties.
Definition of the term " KS " was requested by Indonesian side for mutual understanding.

JICA Study Team would further study on the preceding matters for the selection of a most suitable grade and design train load as these problems are closely related to the consistency in the design criteria adopted for "JABOTABEK" Projects.

2. OTHER MATTERS

(1) Technical Transfer

As to a point raised by a BAPENAS representative regarding the effective use of Indonesian counterpart experts involved in the detailed design work, JICA Study Team stated that technical transfer of the detailed design work to the Indonesian counterpart experts can be accomplished until the end of October 1983 to such an extent as completing the design work for typical structures.

JICA stated that training of an Indonesian counterpart could be made in Japan for a period within this fiscal year.

(2) Use of Local Products.

Due consideration has already been made by JICA Study Team to use local products to the maximum extent provided that the local products will meet the requirements as stipulated in the technical specifications.
This was agreed by Indonesian side.

3. UNDERTAKING OF THE GOVERNMENT OF INDONESIA.

(1) Counterpart Experts.

Counterpart experts as requested by JICA Study Team in the Inception Report was agreed in principle by Indonesian side, yet detailed information such as name, title, assignment and responsibilities will be disclosed in the near future.
JICA Study Team specifically requested to clarify the extent of services and responsibilities.

Since surveying and geological survey would be essential jobs to enable the design team to carry out the detailed design effectively and successfully, JICA Study Team therefore emphasized to request Indonesian side to assign the experts or specialists who are capable of settling the possible trouble that might be claimed by local inhabitants residing in the neighbourhood of the project location .
JICA Study Team also requested Indonesian side for appropriate actions to enable their team members to carry out the work upon entering or trespassing on the privately owned lots.
Indonesian side guaranteed the security.

(2) Office and others.

(a) Office space of 150 M^2 with telephones and airconditioners against the request for 300 m^2 will be provided in the initial stage followed by increase in space at later stage.

(b) Desks and Chairs	40 sets - Agreed
(c) Drafting Tables	4 sets - Agreed
(d) Electric Typewriters	2 units - Agreed
(e) Book Shelves	7 units - Agreed

(f) Large White Board — 1 set - Agreed

(g) Photo Copy Machine — 1 unit common use with JABOTABEK Project Team - Agreed

(h) Kitchen Facilities — Agreed

(i) Two typists, three draftsmen and one office boy — Agreed

(j) Vehicles with fuel and drivers

Since JABOTABEK Project Team has 10 vehicles, a request for vehicles can be made available throuth the person in charge at any time. At present, 2 micro buses are available at anytime.

(3) Necessary Data and Pertinent Information.

Among all the relevant data and information necessary for the project as specified in the Inception Report, page 36, from the item 1 through 13, JICA Study Team requested for data related to roads and airport construction urgently. Indonesian side stated that JICA Study Team would be provided with necessary data and information through PHBD from the relevant sources, however, the request should be made in writing and submitted to PHBD for further action.

(4) The attendents Lists are as per attached.

Ir. GIRI. S. HADIHARDJONO MSE
Chairman of the Indonesian
Steering Committee
Government of Indonesia

Mr. HITOSHI TAKASHIMA
Chairman of Supervisory
Committee
Japan International Cooperation
Agency.

ATTENDANCE LIST OF MEETING INCEPTION
REPORT STUDY OF DETAILED DESIGN ON
CENGKARENG NEW RAILWAY LINE

DATE : JULY 19, 1983

INDONESIAN PARTY

1. Ir. GIRI S. HADIHARDJONO	Directorate General of Land Transport and Inland Waterways.
2. Drs, DARMAWAN	National Planning and Development Board
3. Ir. BIDIHARDJO	Region of Planning and Development of DKI Jaya.
4. GATOT SOEDJANTOKO	Directorate General of Land Transport and Inland Waterways
5. Ir. IMAM SOEDRADJAD	Departement of Communication
6. Ir. NUGROHO	Jabotabek Railway Project
7. ABD. SAFARI	West Exploitation of PJKA
8. AMIROEDIN	Indonesian State Railways
9. WAHJUDI	Indonesian State Railways
10. Ir. SOEPARTO	Jabotabek Railway Peoject
11. SAMPOERNA RAIFOEDIN	Indonesian State Railways
12. TOHIR KARTABRATA	Jabotabek Railway Project
13. Ir. NICO DJAJASINGA	Jabotabek Railway Project
14. Ir. DJAUHARI P.	Directorate General of Land Transport and Inland Waterways
15. T. MATSUMOTO	Expert to DGLT
16. T. HATA	Expert to DGLT
17. K. ASHINA	Expert to DGLT
18. S. SHIBUYA	Expert to DGLT

JAPANESE PARTY.

1. Ministry of Transport

   M. TAKASHIMA

2. Japan Embassy

   M. NAKAMOTO

3. Japanese National Railways

   N. KUMAGAI

4. Japan International Cooperation Agency

   S. KANAI

5. JICA Study Team

   M. KOYAMA

   T. NAKAJIMA

   K. YAMADA

   K. MURATA

   T. YAMADA

   S. INOUE

   T. YAMADA

   M. MASUDA

   T. KURATA

   H. NAMMA

   T. KUBO

   T. TERAKI

   H. AKIMOTO

ATTENDANCE LIST OF MEETING INCEPTION
REPORT STUDY OF DETAILED DESIGN ON
CENGKARENG NEW RAILWAY LINE

DATE : JULY 20, 1983

INDONESIAN PARTY

1. GATOT SOEDJANTOKO	Directorate General of Land Transport and Inland Waterways
2. Ir. SOEPARTO	Jabotabek Railway Project
3. SAMPOERNA RAIFUDIN	Indonesian Railway Project
4. TOHIR KARTABRATA	Jabotabek Railway Project
5. SOETIKNO	Indement Consult
6. ASMAN	Indement Consult
7. SORJANTO	Jabotabek Railway Project
8. Ir. NICO DJAJASINGA	Jabotabek Railway
9. [illegible]JOSUMARNO	Departement of Communication
10. F. TANJUNG	Departement of Communication
11. Ir. DJAUHARI P.	Directorate General of Land Transport and Inland Waterways
12. T. MATSUMOTO	Expert to DGLT
13. T. HATA	Expert to DGLT
14. K. ASHINA	Expert to DGLT
15. S. SHIBUYA	Expert to DGLT

JAPANESE PARTY

1. Ministry of Transport

   H. TAKASHIMA

2. Japanese National Railways

   N. KUMAGAI

3. Japan International Cooperation Agency

   S. KANAI

4. JICA Study Team

   M. KOYAMA

   T. NAKAJIMA

   K. YAMADA

   K. MURATA

   H. AKIMOTO

   S. INOUE

   T. YAMADA

   T. TERAKI

MINUTE OF MEETING
BETWEEN
PJKA / JABOTABEK AND JICA / COUNTERPART
HELD IN PJKA HEAD OFFICE BANDUNG
SEPTEMBER 05, 1983, FROM 09.00 AM – 01.30 PM
(ATTACHED ATTENDANCE LIST)

SUMMARY RESULTS:

1. GRADIENT:

a). HAVE BEEN APPROVED BY PJKA (MR. SITUMORANG) THAT MAXIMUM GRADIENT UP TO SEPT. 05, 1983 IS 15 ‰.

b). FOR BIGGER FIGURE (SAY 20 – 25 ‰) AS REQUESTED BY JICA WILL BE ANSWERED / CONFIRMED LATER (WITHIN 10 DAYS LATER AFTER PJKA RECIEVE THE EXACT CHARACTERISTIC DATA FROM THE MANUFACTURER).

2. DESIGN CRITERIA.

ALMOST ALL DESIGN CRITERIA SUBMITTED BY JICA HAVE BEEN APPROVED BY PJKA EXCEPT FOR:

a). WIDTH OF FORMATION LEVEL (FOR TRACK CENTER RESPECTIVELY), HAVE BEEN DECIDED BY PJKA 2,85 M, INSTEAD OF 2,70 M.

b). PLATFORM LENGTH, BASICALLY APPROVED 190 M INSTEAD OF 270 M AS REQUESTED BY DJKA. DJKA STILL REQUIRE MORE DETAIL EXPLANATION FROM JICA ABOUT THE REAL EXISTING CONDITION IN AIRPORT CENGKARENG AND ALSO EXPLANATION ABOUT THE POSSIBILITIES TO INCREASE THE TRAIN FREQUENCIES BY ADDITIONAL SIGNALLING SYSTEM FOR THE OPERATION BEYOND THE YEAR OF 2010.

c) FORMULA OF TRANSITION CURVE WILL BE GIVEN FROM DJKA TO TEAM JICA

d). VERTICAL CURVE :

HAVE BEEN DECIDED BY DJKA THAT VERTICAL CURVE SHOULD BE 6000 INSTEAD OF 4000.

e). BALLAST THICKNESS OF TRACK HAVE BEEN DECIDED BY DJKA SHOULD BE 300 MM INSTEAD OF 250 MM. JICA WILL DISCUSS THIS MATTER NEXT MEETING.

e) STANDARD OF WEIGHT OF RAIL HAVE BEEN DECIDED BY DJKA SHOULD BE USED UIC 54 INSTEAD OF N 50 kg/m b/. MAX. CANT HAVE BEEN DECIDED BY DJKA SHOULD BE 110 MM INSTEAD OF 105 MM (ACCORDING EXISTING REGULATION).

3. HAVE BEEN INFORMED BY PJKA, THAT ALL DISCUSSION WILL BE LEAD BY MR. SOEPARTO (JABOTABEK) OR PJKA EXPLOITASI BARAT, EXCEPT FOR PRINCIPAL MATTER (I.E FOR GRADIENT).

BANDUNG, SEPT. 05, 1983

MINUTED BY IND. CONSULTANT,

SUTOYO M
PROJ. OFFICER.

AGREED:

PJKA:	JABOTABEK	JICA
MR. SOEHARSO	MR SOEPARTO	MR. M. KAYOMA
DIRECTOR	KEP. DIV. TEKNIK	PROJ. MGR

ATTENDANT LIST

DATE : SEPT 5/1983

NO	NAME	COMPANY	SIGNATURE
1	IR. Soeharso	DIR. INSTALASI TETAP PJKA	[signature]
2	IR. Soeparto.	KADIV TEKNIK JABOTABEK KA	
3	IR. SUTOYO. M	Counterpart Indonesia	
4	Bp. SOETRISNO	KASUBDIT SIGNAL & TELKOM	
1 8	ARIEF HERIYANTO	PROYEK JABOTABEK	[signature]
10	Berlin Silaen	Counterpart Indonesia	[signature]
11	SOERJANTO	PROYEK JABOTABEK	[signature]
12	Simon SILALAHI	Counter part Indonesia	[signature]
9	M HIDAJAT.	PROYEK JABOTABEK	[signature]
10.	MANURIYANTO	PROYEK JABOTABEK	[signature]
11	EMIL A. RONI	[illegible] PROYEK JABOTABEK	[signature]
12	T. YAMADA	JICA	T. Yamada
13	Kairyu AGATA	"	K. Agata
14	Masami SEKINE	"	M. Sekine
15	[illegible] MIFUNE	"	[signature]
16	Kohei MURATA	"	K. Murata
17	SHIBATA/S	"	[signature]
18	Masanao KOYAMA	"	M. Koyama
19			
20			
21			

ATTENDANT LIST

DATE : SEPT 5. 1983

No	NAME	COMPANY	SIGNATURE
1.	Ir. Soeharso	Dir Instalasi Tetap PJKA	
2.	Chaidir Nien Latief SH	Dir Lalu Lintas & Perniagaan PJKA	
3	Ir. Soeparto	Kadiv Teknik Proyek JABOTABEK	
4.	Ir. Sutoyo H	Counterpart Indonesia	
5.	Ir. J.T. Simanjuntak	Dir Traksi & Materiil	
6	Djafek	Kepala Seksi Operasi [illegible]	
7.	Ir. Koestomo	Kasubdit Pengolahan Data Pembangunan (Instalasi Tetap)	
8.	KENANG.	Kasi Telekomunikasi	

MINUTE OF MEETING

BETWEEN

PJKA/JABOTABEK AND JICA/COUNTERPART HELD IN PJKA HEAD OFFICE

BANDUNG, SEPTEMBER 05, 1983, FROM 09.00 AM-01.30 PM

(ATTACHED ATTENDANCE LIST)

1.	Mr. SUHARSO, Ir.	PJKA	Director
2.	Mr. SOEPARTO Ir	JABOTABEK	Kadiv. Teknik
3.	Mr. CH.N. LATIEF, SH	PJKA	Director
4.	Mr. ST. SITUMORANG, Ir	PJKA	Director
5.	Mr. SOETRISNO	PJKA	Kasubdit Signal & Telkom.
6.	Mr. DJAFAR	PJKA	Kaseksi Operasi Lok.
7.	Mr. KOESTOMO, Ir	PJKA	Kasubdit Pengolahan data & Pembangun[illegible]
8.	Mr. KENANG	PJKA	Kasie Telekomunikasi
9.	Mr. T. YAMADA	JICA	-
10.	Mr. K. AGATA	JICA	-
11.	Mr. M. SEKINE	JICA	-
12.	Mr. I. MIZUNO	JICA	-
13.	Mr. K. MURATA	JICA	-
14.	Mr. S. SHIBATA	JICA	-
15.	Mr. M. KOYAMA	JICA	-
16.	Mr. SUTOYO M, Ir	COUNTERPART IND.	-
17.	Mr. BERLIN A.S.Ir	-"-	-
18.	Mr. S. SILALAHI Dipl Ing	-"-	-

19. . . . . . .

19. Mr. SURYANTO, Ir COUNTERPART IND. -

20. Mr. M. HIDAYAT, Ir -"- -

21. Mr. MANURIYANTO, Ir -"- -

22. Mr. ARIEF HARLIYANTO, Ir -"- -

23. Mr. EMIL A. RONI, Ir -"- -

SUMMARY RESULTS :

1. GRADIENT :

a) Have been Approved by PJKA (Mr. Situmorang) that maximum Gradient up to September 05, 1983 is 15 ^{o}/oo.

b) For Bigger figure (Say 20 - 25 ^{o}/oo) as Requested By JICA will be answered/confirmed later (within 10 days later after PJKA recieve the exact characteristic data from the manufacturer).

2. DESIGN CRITERIA

Almost all design criteria submitted by JICA have been Approved by PJKA Except for :

a) Width of formation level (for track center respectively) have been decided by PJKA 2,85 M, instead of 2,70M

b) PLATFORM LENGTH, BASICALLY APPROVED

190 M instead of 270 M as requested by PJKA. PJKA still require more detail explanation from JICA about the real existing condition in Airport Cengkareng and also explanation about the Possibilities to increase the train frecuencies by additional signalling system for the operation beyond the year of 2010.

c) Formula of transition curve will be given from PJKA to Team JICA.

d) . . . . .

d) Vertical Curve :

Have been Decided by PJKA that vertical curve should be 6000 instead of 4000.

e) Ballast thickness of track have been decided by PJKA should be 300 mm instead of 250 mm, JICA will discuss this matter next meeting.

f) Standard of weight of Rail have been decided by PJKA should be used UIC 54 instead of N 50 kg/m equivalent.

g) Max Cant have been decided by PJKA should be 110 mm instead of 105 mm (According existing regulation).

3. Have been informed by PJKA, that all discussion will be lead by Mr Soeparto (JABOTABEK) or PJKA exploitasi Barat, Except for Principal Matter (i.e.for Gradient).

Bandung, September, 5 1983

Minuted by Ind. Counterpart

SUTOYO M.

Proj. OFFICER

AGREED :

PJKA	JABOTABEK	JICA
Mr. SOEHARSO	Mr. SOEPARTO	Mr. M. KOYAMA
DIRECTOR	KEP.DIV. TEHNIK	PROJ. MANAGER

RECORD OF DISCUSSION

FOR

PROGRESS REPORT

ON

DETAILED DESIGN

OF

NEW RAILWAY LINE FOR CENGKARENG AIRPORT

October 29, 1983

Ir. GIRI S. HADIHARDJONO MSE.	Mr. KAORU UMEMOTO
Chairman of the Indonesian	Member of Supervisory
Steering Committee	Committee
Government of Indonesia	Japan International Coorperation
	Agency

RECORD OF DISCUSSION

FOR

PROGRESS REPORT

ON

DETAILED DESIGN

OF

NEW RAILWAY LINE FOR CENGKARENG AIRPORT

The joint meetings for the captioned study were held at Directorate General of Land Transport and Inland Waterways (PHBD) on the 25th of October and in Granadha Building of JABOTABEK on the 26th of October 1983.

The atteadants from both sides are shown in this record as per attached sheets. On the first day, the Indonesian side was represented by Ir. Paatiarso, Project Manager of JABOTABEK Railway Project, supported by Mr. Gatot Soedjantoko, Head of Planning, Directorate General of Land Transport and Inland Waterways and the Japanese side was represented by Mr. Kaoru Umemoto, Member of Supervisory Committee for the JICA Study Team. On the second day, the Indonesian side was represented by Ir. Soeparto, Chief Engineer of Engineering Division, JABOTABEK and the Japanese side was represented by Mr. Kaoru Umemoto.

The Study Team, headed by Mr. Masanao Koyama, submitted thirty (30) copies of Progress Report with Drawings and explained them on the 25th. On the following day, discussion was made as for the Progress Report and its problem areas. The following is the Record of Discussion during the joint meetings.

The Progress Report submitted by JICA Study Team was accepted with the following clarifications and modifications:

1. Interface Problem Area

   (1) The formation level of the bridge crossing the discharge channel at 2 k 021 m 20 within the airport shall be raised by more than

32 cm so as to meet the required clearance for the discharge channel. The level crossing adjacent to the bridge will raised accordingly.

(2) The crossing of the New Railway Line with Access Road at the exit of the Airport which requires shifting of Access Road to the south will be solved by the Indonesian side.

(3) The proposed right-of-way of the New Railway Line passing between Western Line and Harbour Road is imperative for constructing the New Railway Line.

(4) The design of the bridge overpassing Jalan Jembatan Tiga will be decided by the Indonesian side and informed to the Study Team.

(5) The design of overpass between Jakarta Ring Road and S-W Arc of Intra Urban Tollway will be carried out on the basis of the concept that roads will overpass the New Railway Line.

2. Signalling System

The signalling system proposed by the JICA Study Team will be adopted to the detailed design work. It has been confirmed that further study on the signal indication system is essential as this problem is closely related to overall planning of JABOTABEK Railway Project.

3. Overhead Clearance of Over-Road Bridge

The overhead clearance of over-road bridges shall be, in principle, in conformity with the regulation of the Indonesian Government. The Study Team submitted to BINA MARGA and DKI Jakarta a letter for approval of overhead clearance proposed by the Study Team on the 27th of October 1983.

4. Miscellaneous Items

(1) Two Platforms shall be constructed at the same time in Cengkareng Airport Station.

(2) The Study Team will study the introduction of safety siding with elastic buffer stopper in Jayakarta Station Yard.

(3) The Study Team requested that the Indonesian side gives comments on the floor area program for the Airport Terminal Station within two (2) weeks.

5. Special Consideration

The Study Team strongly requested that the Indonesian side would provide answer to the interface problems not yet solved.

ATTENDANCE LIST OF MEETING

FOR

PROGRESS REPORT

ON

DETAILED DESIGN

OF

NEW RAILWAY LINE FOR CENGKARENG AIRPORT

DATE: OCTOBER 25, 1983

Presents:

1.	Ir. Pantiarso	(JABOTABEK)
2.	Mr. Gatot Soedjantoko	(Ditjen Perhubungan Darat)
3.	Mr. Toyohiko, MATSUMOTO	(Ditjen Perhubungan Darat)
4.	Mr. Tomoyoshi, HATA	(Ditjen Perhubungan Darat)
5.	Mr. Susumu, SHIBUYA	(Ditjen Perhubungan Darat)
6.	Ir. Soeparto	(JABOTABEK)
7.	Mr. Hanuriyanto	(JABOTABEK)
8.	Mr. M. Hidayat	(JABOTABEK)
9.	Mr. Tohir Kartabrata	(JABOTABEK)
10.	Mr. Edison	(Departemen Perhubungan)
11.	Mr. Pudjo Sudarno	(Departemen Perhubungan)
12.	Mr. F. Tanjung	(Departemen Perhubungan)
13.	Mr. Y. Suprijo	(PJKA Eksplotasi Barat)
14.	Mr. Wahyudi	(PJKA Pusat)
15.	Mr. Soekiswo	(PJKA Pusat)
16.	Ir. Atiek Soeparyati	(Bina Marga)
17.	Mr. J. Wuryanto	(Ditjen Perhubungan Udara)
18.	Mr. M. Nakamoto	(Embassy of Japan)
19.	Mr. K. Umemoto	(JICA)
20.	Mr. T. Kamiyama	(JICA)
21.	Mr. K. Fukushiro	(JICA)
22.	Mr. M. Koyama	(JICA)
23.	Mr. K. Yamada	(JICA)
24.	Mr. K. Murata	(JICA)
25.	Mr. T. Nakajima	(JICA)

26.	Mr. T. Yamada	(JICA)
27.	Mr. Y. Ushiishi	(JICA)
28.	Mr. K. Isumi	(JICA)
29.	Mr. T. Teraki	(JICA)
30.	Mr. K. Agata	(JICA)
31.	Mr. T. Ajimi	(JICA)
32.	Mr. N. Terauchi	(JICA)
33.	Mr. T. Okinaka	(JICA)
34.	Mr. K. Denda	(JICA)
35.	Mr. N. Sekine	(JICA)
36.	Mr. S. Shibata	(JICA)
37.	Mr. M. Yabuki	(JICA)
38.	Mr. H. Akimoto	(JICA)
39.	Mr. K. Sato	(JICA)
40.	Mr. S. Kurimaru	(JICA)
41.	Mr. T. Kumamaru	(JICA)
42.	Ms. S. Handayani	(BAPPEDA DKI)
43.	Mr. Hajadi	(JIAC)
44.	Mr. Mr. Sutoyo. M	(Counterpart Indonesia)
45.	Mr. Berlin Silaen	(Counterpart Indonesia)
46.	Mr. Daryanto	(Cpunterpart Indonesia)

ATTENDANCE LIST OF MEETING

FOR

PROGRESS REPORT

ON

DETAILED DESIGN

OF

NEW RAILWAY LINE FOR CENGKARENG AIRPORT

DATE: OCTOBER 26, 1983

Presents:

1.	Mr. Soeparto	(JABOTABEK)
2.	Mr. Manuriyanto	(JABOTABEK)
3.	Mr. Daniel Asril	(JABOTABEK)
4.	Mr. Hidayat	(JABOTABEK)
5.	Mr. Heru. S	(JABOTABEK)
6.	Mr. Nugroho	(JABOTABEK)
7.	Mr. Wirjohardjo	(JABOTABEK)
8.	Mr. Satriyo. K	(JABOTABEK)
9.	Mr. Soekiswo	(PJKA Head Office)
10.	Mr. Wahyudi	(PJKA Head Office)
11.	Mr. Soeparwo	(PJKA Jakarta)
12.	Mr. Hata	(PHBD Adviser)
13.	Mr. S. Shibuya	(PHBD Adviser)
14.	Mr. T. Matsumoto	(PHBD Adviser)
15.	Mr. K. Ashina	(PHBD Adviser)
16.	Ms. A. Soeparyati	(BINA MARGA)
17.	Mr. J. Wuryanto	(PHB UDARA)
18.	Mr. Hayadi	(JIAC)
19.	Mr. Soetikno	(PT. Indement Consultant)
20.	Mr. D. Burnama	(PT. Indement Consultant)
21.	Mr. Indriono	(PT. Indement Consultant)
22.	Mr. Shindu. D	(PT. Indement Consultant)
23.	Mr. K. Umemoto	(JICA)

24. Mr. T. Kamiyama (JICA)
25. Mr. N. Fukushiro (JICA)
26. Mr. H. Koyama (JICA)
27. Mr. K. Yamada (JICA)
28. Mr. K. Murata (JICA)
29. Mr. T. Nakajima (JICA)
30. Mr. T. Yamada (JICA)
31. Mr. Y. Ushiishi (JICA)
32. Mr. K. Isumi (JICA)
33. Mr. T. Teraki (JICA)
34. Mr. K. Agata (JICA)
35. Mr. T. Ajimi (JICA)
36. Mr. N. Terauchi (JICA)
37. Mr. T. Okinaka (JICA)
38. Mr. K. Denda (JICA)
39. Mr. M. Sekine (JICA)
40. Mr. S. Shibata (JICA)
41. Mr. Sutoyo. M (Counterpart Indonesia)
42. Mr. Berlin. A (Counterpart Indonesia)
43. Mr. Ichwan (Counterpart Indonesia)
44. Mr. Silalahi. S (Counterpart Indonesia)
45. Mr. Budhi. S (Counterpart Indonesia)
46. Mr. A. Mulyanto (Counterpart Indonesia).

RECORD OF DISCUSSION

FOR

INTERIM REPORT

ON

DETAILED DESIGN

NEW RAILWAY LINE FOR CENGKARENG AIRPORT

March 1, 1984

Mr. GATOT SOEDJANTOKO

Member of the Indonesian
Steering Committee
Government of Indonesia

Mr. HITOSHI TAKASHIMA

Chairman of Supervisory
Committee
Japan International
Cooperation Agency

RECORD OF DISCUSSION

FOR

INTERIM REPORT

ON

DETAILED DESIGN

OF

NEW RAILWAY LINE FOR CENGKARENG AIRPORT

The joint meetings for the discussion on the captioned report were held at JABOTABEK in Graha Purna Yudha Building on the 28th and 29th of February 1984.

The attendants from Indonesian and Japanese sides are shown in this record as per attached sheets. For the - meetings, the Indonesian side was represented by Mr. Gatot Soedjantoko, Head of Planning, Directorate General of Land Transport and Inland Waterways, supported by Ir. Suparto, - Chief Engineer of Engineering Division, JABOTABEK and the Japanese side was represented by Mr. Hitoshi Takashima, - Chairman of Supervisory Committee for the JICA Study Team.

The Study Team, headed by Mr. Masanao KOYAMA, submitted Interim Reports with Tender Documents and made explanation - on the contents of them. Discussion was made to various - items raised by Indonesian side. The Record of Discussion - is as follows :

The Interim Report submitted by JICA Study Team was - accepted with the following clarifications and comments.

1. Construction Schedule

The Indonesian side requested the Study Team to study - the possibility of shortening the proposed construction schedule to two and a half years. JICA Study Team empha sized that the proposed schedule is the minimized sche -

dule .....

K. N.

dule taking account of all necessary factors for the smooth and economical construction of the proposed railway.
However the Indonesian side repeatedly requested the Study Team to study alternative schedule and incorporate it into the Final Report.

2. Signalling System

The Indonesian side requested the Study Team to study a color light signalling system with speed indicating device as an alternative to the proposed signalling system.
The Study Team stated that it is not timewise possible to study such alternative unless JABOTABEK signalling system is decided far in advance of the submission of the Final Report.

3. Location of Bridge Pier at Jl. Jembatan Tiga

The Indonesian side pointed out that the location of bridge pier at Jalan Jembatan Tiga should be shifted from the proposed location so as to accomodate utilities conduit. The Indonesian side will provide JICA Study Team with necessary information.

4. Time Limit for Submission of Comments

JICA Study Team requested that Indonesian side will provide the Study Team with comments on the Interim Report at the earliest possible date. The Indonesian side promised that comments will be made available to the Study Team not later than the 26th of March 1984.

5. Special Consideration

JICA Study Team requested the Indonesian side to take necessary measures to expedite customs clearance of reports and documents for the study.
This request was made due to the considerable inconvenience to the discussion at the meetings caused by lack of materials.

K.N

ATTENDANCE LIST OF MEETING BETWEEN INDONESIAN STEERING COMMITTEE AND JICA TEAM OF DETAIL DESIGN OF NEW RAILWAY LINE FOR CENGKARENG AIRPORT.

D a t e : February, 28 1984.

Indonesian Side

1. Gatot Soedjantoko	- Directorate General of Land Transport and Inland Waterways.
2. Ir. Soeparto	- Jabotabek Railway Project
3. Ir. Imam Soedradjad	- Directorate of Traffic and Urban Transport
4. Ir. Harbani	- Indonesian State Railways
5. Ir. Wahyudi	- Indonesian State Railways
6. Sampoerna Rafiuddin	- Indonesian State Railways
7. Soekiswo	- Indonesian State Railways
8. Nugroho	- Indonesian State Railways
9. Soembadi	- Indonesian State Railways
10. Kenang	- Indonesian State Railways
11. Ir. Soekrisno R.	- Jabotabek Railway Project
12. Ir. Daniel Asril	- Jabotabek Railway Project
13. Ir. Syahriar Bachtiar	- Jabotabek Railway Project
14. Ir. Soeryanto	- Jabotabek Railway Project
15. Ir. M. Hidayat	- Jabotabek Railway Project
16. Maryono	- Jabotabek Railway Project
17. Wiryohardjo	- Jabotabek Railway Project
18. R.N. Sinulingga	- Jabotabek Railway Project
19. Ir. Saiful Said	- Jabotabek Railway Project
20. Ir. Dharma Setiabudi	- Jabotabek Railway Project
21. Ir. Manuriyanto	- Jabotabek Railway Project
22. Soedjilin	- West Exploitation of PJKA
23. Ir. Djauhari P.	- Directorate General of Land Transport and Inland Waterways.
24. Ir. Mulyadi	- Directorate General of Land Transport and Inland Waterways.
25. Ir. Hasril Basri	- Directorate General of Highways
26. Ir. Atiek Soeparyati	- Directorate General of Highways.
27. Ir. Sarwo Handayani	- Planning and Development Board of DKI Jakarta
28. Ir. Pudjo Sumarno	- Departement of Transport
29. Ir. Sutoyo M.	- Jaya Consult.

30. Ir. Amirul Zulkarnain - Jaya Consult
31. Ir. Silalahi Simon - Jaya Consult
32. H a j a d i - J I A C .
33. T. Matsumoto - Expert to DGLT
34. Yoshida - Expert to DGLT
35. Fukui - Expert to DGLT.

Japanese Side

1. H. Takashima - JICA Supervisory Committee
2. K. Nogami - JICA Supervisory Committee
3. M. Koyama - JICA team leader
4. Y. Mieda - JICA
5. K. Murata - JICA member
6. T. Nakajima - JICA member
7. M. Kagami - JICA member
8. I. Mizuno - JICA member
9. K. Agata - JICA member
10. N. Yamauchi - JICA member

ATTENDANCE LIST OF MEETING BETWEEN INDONESIAN STEERING COMMITTEE AND JICA TEAM OF DETAIL DESIGN OF NEW RAILWAY LINE FOR CENGKARENG AIRPORT

D a t e : February, 29. 1984

Indonesian Side

1.	Gatot Soedjantoko	– Directorate General of Land Transport and Inland Waterways.
2.	Ir. Soeparto	– Jabotabek Railway Project
3.	Eddy Soewardi	– Indonesian State Railways
4.	Sampoerna Rafioeddin	– Indonesian State Railways
5.	Kenang	– Indonesian State Railways
6.	Ir. Wahyudi	– Indonesian State Railways
7.	Koestomo	– Indonesian State Railways
8.	Soembadi	– Indonesian State Railways
9.	Soekiswo	– Indonesian State Railways
10.	Muchsin Iskandar	– Indonesian State Railways
11.	Soebandha	– West Exploitation of PJKA
12.	Soedjilin	– West Exploitation of PJKA
13.	Nugroho	– Indonesian State Railways
14.	Ir. Djauhari P.	– Directorate General of Land Transport and Inland Waterways.
15.	Ir. Amirul Zulkarnain	– Jaya Consult
16.	Ir. Silalahi Simon	– Jaya Consult
17.	Ir. Manuhardjo	– Jabotabek Railway Project
18.	Ir. Wiryohardjo	– Jabotabek Railway Project
19.	Ir. Dharma Setiabudi	– Jabotabek Railway Project
20.	Ir. Daniel Asril	– Jabotabek Railway Project
21.	Ir. Syahriar Bachtiar	– Jabotabek Railway Project
22.	H a j a d i	– J I A C
23.	T. Matsumoto	– Expert to DGLT
24.	Yoshida	– Expert to DGLT
25.	Fukui	– Expert to DGLT

K N

Japanese Side

1. H. Takashima - JICA Supervisory Committee
2. K. Nogami - JICA Supervisory Committee
3. M. Koyama - JICA team leader
4. Y. Mieda - JICA
5. K. Murata - JICA member
6. T. Nakajima - JICA member
7. M. Kagami - JICA member
8. I. Mizumo - JICA member
9. K. Agata - JICA member
10. N. Yamauchi - JICA member

STUDY ON SHORTENING OF CONSTRUCTION SCHEDULE

The Government of Indonesia has strongly requested the team to study the possibility of shortening of construction schedule to two and a half years from four years which has originally been proposed on the Report. Although the proposed construction schedule was the shortest possible schedule as prepared after a thorough study taking into account all the necessary factors regarding the execution of the smooth and economical work, another study was made once again for the shortening of the schedule under the following prerequisites:

PREREQUISITES FOR SHORTENING OF CONSTRUCTION SCHEDULE

1. Aquisition of right-of-way and removal of any objectionable matters (obstacles) shall be properly executed such that performance of the work would not be impaired. Where critical delay is anticipated, all the necessary treatments shall be completed by the time of one and a half year after the commencement of the work.

   However, for the location where embankments to be constructed over the poor ground, this problem shall be resolved at the earliest possible stage, and particularly for the location between 19 km 438 and 19 km 514 the matter shall be completed by the time within six months after the commencement of the construction work.

2. Relocation (shifting) of Airport Access Road shall be completed by the time of commencement of the work.

3. Design coordination with relevant personnel of authorities and agencies and concurrence therefor shall be made at an earlier stage such that the performance of the work would not be impaired.

Construction schedule as a result of the study as shown in Table 1, would require at least two and a half years for the Civil Work, Track Work and Electrical Work from the commencement until completion of the work, and further require additional six months for test run that will result in totally three years until commissioning.

In addition, construction cost in the above case, would be increased by approximately 5.3%.

This construction schedule is the extremely difficult one to be implemented, therefore the execution of the work as scheduled would be impracticable unless otherwise the above-mentioned prerequisites are fulfilled, and it is envisaged that various critical problems would be imminent.

The shortened construction schedule is therefore not recommendable.

Alternative

Table 1 Construction Schedule

Commencement of Operation

Work Item	Construction Period	1st Year												2nd Year												3rd Year											
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Surveying	Right-of-Way Stake			—	—																									—	—						
Geological Survey	Boring			—	—																																
Civil Work	Earthworks	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—										
	Bridges and Viaducts					—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—							
	Road Construction Works						—	—	—	—																	—	—	—	—							
Track Work	Track Laying Work									—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—						
	Track Shifting Work										—	—				—	—	—																			
Architectural Work	Airport Station							—	—	—	—	—	—	—	—	—	—	—	—	—	—																
	Kota Intan Station																		—	—	—	—	—	—	—	—	—	—	—	—							
	Signal Station																		—	—	—	—	—	—	—	—	—	—									
	Crossing Watchman's Box																								—	—	—	—									
Electrical Work	Substations										—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—						
	Overhead Contact System										—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—						
	Power Distribution Lines												—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—						
	Signalling System												—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—						
	Telecommunication System														—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—						
Land Acquisition and Removal of Obstacles	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- ->																		
Shifting of Airport Access Road	- ->																																				
Test Run																																—	—	—	—	—	—
Construction Supervision Facilities	- ->																																				

Note: Dotted line indicates the limit of completion of the work.

JICA