(iii) Estimation of population (Java Island) for the 3 years of 1989, 1994 and 2002

With the Indonesian population forecast statistic from 1982 up to 1986 as the reference, the annual rate of increase was anticipated as 1.7%.

(iv) The rate of increase of the number of registered buses was estimated by the GDP per capita and the population increase rate against the year of 1981 for the 3 years of 1989, 1994 and 2002. Furthermore, this rate of increase was made the growth factor of the total transport demand of passengers. (See Table 2.3.3)

Table 2.3.3 Growth Factor of Total Traffic Demand

Classification		1989	1994	2002
Passenger		2.00	2.89	4.27
Freight	Rice	1.50	1.67	1.84
	Maize	1.33	1.36	1.40
	Sugar	1.28	1.46	1.74
	Salt	1.16	1.25	1.40
	Paper	1.94	2.53	3.48
	Steel	3.80	5.55	8.35
	Petroleum products	1.40	1.65	2.05
	Fertilizer	2.00	2.48	3.24
	Cement	2.01	2.65	3.65

Note: Year of 1981 was considered as 1.0.

(2) Forecast of generated traffic volume by zone

Since it was supposed that there would not be a drastic change in the economic structure of each zone, the growth factor of generated traffic volume of each zone was made the same as the growth factor of the total traffic demand, by which the traffic volume classified by zone of 1981 was multiplied, then the future generated traffic volume by zone of the above 3 years was forecast.

(3) Forecast of arrival traffic volume by zone

The arrival traffic volume by zone was also considered to be the same as the generated traffic volume and the growth factor of the arrival traffic volume by zone was made the same as the growth factor of the total traffic demand. The arrival traffic volume classified by zone of 1981 was multiplied by this, then future arrival traffic volume by zone of the above 3 years was forecast.

(4) Forecast of traffic demand between zones

As the method of forecasting the traffic demand between zones, on the basis of the forecast of the arriving and the departing traffic volume classified by zone which was gained by methods (2) and (3) as the formula of forecasting traffic demand between zones, the iteration by the Fratar Method could be considered. However, in this report, the traffic demand between zones was assumed to increase by the same ratio of the total traffic demand. Accordingly, it was by multiplying the traffic demand between zones of 1981 by the growth factor of the total transport demand, then the traffic demand between zones was forecast.

(5) Model of diversion rate from road to railway

① Calculation of railway passenger share by distance zone (without project)

First of all, the railway passenger traffic volume by distance zone (100km space) was obtained by the weighted average from the actual results of 1981.

② Calculation of transportation time and transportation costs by distance zone (without project)

Then, the transportation time and transportation costs by transportation mode and by distance zone of railway and bus were estimated from the regression formula obtained from the actual results.

③ Calculation of transportation condition relative ratio by distance zone (without project)

The transporting condition relative ratio by distance zone was obtained by using the transportation time and transportation costs by distance zone of railway and bus obtained in ② above. The calculation formula is as follows:

$$V_0 = \frac{C_{r0} - C_{b0}}{T_{b0} - T_{r0}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (A)$$

Whereas, V_0: Transporting condition relative ratio without project

C_{r0}: Railway transportation costs without project

C_{b0}: Bus transportation costs without project

T_{r0}: Railway transportation time without project

T_{b0}: Bus transportation time without project

(Note): On the transporting conditions of railway passengers, those of third class passengers occupying the large majority of the traffic volume was adopted.

When both the numerator and denominator of the aforementioned formula (A) are plus (+) or minus (-), it will mean the yardstick which the passenger will make selection between time and costs. When the plus and minus marks of the denominator and nominator differ, for example, when $C_{r0} - C_{b0} > 0$, and $T_{b0} - T_{r0} < 0$, it is likely that the railway with a higher costs and requiring more time is not used. In observing the actual data, however, there is a considerable volume of railway users (especially in long distance) despite the fact that railway is inferior to bus in both aspects of costs and time required. This is considered due to the difference of congestion degree, joggling and accommodation besides time and costs on the transportation conditions of railway and bus, and the degree of fatigue by the users of bus is greater than that of users of railway. In other words, this means that the bus is inferior to the railway in the qualitative aspect of service.

The quantitating of this problem is a difficult problem. However, as a fatigue degree dummy of the bus in the analysis process on distribution of V to be mentioned later, the value (time conversion) by the following formula will be added to the time of bus by simulation as the value which enables comprehension of the present situation.

$Tb_0' = 0.04d - 1$

Whereas, d: Distance (km)

④ Determination of distribution of V_0

Since the distribution type of V_0 in passenger transport practically applies to the logarithmic normal distribution also seen in examples of analysis of other countries, it is recognized as a logarithmic normal distribution and the mean value of distribution $\mu_{\log v_0}$ and the value of standard deviation $\sigma_{\log v_0}$ were obtained from the data of the V_0 value by distance zone and the share value of railway. These values are,

$$\mu_{\log_{10} v_0} = 1.6467$$

$$\sigma_{\log_{10} v_0} = 0.3172$$

⑤ Estimation of theoretical value of railway passenger share by distance zone (without project)

The theoretical value ($S_r(v_0)$) of the railway passenger share by distance zone corresponding to the actual results V_0 was estimated by using the above-mentioned $\mu_{\log_{10} v_0}$ and $\sigma_{\log_{10} v_0}$.

⑥ Calculation of transporting condition relative ratio by distance zone (with project)

The transportation condition relative ratio by distance zone with project was obtained by the following formula.

$$V_w = \frac{C_{rw} - C_{bw}}{T_{bw} - T_{rw}}$$

Whereas, V_w: Transportation condition relative ratio with project

C_{rw}: Railway traffic costs with project

C_{bw}: Bus traffic costs with project

T_{rw}: Railway transportation time with project

T_{bw}: Bus transportation time with project

The real price of the transportation costs in this survey has been recognized as fixed. Therefore, actual $Cr_0 = C_{rw}$ and $Cb_0 = C_{bw}$. Based on the estimated value of transportation time by simulation for each link, T_{rw} has been calculated as 1/2.25 of T_{r0} (when the maximum velocity of the passenger tain is 100 km/h). T_{bw} has been made the same as without project. In other words, $T_{bw} = T_{r0}$.

⑦ Estimation of the theoretical value of railway passenger share by distance zone (with project)

The theoretical value ($S_r(v_w)$) of railway passenger share by distance zone with project has been estimated by the same method as (⑤) when obtaining $S_r(v_0)$. (See Table 2.3.4.)

⑧ Model of diversion rate by distance zone

$S_r(v_0)$, $S_r(v_w)$ and $S_b(v_0)$ have been obtained by undergoing steps ① to ⑦, that is, the diversion rate by distance zone (R_d) has been obtained from the bus passenger share ($1 - S_r(v_0)$) without project. The calculation formula of R_d is as follows.

$$R_d = \frac{S_r(v_w) - S_r(v_0)}{S_b(v_0)}$$

Whereas, $S_b(v_0)$: Share of bus passenger transport without project

Next, the model obtaining R_d by distance was obtained by the polynoominal expression. (See Table 2.3.5.)

The estimation method of the diversion rate is indicated by a flow chart, as shown in Fig. 2.3.2.

Since there are also sections (links) not electrified in some zonal pairs, the diversion rate estimated by the diversion rate model was modified by the electrification ratio. It becomes as follows when expressed by a formula. This is also the same as in case of freight.

$$R_d' = R_d \times R_e$$

$$R_e = d_e/d_a$$

Whereas, R_d': Modified value of R_d

R_d: Diversion rate

R_e: Electification ratio

d_e: Distance of electrified section

d_a: Distance between zones

Table 2.3.4 Estimation of Share and Diversion Rate by Distance Zone

Without				With (Max. speed 100 km/h)		
Distance	V_s (Rp./h)	$S_r(v_s)$ Results	$S_r(v_s)$ Theoretical value	V_w (Rp./h)	$S_r(v_w)$ Theoretical value	Diversion rate b → r $R_d = \frac{S_r(v_w) - S_r(v_s)}{S_b(v_s)}$
		(%)	(%)		(%)	
50	331.1	4.4	0.3	139.1	5.8	0.055
150	121.5	3.7	8.4	57.8	35.9	0.300
250	93.6	8.1	15.4	44.1	50.4	0.414
350	78.6	15.4	21.8	37.5	59.2	0.478
450	70.7	31.5	26.1	34.1	64.2	0.516
550	65.8	17.8	29.4	31.9	67.4	0.538
700	61.7	44.6	32.7	30.0	70.3	0.559
950	57.5	32.0	36.3	28.0	73.6	0.586

Notes:
1. $V_s = \frac{C_r - C_b}{T_b - T_r}$ In actual calculation, 0.04d-1 (d: distance, km) is added to T_b as fatigue dummy for every distance zone.
2. It is assumed that the theoretical values of $S_r(v_s)$ are in the logarithmic normal distribution of $\mu_{\log v_s} = 1.6467$ and $\sigma_{\log v_s} = 0.3172$.
3. When determining V_w for with, 1/2.25 of without was used for T_r.
4. Equations for estimating diversion rate:
   $R_d = -0.1388 + 4.5414 \times 10^{-3}d - 1.4049 \times 10^{-5}d^2 + 2.3822 \times 10^{-8}d^3 - 2.0672 \times 10^{-11}d^4 + 7.1118 \times 10^{-15}d^5$
5. V_s and $S_r(v_s)$ respectively mean transportation condition relative ratio and railway share in the case of Without. V_w and $S_r(v_w)$ respectively mean transportation condition relative ratio and railway share in the case of With. (Same as hereinafter.)

Table 2.3.5 Equations for Estimating Diversion Rates of Traffic Demand

Classification of transportation		Equation for estimating diversion rate
① Passenger		$R_d(p) = -0.1388+4.5414\times10^{-3}d-1.4049\times10^{-5}d^2+2.3822\times10^{-8}d^3-2.0672\times10^{-11}d^4+7.1118\times10^{-15}d^5$
Freight	② Rice	$R_d(r) = -0.00491+1.5124\times10^{-4}d-8.3352\times10^{-7}d^2+1.7715\times10^{-9}d^3+3.8724\times10^{-12}d^4-4.0676\times10^{-15}d^5$
	③ Maize	$R_d(m) = R_d(r)$
	④ Salt	$R_d(sa) = R_d(r)$
	⑤ Sugar	$R_d(su) = 0.0016+3.1402\times10^{-5}d-6.7158\times10^{-8}d^2+6.6403\times10^{-10}d^3-3.8739\times10^{-13}d^4+1.6976\times10^{-16}d^5$
	⑥ Paper	$R_d(pa) = 0.0021-4.6558\times10^{-5}d+5.1819\times10^{-7}d^2-1.8532\times10^{-9}d^3+3.7424\times10^{-12}d^4-1.7574\times10^{-15}d^5$
	⑦ Steel	$R_d(st) = -0.09576+6.8706\times10^{-4}d-1.7280\times10^{-6}d^2+1.7640\times10^{-9}d^3-5.1426\times10^{-13}d^4$
	⑧ Petroleum Products	$R_d(pet) = 0.7135-6.2128\times10^{-4}d-2.7739\times10^{-6}d^2+2.5376\times10^{-9}d^3+2.9151\times10^{-12}d^4-2.7997\times10^{-15}d^5$
	⑨ Fertilizer	$R_d(f) = 0.6192+4.8412\times10^{-5}d-3.1804\times10^{-7}d^2+6.3516\times10^{-11}d^3+1.4082\times10^{-13}d^4-9.3523\times10^{-17}d^5$
	⑩ Cement	$R_d(c) = R_d(f)$

Notes) 1. Equations for estimating diversion rates for freight reflect consideration of the factor of transport modernization involving electrification. Concretely, transport modernization takes the form of shortened transportation time.

2. The estimating diversion rates for traffic demand shows passenger train maximum speed is 100 km/h. The freight train maximum speed is 80 km/h.

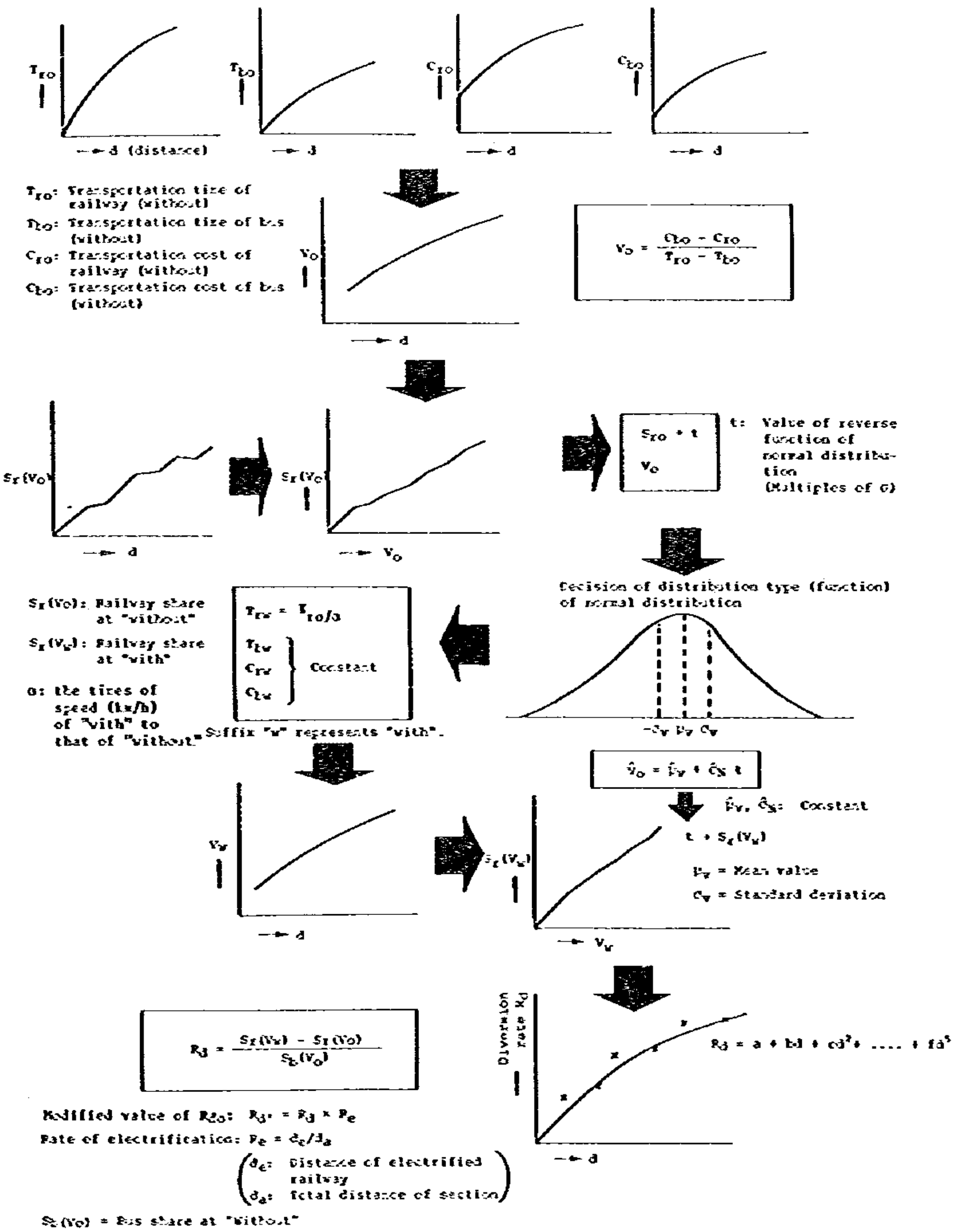


Fig. 2.3.2 Estimating of Diversion Rates

On the above premises, traffic demand of passengers between zones was forecast. However, in this report, the forecast of the intrazonal traffic demand (including the transport of commuters) is excluded from the objectives of analysis.

2.3.4 Forecast of Freight Traffic Demand

(1) Forecast of total demand

Here, total transport demand means the total transport tonnage for railways and roads by zonal pair. Here, too, we considered that the future industrial structure would be generally constant similarly to passenger transportation. So, we assumed that the rate of increase of the total traffic demand was the same as the rates of increase of the generating traffic volume by zone and the arrival traffic volume by zone. The actual calculation was made on forecasting following generated traffic volume and arriving traffic volume classified by zone. Therefore, no special calculation for the growth factor of the total traffic volume was made.

(2) Forecast of generated traffic volume by zone

Here, too, we estimated the increasing ratio of the generated traffic volume classified by zone, and took it as its growth factor.

So, the future rate of increase of the economic index most deeply related to freight transport volume by article was used as the growth factor of the generating traffic volume by article and by zone. We selected production volume by article as this economic index and we used the Five and Ten Year Development Plan 1979 ∿ 1989 of Indonesia as data. (Table 2.3.6.)

The estimating equation is based on a regressive equation using the year as an explanatory variable and production (or consumption) by article an explained variable. Namely,

(i) Rice: $y = 10{,}825.63 + 324.1t$

y: Rice production in Java (1,000t)

t: 2, 7, 12 (2 = Year 1980)

Table 2.3.6 Data for Estimating of Growth Factor of Freight Traffic

(Unit: 1000 ton)

t	Year	Rice	Maize	Sugar	Salt	Paper	Steel	Petroleum Products	Ferti-lizer	Cement
1	1979		3,149	1,342.2	258	179	160	88,917	2,333	5,532
2	1980	11,385.7	3,182	1,439.1		276	227	93,837	2,481	6,507
3	1981		3,221	1.559.1		302	326	98,758	3,359	7,157
4	1982		3,206	1,646.3		355	560	103,679	4,217	7,707
5	1983		3,218	1.713.2	279	369	675	108,599	4,380	9,407
6	1984		3,251			398	765	113,520	4,491	9,907
7	1985	13,270.2	3,259			424	944	118,440	4,595	11,107
8	1986		3,267			459	1,140	123,361	4,595	
9	1987		3,271			494	1,270	128,281	4,595	
10	1988		3,267	1,848.6	305	528	1,270	133,202	4,595	
11	1989									
12	1990	14,627.4								
		Produc-tion in Java	Produc-tion in Indonesia	Produc-tion in Java	Consump-tion in Java	Produc-tion in Indonesia	Distribu-tions of produc-tion in Java	Produc-tion in Indonesia	Produc-tion in Indonesia	Planned produc-tion in Indonesia

Note) Data Source: Indonesian State Railways, "A Five And Ten Year Development Plan 1979∿1989" Bandung, August 15, 1978.

(ii) Maize: $y = 3,158.866 + 12.798t$

y: Maize production in Indonesia (1,000t)

t: $1 \sim 10$ (1 = Year 1979: same hereinafter)

(iii) Sugar: $y = 1,365.705 + 54.1508t$

y: Sugar production in Java (1,000t)

t: $1 \sim 5$, 10

(iv) Salt: $y = 252.8197 + 5.2213t$

y: Salt consumption in Java (1,000t)

t: 1, 5, 10

(v) Paper: $y = 188.8001 + 34.4727t$

y: Paper production in Indonesia (1,000t)

t: $1 \sim 10$

(vi) Steel: $y = 19.7333 + 136.9879t$

y: Distributions of steel production in Java (1,000t)

t: $1 \sim 10$

(vii) Petroleum products: $y = 83,966.32 + 4920.558t$

y: Production of petroleum products in Indonesia (1,000t)

t: $1 \sim 10$

(viii) Fertilizer: $y = 2,544.734 + 258.0667t$

y: Fertilizer production in Indonesia (1,000t)

t: $1 \sim 10$

(ix) Cement: $y = 4,507.0 + 920.5357t$

y: Production based on cement production plan in Indonesia (1,000t)

t: $1 \sim 7$

According to the above estimated equations, the production and consumption volume classified by article and zone was forecast, and by calculating the increasing ratio for 1981 of these forecast ratios, further, multiplying the generated traffic volume classified by article and zone of 1981 by this increased ratio, the traffic volume classified by article and zone for the three years (1989, 1994 and 2002) was forecast.

(3) Forecast of arrival traffic volume by zone

The growth factor of the future arrival traffic volume by zone was supposed to be the same as that of the future generated traffic volume by zone. So, multiplying the arrival traffic volume classified by article and zone of 1981 by the increased ratio for the production and consumption volume classified by article and zone, that is, the increased ratio for the generated traffic volume classified by article and zone, the arrival traffic volume classified by article and zone for the three years (1989, 1994 and 2002) was forecast.

(4) The forecast of the traffic demand between zones

This forecast was conducted by a method similar to that for the passengers. That is, it was assumed that the traffic demand between zones classified by article will increase at the same ratio of that of the generated (arriving) traffic volume classified by article and zone. Therefore, the traffic demand between zones classified by article for the three years (1989, 1994 and 2002) was forecast by multiplying the traffic demand between zones classified by article for 1981 by the increased ratio (growth factor) of generated (arriving) traffic volume classified by zone and article.

(5) Model of diversion rate from road to railway

① Calculation of railway freight share by distance zone and by article

Similarly to the case of passengers, the railway freight traffic volume by distance zone and by article was obtained from the results of 1981 by a weighted average.

② Calculation of transportation time and transportation costs by distance zone and by article (without project)

Then, estimation was made by a regressional equation based on the results of 1981 separately by mode of transportation which are railway and truck, and by distance zone and by article.

③ Calculation of transportation condition relative ratio by distance zone and by article (without project)

Using the transportation time and transportation costs of railways and trucks by distance zone and by article obtained by ②, the transportation condition relative ratio by distance zone and by article was determined by the following calculating equation.

$$V_0 = \frac{C_{t0} - C_{r0}}{T_{r0} - T_{t0}}$$

Whereas, V_0: Transportation condition relative ratio without project

C_{t0}: Truck transportation costs without project

C_{r0}: Railway transportation costs without project

T_{r0}: Railway transportation time without project

T_{t0}: Truck transportation time without project

④ Determination of distribution of V_0

The distribution type of V_0 for freight was found to be generally normal distribution by the study of data.

V_0 value and V_0's mean value μ_{V_0}, and value of standard deviation, σ_{V_0} obtained from the data on railway share by distance zone for each article are as shown in Table 2.3.7.

⑤ Estimation of theoretical value of railway freight share by distance zone and by article (without project)

We estimated this theoretical value of railway freight share by distance zone and by article ($S_r(v_0)$).

Table 2.3.7 Distribution Type of V_0 by Article

Article	μ_{V_0}	σ_{V_0}
Rice	65.98	13.85
Maize	65.98	13.85
Sugar	103.93	32.99
Salt	65.98	13.85
Paper	63.56	12.38
Steel	267.25	74.16
Petroleum products	19.17	3.90
Fertilizer	32.81	7.83
Cement	32.81	7.83

⑥ Calculation of transportation condition relative ratio by distance zone (with project)

The transportation condition relative ratio by distance zone and by article with project was obtained by the following equation:

$$V_W = \frac{C_{tW} - C_{rW}}{T_{rW} - T_{tW}}$$

Whereas, V_W: Transportation condition relative ratio with project

C_{tW}: Truck transportation costs with project

C_{rW}: Railway transportation costs with project

T_{rW}: Railway transportation time with project

T_{tW}: Truck transportation time with project

As in the case of passengers, we assumed that the real price of freight transport costs was constant. So, $C_{r0} = C_{rW}$ and $C_{t0} = C_{tW}$. A half of T_{r0} was used as T_{rW}, railway transportation time (as in the case of passenger transportation), based on the value of transportation time forecasted by simiilation for each link. In freight transportation, it is believed that, besides the effect of the shortening of transportation time resulting from electrification, considerable effects can be expected of the modernization of various facilities and measures which will be carried out at the same time. Though it is difficult to decide how far these modernizing efforts will affect railway traffic demand, the value of what is to deduce the time into which the element of modernization is converted, from the transportation of the railway in the case of "with project" was estimated at about 12 hours as the result of simulation in the light of other countries with modernized railways.

⑦ Estimation of the theoretical value of railway freight share by distance zone and by article (with project)

We estimated the theoretical value ($S_r(v_w)$) of railway freight share by distance and article "with project" in the same way (5) as we gained the theoretical value ($S_r(v_0)$), the share of railway freight classified by distance and article on "without project." (See Tables 2.3.8 ∿ 13.)

⑧ Model of diversion rate by distance zone and by article

From $S_r(v_0)$ and $S_r(v_w)$ obtained from steps ① to ⑦ and $S_t(v_0)$, namely, the share of truck freight in "without project" $(1 - S_r(v_0))$, diversion rate by distance zone and article (R_d) were obtained. And a model making R_d the function of distance was obtained by a polynominal. (See Table 2.3.5)

Furthermore, as mentioned above, the forecast of the freight traffic demand was conducted for 9 main articles. However, at present, the transport of iron ore, automobiles and containers is relatively small in volume, but expected to increase in future. Considering that, the fregith traffic demand for the railways will exceed our forecast. That is, our forecast value for the 9 articles is rather conservative.

Also, the forecast of freight traffic demand was limited to that between zones, as in the case of the passengers, and a forecast of intrazone of traffic demand was conducted, but is not shown in this report.

Table 2.3.8 Estimation of Share and Diversion Rate by Distance Zone

Items: ② Rice, ③ Maize, ⑤ Salt

Without				With					
				Electrification (I)			Electrification + Normalization (II)		
Distance	V_o (R_p/h)	$S_r(V_o)$		V_w (R_p/h)	$S_r(V_w)$	Diversion rate $t \to r$	V_w (R_p/h)	$S_r(V_w)$	Diversion rate $t \to r$
		Results	Theoretical value		Theoretical value	$R_d = \frac{S_r(V_w)-S_r(V_o)}{S_t(V_o)}$		Theoretical value	$R_d = \frac{S_r(V_w)-S_r(V_o)}{S_t(V_o)}$
50	21.18	0.2 (%)	0.1 (%)	21.56	0.1 (%)	0	26.16	0.2 (%)	0.001
150	25.63	0.3	0.2	26.74	0.2	0	32.50	0.8	0.006
250	29.90	0.6	0.5	31.97	0.6	0.001	38.91	2.5	0.020
350	34.02	0.6	1.0	37.27	1.9	0.009	45.43	6.9	0.060
450	38.00	4.0	2.2	42.63	4.6	0.025	52.04	15.6	0.137
550	41.84	1.6	4.1	48.08	9.9	0.060	58.78	30.2	0.272
700	47.75	15.0	9.0	56.37	24.5	0.170	69.07	58.7	0.546
950	55.98	6.5	23.6	70.57	62.9	0.514	86.80	93.3	0.912

Notes) 1. Equation for estimating diversion rate for With (I): $R_d = -0.1372+1.2809\times10^{-3}d-4.2459\times10^{-6}d^2+5.8536\times10^{-9}d^3-2.1515\times10^{-12}d^4$ If $R_d \leqq 0$, 0 used.

2. Equation for estimating diversion rate for With (II): $R_d = -0.00491+1.52124\times10^{-4}d-8.3352\times10^{-7}d^2+1.7715\times10^{-9}d^3+3.8724\times10^{-12}d^4-4.0676\times10^{-15}d^5$

3. T_r for With (I) is $\frac{1}{2}$ of T_r for Without. (Same as hereinafter.)

4. T_r for With (II) is subtracted 12 hours from T_r for With (I). This is because of consideration for normalization attended by the normalization of freight transportation. (Same as hereinafter.)

Table 2.3.9 Estimation of Share and Diversion Rate by Distance Zone

Item: (4) Sugar

Without				With					
				Electrification (I)			Electrification + Normalization (II)		
Distance	V_o (R_p/h)	$S_r(V_o)$ Results	$S_r(V_o)$ Theoretical value	V_w (R_p/h)	$S_r(V_w)$ Theoretical value	Diversion rate $t \to r$ $R_d = \frac{S_r(V_w)-S_r(V_o)}{S_t(V_o)}$	V_w (R_p/h)	$S_r(V_w)$ Theoretical value	Diversion rate $t \to r$ $R_d = \frac{S_r(V_w)-S_r(V_o)}{S_t(V_o)}$
50	21.62	0.5 (%)	0.6 (%)	22.00	0.7 (%)	0.001	26.70	0.9 (%)	0.003
150	26.91	1.1	1.0	28.07	1.1	0.001	34.12	1.7	0.007
250	31.99	1.6	1.5	34.20	1.7	0.002	41.63	2.9	0.014
350	36.89	2.8	2.1	40.41	2.7	0.006	49.26	4.8	0.028
450	41.62	4.2	2.9	46.70	4.2	0.013	57.01	7.8	0.050
550	46.20	6.3	4.0	53.09	6.2	0.023	64.90	11.9	0.082
700	52.77	4.0	6.1	62.81	10.6	0.048	76.95	20.6	0.154
950	63.03	6.2	10.7	79.45	23.0	0.138	97.72	42.5	0.356

Notes) 1. Equation for estimating diversion rate for With (I): $R_d = 0.0013-2.3685\times10^{-6}d-6.1334\times10^{-8}d^2+4.6816\times10^{-10}d^3-5.8857\times10^{-13}d^4+3.5198\times10^{-16}d^5$

2. Equation for estimating diversion rate for With (II): $R_d = 0.0016+3.1482\times10^{-5}d-6.7158\times10^{-8}d^2+6.6403\times10^{-10}d^3-3.8739\times10^{-13}d^4+1.6976\times10^{-16}d^5$

Table 2.3.10 Estimation of Share and Diversion Rate by Distance Zone

Item: ⑥ Paper

Without				With					
				Electrification (I)			Electrification + Normalization (II)		
Distance	V_o (Rp/h)	$S_r(V_o)$ Results	$S_r(V_o)$ Theoretical value	V_w (Rp/h)	$S_r(V_w)$ Theoretical value	Diversion rate $t \to r$ $R_d = \frac{S_r(V_w)-S_r(V_o)}{S_t(V_o)}$	V_w (Rp/h)	$S_r(V_w)$ Theoretical value	Diversion rate $t \to r$ $R_d = \frac{S_r(V_w)-S_r(V_o)}{S_t(V_o)}$
50	20.32	0.0 (%)	0.0 (%)	20.68	0.0 (%)	0.000	25.09	0.1 (%)	0.001
150	23.08	0.0	0.1	24.08	0.1	0.000	29.27	0.3	0.002
250	25.73	0.0	0.1	27.51	0.2	0.001	33.48	0.8	0.007
350	28.28	0.2	0.2	30.98	0.4	0.002	37.77	1.9	0.017
450	30.75	0.4	0.4	34.50	0.9	0.005	42.11	4.2	0.038
550	33.13	1.0	0.7	38.07	2.0	0.013	46.54	8.5	0.079
700	36.55	1.2	1.5	43.50	5.3	0.039	53.30	20.3	0.191
950	41.89	3.8	4.0	52.81	19.2	0.158	64.95	54.4	0.525

Notes) 1. Equation for estimating diversion rate for With (I): $R_d = 0.0057-4.4429\times10^{-5}d+1.5591\times10^{-7}d^2-3.0811\times10^{-10}d^3+3.9039\times10^{-13}d^4$

2. Equation for estimating diversion rate for With (II): $R_d = 0.0021-4.6558\times10^{-5}d+5.1819\times10^{-7}d^2-1.8532\times10^{-9}d^3+3.7424\times10^{-12}d^4-1.7574\times10^{-15}d^5$

Table 2.3.11 Estimation of Share and Diversion Rate by Distance Zone

Item: ⑦ Steel

Without				With					
				Electrification (I)			Electrification + Normalization (II)		
Distance	V_o (R_p/h)	$S_r(V_o)$ Results	$S_r(V_o)$ Theoretical value	V_w (R_p/h)	$S_r(V_w)$ Theoretical value	Diversion rate $t \to r$ $R_d = \frac{S_r(V_w)-S_r(V_o)}{S_t(V_o)}$	V_w (R_p/h)	$S_r(V_w)$ Theoretical value	Diversion rate $t \to r$ $R_d = \frac{S_r(V_w)-S_r(V_o)}{S_t(V_o)}$
50	0.14	0.0 (%)	0.0 (%)	0.15	0.0 (%)	0.000	0.18	0.0 (%)	0.000
150	14.59	0.0	0.0	15.22	0.0	0.000	18.50	0.0	0.000
250	28.51	0.0	0.1	30.48	0.1	0.000	37.10	0.1	0.000
350	41.95	0.1	0.1	45.95	0.1	0.000	56.01	0.2	0.001
450	54.91	0.2	0.2	61.61	0.3	0.001	75.21	0.5	0.003
550	67.45	0.5	0.4	77.51	0.5	0.001	94.75	1.0	0.006
700	85.46	0.9	0.7	101.72	1.3	0.006	124.62	2.7	0.020
950	113.57	1.4	1.9	143.17	4.7	0.029	176.09	10.9	0.091

Notes) 1. Equation for estimating diversion rate for With (I): $R_d = 0.0330-1.1237\times10^{-4}d+9.4476\times10^{-8}d^2+2.3551\times10^{-11}d^3$

2. Equation for estimating diversion rate for With (II): $R_d = -0.09576+6.8706\times10^{-4}d-1.7280\times10^{-6}d^2+1.7640\times10^{-9}d^3-5.1426\times10^{-13}d^4$

Table 2.3.12 Estimation of Share and Diversion Rate by Distance Zone

Item: ⑧ Petroleum Products

Without				With					
				Electrification (I)			Electrification + Normalization (II)		
Distance	V_o (R_p/h)	$S_r(V_o)$		V_w (R_p/h)	$S_r(V_w)$	Diversion rate $t \rightarrow r$ $R_d = \frac{S_r(V_w) - S_r(V_o)}{S_t(V_o)}$	V_w (R_p/h)	$S_r(V_w)$	Diversion rate $t \rightarrow r$ $R_d = \frac{S_r(V_w) - S_r(V_o)}{S_t(V_o)}$
		Results	Theoretical value		Theoretical value			Theoretical value	
50	18.58	39.9 (%)	44.0 (%)	18.89	47.2 (%)	0.057	22.72	81.9 (%)	0.676
150	16.78	8.9	27.1	17.47	33.0	0.081	21.04	68.4	0.567
250	15.02	1.0	14.5	16.01	20.9	0.075	19.31	51.6	0.434
350	13.32	1.0	6.7	14.54	11.7	0.054	17.56	34.1	0.294
450	11.68	2.5	2.7	13.04	5.8	0.032	15.77	19.2	0.170
550	10.09	1.6	1.0	11.53	2.5	0.015	13.96	9.0	0.081
700	7.81	2.6	0.2	9.23	0.5	0.003	11.19	2.0	0.018
950	4.23	2.1	0.0	5.28	0.0	0.000	6.43	0.1	0.001

Notes) 1. Equation for estimating diversion rate for With (I): $R_d = 0.0287 + 6.9498 \times 10^{-4} d - 2.7099 \times 10^{-6} d^2 + 2.5705 \times 10^{-9} d^3 + 8.1817 \times 10^{-13} d^4 - 1.5619 \times 10^{-15} d^5$

2. Equation for estimating diversion rate for With (II): $R_d = 0.7135 - 6.2128 \times 10^{-4} d - 2.7739 \times 10^{-6} d^2 + 2.5346 \times 10^{-9} d^3 + 2.9151 \times 10^{-12} d^4 - 2.7997 \times 10^{-15} d^5$

Table 2.3.13 Estimation of Share and Diversion Rate by Distance Zone

Items: ⑨ Fertilizer, ⑩ Cement

Without				With					
				Electrification (I)			Electrification + Normalization (II)		
Distance	V_o (Rp/h)	$S_r(V_o)$ Results	$S_r(V_o)$ Theoretical value	V_w (Rp/h)	$S_r(V_w)$ Theoretical value	Diversion rate $t \to r$ $R_d = \frac{S_r(V_w)-S_r(V_o)}{S_t(V_o)}$	V_w (Rp/h)	$S_r(V_w)$ Theoretical value	Diversion rate $t \to r$ $R_d = \frac{S_r(V_w)-S_r(V_o)}{S_t(V_o)}$
50	26.11	11.0 (%)	19.5 (%)	26.82	22.1 (%)	0.032	36.81	69.5 (%)	0.621
150	24.78	14.7	15.2	26.44	20.9	0.067	36.45	67.7	0.619
250	23.49	20.0	11.7	26.01	19.2	0.085	36.00	65.9	0.614
350	22.26	9.8	9.0	25.58	17.9	0.097	35.54	63.7	0.601
450	21.10	9.4	6.7	25.13	16.4	0.104	35.06	61.4	0.586
550	20.02	2.4	5.2	24.68	14.9	0.102	34.58	59.1	0.569
700	18.44	5.5	3.3	23.98	12.9	0.099	33.81	55.2	0.537
950	16.08	0.2	1.7	22.77	10.0	0.084	32.46	48.4	0.475

Notes) 1. Equation for estimating diversion rate for With (I): $R_d = 0.00811+5.4135\times10^{-4}d-1.2498\times10^{-6}d^2+1.6198\times10^{-9}d^3-1.2606\times10^{-12}d^4+4.2331\times10^{-16}d^5$

2. Equation for estimating diversion rate for With (II): $R_d = 0.6192+4.8412\times10^{-5}d-3.1804\times10^{-7}d^2+6.3516\times10^{-11}d^3+1.4082\times10^{-13}d^4-9.3523\times10^{-17}d^5$

2.3.5 The Results of Demand Forecast

(1) The share of railway traffic demand

① Passengers

The P.J.K.A.'s share in Java Island for the future passenger traffic demand is increased, before the restriction by railway capacity, from 18.0% (1989) to 39.4% (2002). After the restriction by railway capacity, it is increased from 15.8% to 21.2%. However, compared to the 21.6% of 1994, the share for 2002 is decreased by 0.4%, which means that, at the time of electrification, railway capacity increases, but afterwards, it does not increase. Accordingly, traffic demand does not increase, being restricted by railway capacity, but on the contrary the total demand is increasing independent of railway capacity. (See Table 2.3.14.)

② Freights

P.J.K.A.'s share in Java Island for future freight traffic demand is increased before being restricted by railway capacity, from 10.3% (1989) to 24.2% (2002). After the restriction by railway capacity, it is also slightly increased from 8.9% to 11.4%. In case of freight transport, compared to the 12.5% for 1994, the share for 2002 is decreased by 1.1%. This is due to the same reason as that for passenger transprot.

(2) Traffic demand between zones

The retults of the forecast of traffic demand between zones for passengers and freight (the total of 9 articles) are seen in Table 2.3.15∿17 and Tables 2.3.18∿20. In addition, the results of forecast of the total of departures and arrivals classified by zone, passenger and freights and by article, is in Table 2.3.21∿3.23).

The above forecast value was estimated on the premise that the maximum velocity was 100 km/h, and restricted by railway capacity.

Table 2.3.14 Future Share of Railway Traffic Demand

(Unit: 10,000 pass. or ton·km)

Item			Year	1989	1994	2002
Passengers	Traffic demand	Total demand		9,407,040	13,564,300	20,045,600
		Railway	Before restriction by railway capacity	1,694,300	3,903,820	7,905,080
			After restriction by railway capacity	1,489,520	2,936,620	4,258,170
	Share (%)	Before restriction by railway capacity		18.0	28.8	39.4
		After restriction by railway capacity		15.8	21.6	21.2
Freights	Traffic demand	Total demand		1,388,220	1,768,850	2,362,320
		Railway	Before restriction by railway capacity	142,642	302,607	572,506
			After restriction by railway capacity	123,786	220,402	268,125
	Share (%)	Before restriction by railway capacity		10.3	17.1	24.2
		After restriction by railway capacity		8.9	12.5	11.4

Note: 1. From 1994 to 2002 the railway share after the restriction by railway capacity is decreased, which is caused by that the total demand increases every year irrespective of the railway capacity; on the other hand the railway capacity increases at the time of electrification.

Table 2.3.15 Railway Passenger Traffic Matrix (after Restriction by Railway Capacity; Maximum Speed 100 km/h)

Year 1989 (100 pass.)

Origin \ Destination	1 MERAK	2 RANKAS BITUNG	3 JAKA RTA	4 CIKAM PEK	5 SUKA BUMI	6 BAND UNG	7 CIRE BON	8 TASIKU MA LAYA	9 KROJA	10 PEKA LON GAN	11 KEBU MEN	12 SEMA RANG	13 PURWO DADI	14 YOGYA KARTA	15 SOLO	16 MADIUN	17 BOJO NEGORO	18 SURA BAYA	19 KERTO SONO	20 TULUN GAGUNG	21 BANGIL	22 MALANG	23 PROBO LINGGO	24 JEMBER	25 BANYU WANGI	TOTAL
1 MERAK		3,840	5,100	0	0	1,828	40	16	80	266	80	385	0	186	315	80	40	554	120	20	0	0	0	0	0	12,919
2 RANKASBITUNG			10,440	121	0	275	31	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14,744
3 JAKARTA				81,704	14,770	132,565	59,169	38,262	9,168	13,232	9,731	12,170	27	9,201	14,665	4,835	1,820	10,365	3,407	1,760	20	542	93	100	301	433,380
4 CIKAMPEK					27	3,072	14,079	674	213	645	240	86	0	240	64	36	0	71	20	0	0	0	0	0	0	101,291
5 SUKABUMI						4,840	29	140	0	23	20	7	0	20	0	0	0	0	0	0	0	0	0	0	0	19,806
6 BANDUNG							34,013	9,500	2,660	2,460	3,650	3,133	22	4,040	1,260	700	0	4,440	600	20	0	471	0	40	299	209,917
7 CIREBON								0	380	240	420	689	0	1,220	400	120	100	900	220	40	0	0	0	0	0	112,082
8 TASIKUMALAYA									4,040	0	1,589	0	0	1,640	520	180	0	1,700	320	20	0	20	20	60	60	58,789
9 KROJA										0	1,220	0	0	1,500	800	240	0	1,420	400	60	20	20	20	60	20	22,321
10 PEKALONGAN											0	580	0	0	0	0	60	560	0	0	0	0	0	0	0	18,066
11 KEBUMEN												0	0	200	340	120	0	1,260	180	20	0	20	40	100	20	19,271
12 SEMARANG													7,560	0	2,320	0	1,760	2,280	0	0	0	20	0	0	0	30,980
13 PURWODADI														0	1,740	0	1,220	720	0	0	0	0	0	0	0	11,289
14 YOGYAKARTA															300	500	0	3,860	760	100	60	40	200	360	140	24,508
15 SOLO																880	0	2,980	340	20	140	60	140	180	20	27,484
16 MADIUN																	0	1,660	60	20	40	20	80	160	20	9,751
17 BOJONEGORO																		4,220	0	0	0	0	0	0	0	9,220
18 SURABAYA																			12,360	5,900	2,320	6,140	840	3,580	4,360	72,489
19 KERTOSONO																				1,120	40	380	60	120	40	20,547
20 TULUNGAGUNG																					460	4,060	0	40	60	13,720
21 BANGIL																						1,180	60	160	540	5,040
22 MALANG																							20	40	80	13,113
23 PROBOLINGGO																								120	300	1,993
24 JEMBER																									1,740	6,800
25 BANYUWANGI																										8,000
TOTAL																										1,277,550

Note: 1) Intra zonal pairs are excluded.
2) The figures of column of righthand "TOTAL" are the total of arrival and departure.

Table 2.3.16 Railway Passenger Traffic Matrix (after Restriction by Railway Capacity; Maximum Speed 100 km/h)

Year 1994 (100 pass.)

Origin \ Destination	1 MERAK	2 RANKAS BITUNG	3 JAKA RTA	4 CIKAM PEK	5 SUKA BUMI	6 BAND UNG	7 CIRE BON	8 TASIKU MA LAYA	9 KROJA	10 PEKA LON GAN	11 KEBU MEN	12 SEMA RANG	13 PURWO DADI	14 YOGYA KARTA	15 SOLO	16 MADIUN	17 BOJO NEGORO	18 SURA BAYA	19 KERTO SONO	20 TULUN GAGUNG	21 BANGIL	22 MALANG	23 PROBO LINGGO	24 JEMBER	25 BANYU WANGI	TOTAL
1 MERAK		20,221	127,038	0	47	4,366	58	19	116	299	116	471	0	335	679	116	58	656	173	29	0	0	0	0	0	154,796
2 RANKASBITUNG			25,123	204	60	518	31	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46,200
3 JAKARTA				118,062	21,241	169,468	54,758	27,194	12,317	13,190	14,048	11,968	33	14,386	24,189	7,229	2,639	14,973	4,971	2,543	29	649	115	145	423	666,712
4 CIKAMPEK					39	4,132	12,629	866	311	496	347	119	0	347	98	79	0	93	29	0	0	0	0	0	0	137,851
5 SUKABUMI						6,994	21	202	0	13	29	4	0	31	0	0	0	0	0	0	0	0	0	0	0	28,690
6 BANDUNG							24,632	13,727	3,844	1,432	5,556	1,823	13	6,758	2,707	1,051	0	5,570	884	29	0	361	0	58	409	254,331
7 CIREBON								446	32,504	347	630	983	0	1,791	578	173	145	1,301	318	58	23	1	0	0	7	131,436
8 TASIKUMALAYA									5,838	213	2,556	2,119	0	2,737	751	260	0	2,563	535	29	0	1,647	29	87	87	61,940
9 KROJA										5,188	1,771	4,446	0	26,708	2,676	432	0	2,084	578	87	29	168	90	87	29	99,299
10 PEKALONGAN											3,709	838	0	184	0	0	87	809	0	112	0	10	0	0	0	26,926
11 KEBUMEN												7,200	0	19,861	2,945	226	14	1,915	260	29	0	29	58	145	29	61,471
12 SEMARANG													10,924	16,531	3,352	1,059	2,543	3,295	963	412	26	1,458	0	70	65	70,700
13 PURWODADI														34	2,514	0	1,763	1,040	0	0	0	0	0	0	0	16,321
14 YOGYAKARTA															15,705	3,223	124	23,373	1,298	145	178	3,256	716	555	202	138,478
15 SOLO																13,740	0	70,189	5,658	66	260	1,090	393	260	2,361	150,203
16 MADIUN																	4,749	48,606	1,250	550	58	218	164	791	344	84,348
17 BOJONEGORO																		6,098	244	147	74	477	0	87	0	19,239
18 SURABAYA																			46,474	42,886	3,352	8,923	19,195	33,737	34,092	371,224
19 KERTOSONO																				1,618	786	549	366	207	85	67,246
20 TULUNGAGUNG																					806	5,867	827	88	690	57,016
21 BANGIL																						1,705	1,601	664	3,251	12,845
22 MALANG																							6,472	2,521	155	35,554
23 PROBOLINGGO																								173	433	30,633
24 JEMBER																									2,514	42,187
25 BANYUWANGI																										45,176
TOTAL																										2,810,822

Note: 1) Intra zonal pairs are excluded.

2) The figures of column of righthand "TOTAL" are the total of arrival and departure.

Table 2.3.17 Railway Passenger Traffic Matrix (after Restriction by Railway Capacity; Maximum Speed 100 km/h)

Year 2002 (100 pass.)

Origin \ Destination	1 MERAK	2 RANKAS BITUNG	3 JAKA RTA	4 CIKAM PEK	5 SUKA BUMI	6 BAND UNG	7 CIRE BON	8 TASIKU MA LAYA	9 KROJA	10 PEKA LON GAN	11 KEBU MEN	12 SEMA RANG	13 PURWO DADI	14 YOGYA KARTA	15 SOLO	16 MADIUN	17 BOJO NEGORO	18 SURA BAYA	19 KERTO SONO	20 TULUN GAGUNG	21 BANGIL	22 MALANG	23 PROBO LINGGO	24 JEMBER	25 BANYU WANGI	TOTAL
1 MERAK		24,674	145,265	0	91	2,932	85	33	171	260	171	532	0	268	333	171	85	773	256	43	0	0	0	0	0	176,143
2 RANKASBITUNG			37,119	302	234	348	9	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62,749
3 JAKARTA				174,437	111,594	119,846	44,316	53,963	11,347	15,891	20,237	14,837	46	12,767	20,878	9,851	3,856	22,122	7,207	3,758	43	910	154	214	618	831,296
4 CIKAMPEK					135	4,289	9,476	1,400	399	509	512	174	0	512	131	57	0	139	43	0	0	0	0	0	0	192,515
5 SUKABUMI						40,429	9	487	0	10	43	3	0	54	0	0	0	0	0	0	0	0	0	0	0	153,088
6 BANDUNG							7,214	44,482	7,969	821	9,708	1,306	10	11,835	5,195	1,587	0	8,050	1,316	43	0	415	0	85	592	268,474
7 CIREBONG								1,091	43,304	7,290	927	5,329	0	2,634	854	256	214	3,349	470	85	1,658	50	0	0	79	128,699
8 TASIKUMALAYA									22,797	2,635	4,895	4,869	0	4,242	1,110	384	0	3,727	786	43	0	3,099	43	128	128	150,405
9 KROJA										44,261	2,616	7,139	0	28,584	3,280	600	0	3,054	854	128	43	252	73	128	43	177,042
10 PEKALONGAN											28,236	9,573	0	1,192	615	0	771	2,376	0	424	0	144	0	0	0	115,009
11 KEBUMEN												12,872	0	20,669	3,264	311	30	2,757	384	43	0	43	85	214	43	103,060
12 SEMARANG													29,291	69,964	41,295	3,472	34,189	32,134	2,371	1,232	263	16,939	0	169	182	268,121
13 PURWODADI														94	4,738	0	2,605	1,537	0	0	0	0	0	0	0	33,322
14 YOGYAKARTA															23,204	4,762	701	20,862	1,917	214	193	8,355	637	714	299	214,673
15 SOLO																20,301	288	53,087	8,359	116	340	3,120	393	384	1,834	193,118
16 MADIUN																	5,620	36,315	1,818	1,462	85	994	195	718	316	89,304
17 BOJONEGORO																		28,282	392	300	354	3,015	0	127	0	80,850
18 SURABAYA																			46,682	53,491	4,953	13,261	10,649	34,814	49,566	431,980
19 KERTOSONO																				3,376	602	18,735	266	281	113	96,247
20 TULUNGAGUNG																					1,126	55,714	534	112	830	123,073
21 BANGIL																						5,297	874	922	6,751	23,503
22 MALANG																							6,043	4,474	277	141,136
23 PROBOLINGGO																								12,224	1,183	33,353
24 JEMBER																									3,856	59,556
25 BANYUWANGI																										66,709
TOTAL																										4,243,425

Note: 1) Intra zonal pairs are excluded.
2) The figures of column of righthand "TOTAL" are the total of arrival and departure.

Table 2.3.18 Railway Freight Traffic Matrix (after Restriction by Railway Capacity; Maximum Speed 80 km/h)

Year 1989 (100 ton)

Origin \ Destination	1 MERAK	2 RANKAS BITUNG	3 JAKA RTA	4 CIKAM PEK	5 SUKA BUMI	6 BAND UNG	7 CIRE BON	8 TASIKU MA LAYA	9 KROJA	10 PEKA LON GAN	11 KEBU MEN	12 SEMA RANG	13 PURWO DADI	14 YOGYA KARTA	15 SOLO	16 MADIUN	17 BOJO NEGORO	18 SURA BAYA	19 KERTO SONO	20 TULUN GAGUNG	21 BANGIL	22 MALANG	23 PROBO LINGGO	24 JEMBER	25 BANYU WANGI	TOTAL
1 MERAK		0	316	179	1	4	6	4	15	4	3	12	2	8	12	6	4	51	5	9	2	8	7	21	11	691
2 RANKASBITUNG			5	339	0	5	2	3	17	3	2	17	1	5	4	3	14	61	4	5	2	5	6	15	15	532
3 JAKARTA				5,800	10	7,080	4,320	1,401	294	1,410	39	1,473	168	401	658	228	87	904	124	133	12	68	150	269	340	25,685
4 CIKAMPEK					584	1,337	1,581	416	15	22	2	26	101	4	4	3	32	49	4	6	2	6	7	20	33	10,569
5 SUKABUMI						0	16	0	0	5	0	13	3	0	1	0	7	84	1	0	3	9	10	28	22	798
6 BANDUNG							32	0	297	6	0	39	5	0	2	1	15	174	55	1	11	38	71	83	81	9,334
7 CIREBON								0	123	0	0	0	0	0	0	0	0	112	0	1	0	1	0	0	0	6,194
8 TASIKUMALAYA									53	0	0	4	0	0	0	0	1	27	1	0	1	0	8	4	0	1,926
9 KROJA										2	292	613	294	1,039	2,243	86	143	241	0	14	0	4	11	35	24	5,858
10 PEKALONGAN											0	1,867	0	0	0	0	0	67	0	0	0	8	1	0	5	3,399
11 KEBUMEN												0	0	0	0	0	0	0	0	0	0	0	0	0	0	338
12 SEMARANG													0	1	16	9	300	1,035	13	0	0	0	0	0	0	5,506
13 PURWODADI														0	0	0	0	14	0	0	0	0	0	0	0	587
14 YOGYAKARTA															6	0	0	531	0	0	0	0	36	8	0	2,038
15 SOLO																72	0	903	0	0	0	0	0	0	1	3,922
16 MADIUN																	0	2,649	0	0	0	0	0	2	5	3,063
17 BOJONEGORO																		272	0	0	0	0	0	0	0	875
18 SURABAYA																			2,244	298	271	2,086	811	1,120	688	14,751
19 KERTOSONO																				0	0	0	0	0	0	2,450
20 TULUNGAGUNG																					0	0	0	0	0	468
21 BANGIL																						0	0	0	0	304
22 MALANG																							0	0	0	2,233
23 PROBOLINGGO																								0	0	1,119
24 JEMBER																									3	1,616
25 BANYUWANGI																										1,227
25 TOTAL																										105,453

Note: 1) Traffic of intra zonal pairs are excluded.
2) Each zonal pair is the total of main 9 articles.
3) The figures of column of righthand "TOTAL" are the total of arrival and departure.

Table 2.3.19 Railway Freight Traffic Matrix (after Restriction by Railway Capacity; Maximum Speed 80 km/h)

Year 1994 (100 ton)

Origin \ Destination	1 MERAK	2 RANKAS BITUNG	3 JAKA RTA	4 CIKAM PEK	5 SUKA BUMI	6 BAND UNG	7 CIRE BON	8 TASIKU MA LAYA	9 KROJA	10 PEKA LON GAN	11 KEBU MEN	12 SEMA RANG	13 PURWO DADI	14 YOGYA KARTA	15 SOLO	16 MADIUN	17 BOJO NEGORO	18 SURA BAYA	19 KERTO SONO	20 TULUN GAGUNG	21 BANGIL	22 MALANG	23 PROBO LINGGO	24 JEMBER	25 BANYU WANGI	TOTAL
1 MERAK		2	3,706	454	4	7	6	4	21	3	5	11	2	16	23	15	3	61	14	23	2	8	7	22	13	4,432
2 RANKASBITUNG			3,040	835	2	7	2	3	21	2	3	17	1	7	7	5	14	45	8	10	1	4	4	12	11	4,060
3 JAKARTA				7,130	12	7,782	2,721	802	339	755	46	1,026	88	609	1,108	405	72	1,058	158	234	9	53	161	226	256	31,796
4 CIKAMPEK					723	1,503	1,861	420	18	21	3	29	124	7	8	7	38	50	11	16	1	4	5	15	24	13,306
5 SUKBUMI						0	9	0	0	2	0	6	1	1	3	2	3	54	4	4	2	4	6	18	13	875
6 BANDUNG							18	0	378	3	0	33	2	1	3	4	9	184	58	7	10	34	70	63	51	10,227
7 CIREBON								38	3,270	0	6	0	0	14	22	22	0	135	37	64	0	3	3	9	17	8,258
8 TASIKUMALAYA									68	2	1	21	3	4	5	7	10	525	9	13	9	19	36	105	199	2,303
9 KROJA										113	4,303	2,092	635	6,599	5,313	632	225	455	90	169	6	37	34	83	112	25,014
10 PEKALONGAN											2	2,195	0	2	0	2	0	82	3	6	0	10	5	14	38	3,260
11 KEBUMEN												7	1	5	4	3	2	78	4	7	2	7	7	14	33	4,544
12 SEMARANG													0	6	21	13	354	1,442	19	10	0	2	3	19	25	7,353
13 PURWODADI														1	0	1	0	17	1	2	0	0	1	2	5	859
14 YOGYAKARTA															16	5	2	2,734	4	8	3	9	48	45	101	10,247
15 SOLO																102	0	4,265	4	9	3	8	12	45	121	11,102
16 MADIUN																	15	5,990	4	3	1	2	4	16	43	7,303
17 BOJONEGORO																		333	2	2	1	1	2	3	8	1,160
18 SURABAYA																			7,729	2,845	2,821	4,468	4,272	3,857	1,828	45,327
19 KERTOSONO																				0	1	0	3	8	23	8,192
20 TULUNGAGUNG																					1	0	3	9	25	3,473
21 BANGIL																						0	1	1	1	2,877
22 MALANG																							3	2	4	4,680
23 PROBOLINGGO																								0	0	4,691
24 JEMBER																									3	4,592
25 BUNYUWANGI																										2,954
TOTAL																										222,855

Note: 1) Traffic of intra zonal pairs are excluded.
2) Each zonal pair is the total of main 9 articles.
3) The figures of column of righthand "TOTAL" are the total of arrival and departure.

Table 2.3.20 Railway Freight Traffic Matrix (after Restriction by Railway Capacity; Maximum Speed 180 km/h)

Year 2002 (100 ton)

Origin \ Destination	1 MERAK	2 RANKAS BITUNG	3 JAKA RTA	4 CIKAM PEK	5 SUKA BUMI	6 BAND UNG	7 CIRE BON	8 TASIKU MA LAYA	9 KROJA	10 PEKA LON GAN	11 KEBU MEN	12 SEMA RANG	13 PURWO DADI	14 YOGYA KARTA	15 SOLO	16 MADIUN	17 BOJO NEGORO	18 SURA BAYA	19 KERTO SONO	20 TULUN GAGUNG	21 BANGIL	22 MALANG	23 PROBO LINGGO	24 JEMBER	25 BANYU WANGI	TOTAL
1 MERAK		2	3,874	479	5	3	4	5	5	1	1	9	1	4	9	4	2	79	4	6	1	5	4	16	11	4,535
2 RANKASBITUNG			3,950	1,090	5	4	0	3	5	1	1	17	0	1	1	1	15	40	2	2	1	2	3	7	8	5,162
3 JAKARTA				9,240	8,372	4,971	713	1,498	267	435	20	954	66	178	337	175	75	1,328	135	116	8	53	185	216	248	37,414
4 CIKAMPEK					2,193	1,166	2,327	643	4	25	1	36	162	2	2	1	50	59	2	4	1	4	4	13	24	17,531
5 SUKABUMI						7	3	1	33	1	3	5	1	4	5	4	3	63	6	8	1	4	5	15	12	10,757
6 BANDUNG							4	2	614	1	2	34	1	4	5	6	9	214	60	11	10	33	71	56	42	7,328
7 CIREBON								69	3,759	14	6	14	5	11	17	17	14	1,110	28	55	17	67	18	67	144	8,485
8 TASIKUMALAYA									5,573	21	5	34	5	6	6	8	18	437	9	15	6	26	22	54	112	8,579
9 KROJA										807	5,598	2,882	783	6,554	5,876	619	308	515	78	181	4	46	27	82	85	34,705
10 PEKALONGAN											12	2,729	3	10	6	6	6	1,444	7	18	4	24	7	27	85	5,696
11 KEBUMEN												10	1	3	3	2	3	47	3	6	1	8	3	6	17	5,760
12 SEMARANG													6	16	48	20	444	5,725	26	22	3	16	4	28	51	13,133
13 PURWODADI														2	1	1	2	1,289	2	5	1	3	1	3	10	2,356
14 YOGYAKARTA															20	5	7	2,210	5	12	2	17	47	25	54	9,199
15 SOLO																140	8	3,523	5	13	2	18	4	21	68	10,139
16 MADIUN																	13	5,851	4	7	1	8	2	9	30	6,934
17 BOJONEGORO																		7,202	2	4	2	5	1	3	11	8,205
18 SURABAYA																			6,564	3,078	3,663	8,450	2,693	3,835	2,360	61,780
19 KERTOSONO																				5	1	8	1	4	17	6,979
20 TULUNGAGUNG																					1	3	2	6	21	3,601
21 BANGIL																						1	0	1	2	3,732
22 MALANG																							2	3	9	8,816
23 PROBOLINGGO																								6	10	3,121
24 JEMBER																									13	4,517
25 BANYUWANGI																										3,444
TOTAL																										291,908

Note: 1) Traffic of intra zonal pairs are excluded.
2) Each zonal pair is the total of main 9 articles.
3) The figures of column of righthand "TOTAL" are the total of arrival and departure.

Table 2.3.21 Total Arrival and Departure Traffic Volume Classified by Zone (With Project; after Restriction by Railway Capacity; Maximum Speed 100 km/h)

(Year: 1989) (Unit: 100 pass., 100 tons)

Articles / Zone No.	Passenger	Freights									
		Rice	Maize	Sugar	Salt	Paper	Steel	Petroleum products	Fertilizer	Cement	Total
1	12,959	41	47	62	6	0	82	2	190	259	691
2	14,744	48	50	6	31	0	0	4	393	0	532
3	433,389	257	533	172	169	61	427	10,930	858	11,828	25,655
4	101,291	94	64	10	10	0	0	3,235	5,412	1,744	10,569
5	19,806	50	74	6	22	0	0	0	645	0	693
6	209,917	173	382	26	45	13	0	3,932	1,420	3,283	9,334
7	112,052	65	15	2	5	2	1	1,879	1,680	2,544	6,194
8	55,769	12	8	3	10	2	1	539	450	630	1,926
9	22,321	155	26	22	6	4	87	1,211	2,134	2,214	5,858
10	18,066	83	18	41	0	2	4	2,241	60	925	3,359
11	19,271	8	5	2	0	2	4	14	295	8	338
12	30,950	165	33	58	121	3	4	2,450	195	2,535	5,506
13	11,289	12	3	1	0	1	2	19	403	142	587
14	24,508	84	6	2	0	5	13	172	455	1,291	2,038
15	27,495	102	7	33	0	8	16	934	760	2,060	3,922
16	9,751	60	7	17	0	4	20	1,724	540	692	3,063
17	9,220	25	35	2	45	1	3	368	374	21	875
18	72,459	144	431	33	93	3	219	6,056	4,336	3,431	14,751
19	20,547	25	134	13	0	1	18	1,635	604	18	2,450
20	13,720	38	33	2	0	3	20	2	293	67	458
21	5,040	6	20	1	6	0	1	3	268	0	304
22	13,333	14	53	6	0	1	10	1,491	606	16	2,233
23	1,993	47	227	4	20	4	51	187	564	15	1,119
24	6,800	30	309	20	0	3	34	550	554	117	1,616
25	8,000	35	321	32	0	0	33	225	268	293	1,227

Table 2.3.22 Total Arrival and Departure Traffic Volume Classified by Zone (With Project; after Restriction by Railway Capacity; Maximum Speed 100 km/h)

(Year: 1995) (Unit: 100 pass., 100 tons)

Articles / Zone No.	Passenger	Rice	Freights								
			Maize	Sugar	Salt	Paper	Steel	Petroleum products	Fertilizer	Cement	Total
1	154,796	70	49	74	5	0	138	1,155	637	2,272	4,432
2	45,200	64	44	6	31	0	0	1,656	1,109	1,149	4,060
3	665,712	270	914	186	160	80	697	13,305	1,502	14,773	31,755
4	337,651	312	53	10	8	0	0	3,814	7,010	2,299	13,306
5	28,690	39	50	5	16	0	0	0	765	0	875
6	254,331	156	340	21	40	17	0	4,197	1,610	3,855	10,227
7	131,436	221	70	19	5	1	1	3,362	2,595	1,983	8,258
8	61,950	197	266	37	39	3	3	315	907	537	2,303
9	99,299	321	92	81	27	10	129	12,411	3,812	8,131	25,014
10	26,926	113	43	65	0	1	3	2,434	55	504	3,260
11	61,471	90	37	14	7	4	7	2,019	956	1,411	4,544
12	70,760	160	51	76	130	2	3	3,703	243	2,954	7,353
13	36,321	19	7	2	0	1	1	201	506	153	889
14	138,478	215	102	30	12	10	25	3,934	2,078	3,842	10,247
15	150,203	243	118	75	9	16	34	4,277	2,499	3,830	11,102
16	84,345	173	42	35	2	8	41	3,229	1,712	2,059	7,303
17	19,239	53	40	5	50	1	2	457	454	19	1,160
18	371,224	257	452	126	145	13	324	17,934	13,493	12,570	45,327
19	67,245	137	162	26	1	4	35	4,037	1,445	2,335	8,192
20	57,016	183	97	22	1	8	45	1,330	745	1,070	3,473
21	12,845	26	23	2	7	0	1	1,265	728	806	2,877
22	35,554	58	107	11	1	1	8	2,524	1,028	942	4,650
23	30,633	93	261	13	23	9	72	1,777	1,237	1,200	4,691
24	47,167	117	429	61	1	2	33	1,539	1,469	940	4,592
25	45,176	244	626	150	1	4	31	430	903	566	2,954

Table 2.3.23 Total Arrival and Departure Traffic Volume Classified by Zone (With Project; after Restriction by Railway Capacity; Maximum Speed 100 km/h)

(Year: 2002) (Unit: 100 pass., 100 tons)

Articles / Zone No.	Passenger	Freights									
		Rice	Maize	Sugar	Salt	Paper	Steel	Petroleum products	Fertilizer	Cement	Total
1	176,153	39	28	73	4	0	112	1,319	660	2,459	4,535
2	62,749	34	22	4	33	0	0	2,054	1,427	1,587	5,162
3	831,236	253	878	210	175	54	761	16,445	2,491	16,157	37,414
4	192,515	65	39	8	9	1	0	4,727	9,456	3,176	17,531
5	153,088	67	51	8	18	1	0	4,293	2,845	3,459	10,757
6	268,474	145	335	22	43	22	0	2,793	1,316	2,645	7,328
7	128,659	351	247	63	9	3	3	2,653	4,023	932	8,495
8	150,405	245	169	34	33	3	6	3,359	3,000	1,721	8,579
9	177,042	303	57	69	18	4	180	16,527	6,853	10,692	34,705
10	315,009	232	85	118	12	3	4	3,762	1,100	350	5,656
11	103,660	77	20	11	4	2	3	2,482	1,223	1,939	5,760
12	288,121	277	77	110	358	4	3	5,719	2,956	3,830	13,133
13	38,322	45	11	5	1	1	1	656	1,369	276	2,356
14	214,673	210	57	21	6	4	7	3,287	1,693	3,914	9,199
15	193,118	241	72	73	5	6	10	3,654	2,207	3,851	10,139
16	83,304	169	30	35	1	3	25	3,337	1,529	1,805	6,934
17	80,850	113	47	11	57	1	2	3,176	2,650	2,149	8,205
18	431,980	327	473	123	149	17	497	22,560	20,722	16,921	61,780
19	56,247	123	159	28	1	1	31	3,676	1,415	1,545	6,979
20	123,073	154	82	23	1	3	22	1,293	878	1,093	3,601
21	23,503	34	26	3	7	0	1	1,555	951	1,113	3,732
22	141,136	151	150	27	1	1	9	4,128	1,720	2,628	8,815
23	33,353	92	245	10	25	10	105	918	1,148	566	3,121
24	59,556	100	376	60	1	3	32	1,514	1,555	877	4,517
25	66,769	216	572	180	1	4	34	528	1,365	742	3,444

(3) Link traffic volume

On the basis of the outcome of forecast traffic demand between zones, the traffic volume of railways and roads by each link was estimated. Tables 2.3.24∿26 express the outcome of calculating the railway link traffic "with project." Each is for the number of passing trains (the total of passenger and freight) by link per day and the number of passing passengers as well as passing tonnage.

In these tables, "Actual Traffic of Railway" means "the traffic demand which may be realized after the restriction by railway capacity in the demand of railway transport," and it means the same as the above-mentioned traffic demand after restriction by railway capacity. Accordingly, in these tables, "Demand to Railway" means the traffic demand before restriction by railway capacity.

Next, Figs. 2.3.3∿5 show the actual number of passing trains (the total number of passenger and freight trains) by each link. Also, Figs. 2.3.6∿11 show the actual passing passenger between links per day, Figs. 2.3.12∿17 similarly show the passing tonnage by each link per day.

Lastly, the estimated results for traffic volume (the number of passing buses and trucks) between road links are shown on Tables 2.3.27∿29 (before restriction by railway capacity) and Tables 2.3.30 ∿ 32(after restriction by railway capacity). In these tables, the traffic volume (the number of trains) between railway links is shown, calculated in accordance with the classification of "with project" and "without project."

2.3.6 Integrated Evaluation

In order to obtain an integrated evaluation for the outcome of the demand forecast, we estimated the saved time and railway passenger traffic volume (pass. km), railway freight traffic volume (ton•km) by electrification, and also the decrease of the traffic volume of buses (the number of buses•km) and the traffic volume of trucks (the number of trucks•km) caused by the diversion of traffic demand from roads to railways. The results of the calculation for these factors are shown in Table 2.3.33.

Table 2.3.24 RAILWAY LINK TRAFFIC

"WITH PROJECT"

YEAR: 1999

LINK NO.	NODE	NUMBER OF TRAINS PER DAY				PASSENGER (100 PASSENGER/DAY)			FREIGHT (100 TON/DAY)		
		CAPACITY	TOTAL DEMAND (HIGHWAY + RAILWAY)	DEMAND TO RAILWAY	ACTUAL TRAFFIC OF RAILWAY	TOTAL DEMAND (HIGHWAY + RAILWAY)	DEMAND TO RAILWAY	ACTUAL TRAFFIC OF RAILWAY	TOTAL DEMAND (HIGHWAY + RAILWAY)	DEMAND TO RAILWAY	ACTUAL TRAFFIC OF RAILWAY
1	1 ~ 2	28	179	6	5	1177	37	35	70	2	2
2	2 ~ 3	49	159	9	8	1006	56	55	92	4	3
3	3 ~ 4	240	657	193	171	3944	1256	1117	524	87	74
4	3 ~ 5	40	89	6	6	541	41	41	65	2	2
5	5 ~ 6	42	36	2	2	245	14	14	7	0	0
6	4 ~ 7	90	314	111	90	1719	719	565	365	49	39
7	4 ~ 6	94	332	106	91	2143	712	607	155	33	30
8	6 ~ 8	25	203	34	25	1392	230	169	72	9	6
9	7 ~ 10	23	129	28	24	690	170	147	161	21	17
10	7 ~ 9	36	143	26	23	809	174	157	175	8	6
11	8 ~ 9	27	52	9	9	237	63	63	50	1	1
12	10 ~ 12	29	80	21	18	359	116	104	143	21	19
13	9 ~ 11	46	156	33	31	786	203	191	223	20	19
14	12 ~ 13	26	127	16	15	733	91	89	124	14	13
15	12 ~ 26	30	99	1	1	637	6	6	50	2	2
16	26 ~ 27	38	99	1	1	637	6	6	50	2	2
17	11 ~ 14	32	171	27	25	935	163	151	193	19	18
18	15 ~ 27	36	113	2	2	718	11	11	63	3	3
19	14 ~ 15	52	233	21	20	1433	125	118	186	16	15
20	13 ~ 27	38	14	1	1	81	5	5	13	1	1
21	13 ~ 17	25	76	13	13	372	76	73	120	15	13
22	15 ~ 16	32	128	13	13	726	80	80	123	8	7
23	17 ~ 18	28	91	13	12	431	74	73	156	13	12
24	16 ~ 19	36	154	12	12	893	64	64	165	13	13
25	18 ~ 21	59	331	12	12	1934	61	60	257	19	18
26	18 ~ 19	55	263	17	17	1597	93	93	193	19	19
27	19 ~ 20	36	94	4	4	578	28	28	68	1	1
28	21 ~ 22	43	130	5	5	863	24	23	58	6	6
29	20 ~ 22	26	61	2	2	425	13	13	7	0	0
30	21 ~ 23	49	225	7	7	1331	34	34	191	12	11
31	23 ~ 24	43	164	6	6	962	31	31	147	9	8
32	24 ~ 25	40	82	4	4	473	22	22	73	4	3

TABLE 2.3.25 RAILWAY LINK TRAFFIC

"WITH PROJECT"

YEAR: 1994

LINK NO.	NODE	NUMBER OF TRAINS PER DAY: CAPACITY	NUMBER OF TRAINS PER DAY: TOTAL DEMAND (HIGHWAY + RAILWAY)	NUMBER OF TRAINS PER DAY: DEMAND TO RAILWAY	NUMBER OF TRAINS PER DAY: ACTUAL TRAFFIC OF RAILWAY	PASSENGER (100 PASSENGER/DAY): TOTAL DEMAND (HIGHWAY + RAILWAY)	PASSENGER (100 PASSENGER/DAY): DEMAND TO RAILWAY	PASSENGER (100 PASSENGER/DAY): ACTUAL TRAFFIC OF RAILWAY	FREIGHT (100 TON/DAY): TOTAL DEMAND (HIGHWAY + RAILWAY)	FREIGHT (100 TON/DAY): DEMAND TO RAILWAY	FREIGHT (100 TON/DAY): ACTUAL TRAFFIC OF RAILWAY
1	1 ~ 2	74	257	63	62	1701	434	424	96	13	12
2	2 ~ 3	81	228	68	66	1453	450	440	121	25	23
3	3 ~ 4	240	937	297	208	5699	1944	1374	698	123	76
4	3 ~ 5	40	126	9	9	781	59	59	83	3	2
5	5 ~ 6	42	51	3	3	354	20	20	8	0	0
6	4 ~ 7	90	444	178	95	2483	1161	632	493	76	34
7	4 ~ 6	94	475	153	98	3105	1037	660	201	40	30
8	6 ~ 8	25	300	52	25	2011	354	172	93	11	5
9	7 ~ 10	29	161	53	29	937	336	186	204	29	14
10	7 ~ 9	81	210	83	53	1170	546	351	232	32	18
11	8 ~ 9	27	72	19	17	429	129	112	58	5	4
12	10 ~ 12	29	110	30	21	534	172	124	177	28	18
13	9 ~ 11	110	218	93	70	1136	548	402	292	80	68
14	12 ~ 13	26	179	23	21	1059	138	129	153	20	14
15	12 ~ 26	30	141	15	15	920	100	100	61	6	6
16	26 ~ 27	38	141	15	15	920	100	100	61	6	6
17	11 ~ 14	66	240	88	69	1352	530	412	255	68	56
18	15 ~ 27	36	161	17	17	1038	107	107	76	8	8
19	14 ~ 15	116	337	76	64	2071	457	392	233	54	45
20	13 ~ 27	38	19	2	2	118	7	7	15	2	2
21	13 ~ 17	25	105	20	18	538	116	107	147	19	14
22	15 ~ 16	77	179	69	67	1043	440	435	161	35	31
23	17 ~ 18	28	125	22	19	622	129	119	191	18	13
24	16 ~ 19	87	217	82	81	1291	517	515	182	46	41
25	18 ~ 21	59	467	60	55	2882	342	314	318	61	54
26	18 ~ 19	165	373	112	112	2308	698	696	251	71	71
27	19 ~ 20	36	134	25	24	835	160	159	83	11	10
28	21 ~ 22	43	186	12	11	1227	68	62	72	13	13
29	20 ~ 22	55	83	5	5	614	35	35	8	0	0
30	21 ~ 23	49	316	55	50	1923	335	306	232	40	34
31	23 ~ 24	49	230	40	36	1390	245	226	178	26	21
32	24 ~ 25	40	114	21	19	693	134	124	86	11	8

TABLE 2.3.26 RAILWAY LINK TRAFFIC

"WITH PROJECT"

YEAR: 2002

LINK NO.	NODE	NUMBER OF TRAINS PER DAY				PASSENGER (100 PASSENGER/DAY)			FREIGHT (100 TON/DAY)		
		CAPACITY	TOTAL DEMAND (HIGHWAY + RAILWAY)	DEMAND TO RAILWAY	ACTUAL TRAFFIC OF RAILWAY	TOTAL DEMAND (HIGHWAY + RAILWAY)	DEMAND TO RAILWAY	ACTUAL TRAFFIC OF RAILWAY	TOTAL DEMAND (HIGHWAY + RAILWAY)	DEMAND TO RAILWAY	ACTUAL TRAFFIC OF RAILWAY
1	1 ~ 2	74	373	95	70	2513	650	483	136	19	12
2	2 ~ 3	81	334	102	78	2147	675	519	166	35	27
3	3 ~ 4	240	1374	498	223	8421	3198	1491	973	201	70
4	3 ~ 5	69	184	50	49	1154	308	307	111	32	29
5	5 ~ 6	61	75	16	16	523	114	112	9	1	0
6	4 ~ 7	90	649	291	90	3669	1868	610	670	131	25
7	4 ~ 6	96	697	268	82	4587	1822	552	273	63	24
8	6 ~ 8	54	441	163	55	2372	1126	379	127	25	8
9	7 ~ 10	69	261	128	67	1474	809	454	271	75	19
10	7 ~ 9	81	306	136	85	1727	909	586	321	44	17
11	8 ~ 9	75	103	53	38	635	344	240	69	24	20
12	10 ~ 12	77	156	74	37	768	428	221	230	71	28
13	9 ~ 11	110	313	153	95	1673	934	577	391	109	70
14	12 ~ 13	72	258	82	68	1564	436	438	196	64	34
15	12 ~ 26	80	206	62	58	1359	428	338	78	11	9
16	26 ~ 27	90	206	62	58	1359	428	338	78	11	9
17	11 ~ 14	86	349	141	82	1397	873	504	341	94	55
18	15 ~ 27	65	234	65	60	1533	444	415	96	14	12
19	14 ~ 15	116	430	140	93	3059	834	645	306	75	43
20	13 ~ 27	90	28	3	3	174	16	16	17	4	3
21	13 ~ 17	67	149	73	60	795	429	372	189	65	38
22	15 ~ 16	77	259	106	73	1551	687	492	211	47	26
23	17 ~ 15	77	178	77	61	919	436	359	246	81	55
24	16 ~ 19	87	314	126	78	1907	813	438	236	62	33
25	18 ~ 21	106	678	157	70	4258	953	411	411	120	64
26	18 ~ 19	165	544	192	104	3410	1154	650	333	100	63
27	19 ~ 20	92	194	62	41	1234	414	273	106	21	10
28	21 ~ 22	77	273	36	24	1812	223	133	95	25	24
29	20 ~ 22	71	129	35	35	908	251	247	9	0	0
30	21 ~ 23	56	457	154	54	2242	976	343	236	84	30
31	23 ~ 24	77	333	132	50	2054	851	325	226	65	22
32	24 ~ 25	81	164	76	28	1023	438	183	106	32	9

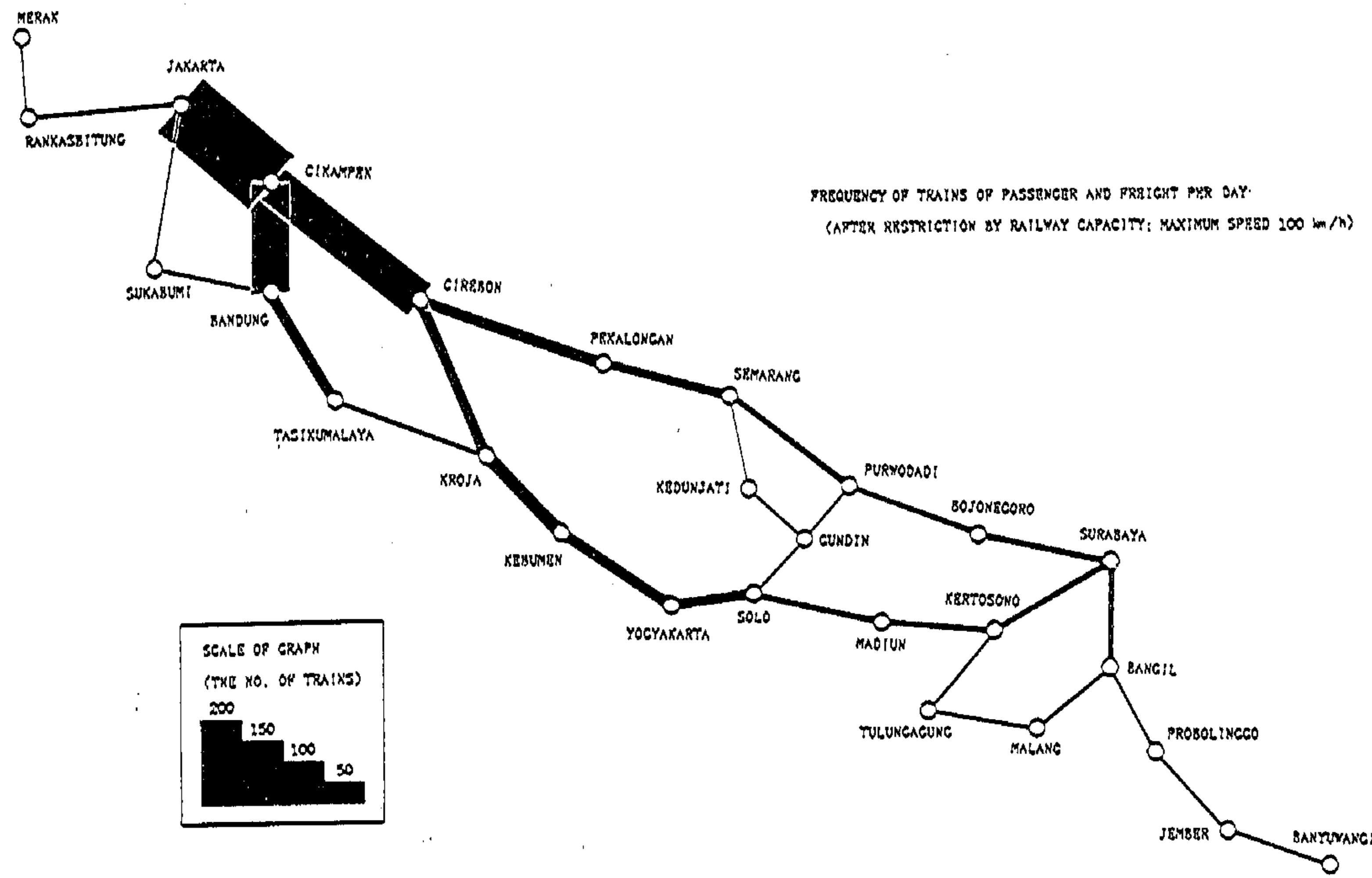
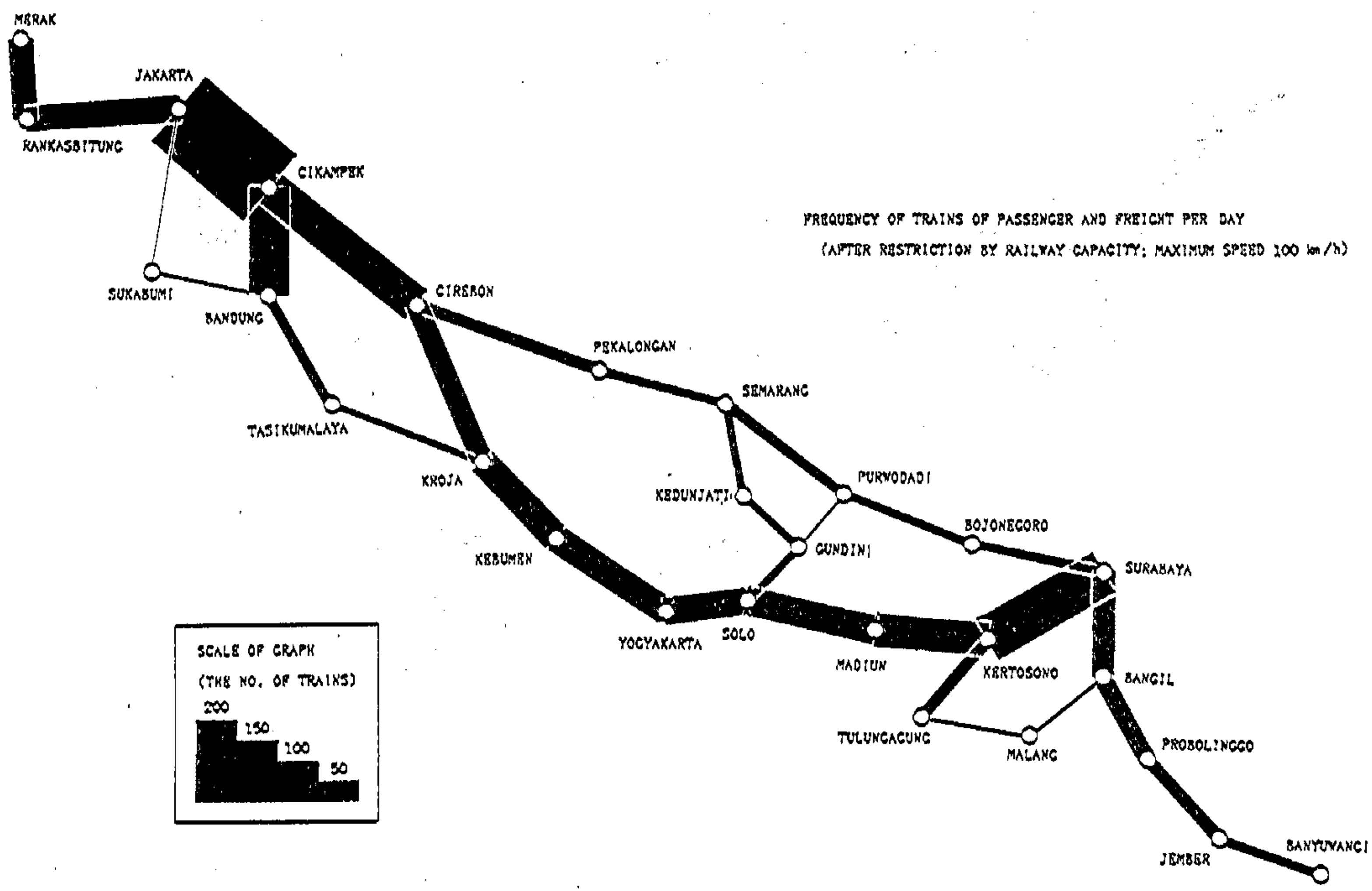
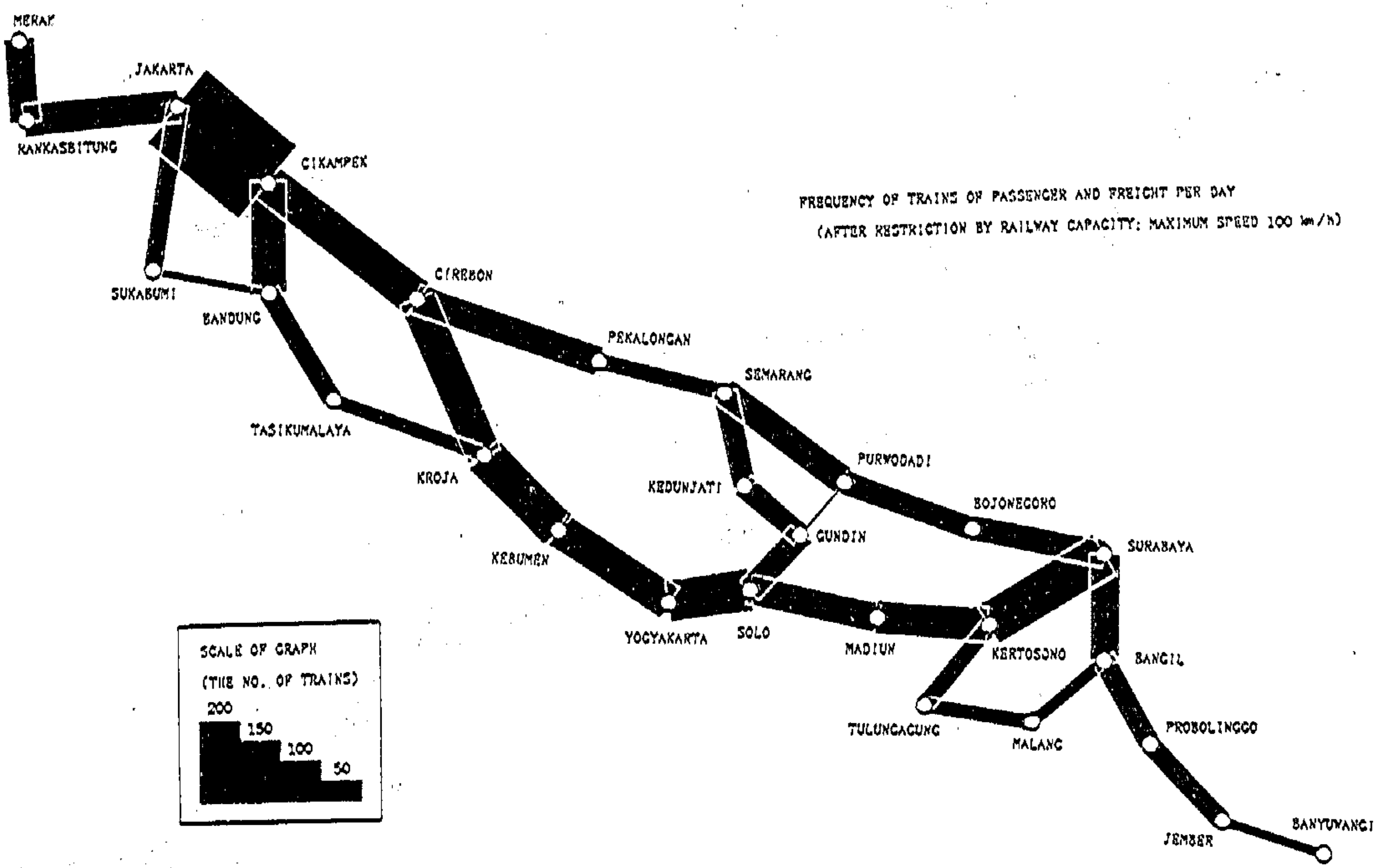


Fig. 2.3.3 RAILWAY LINK TRAFFIC
(Year: 1989)



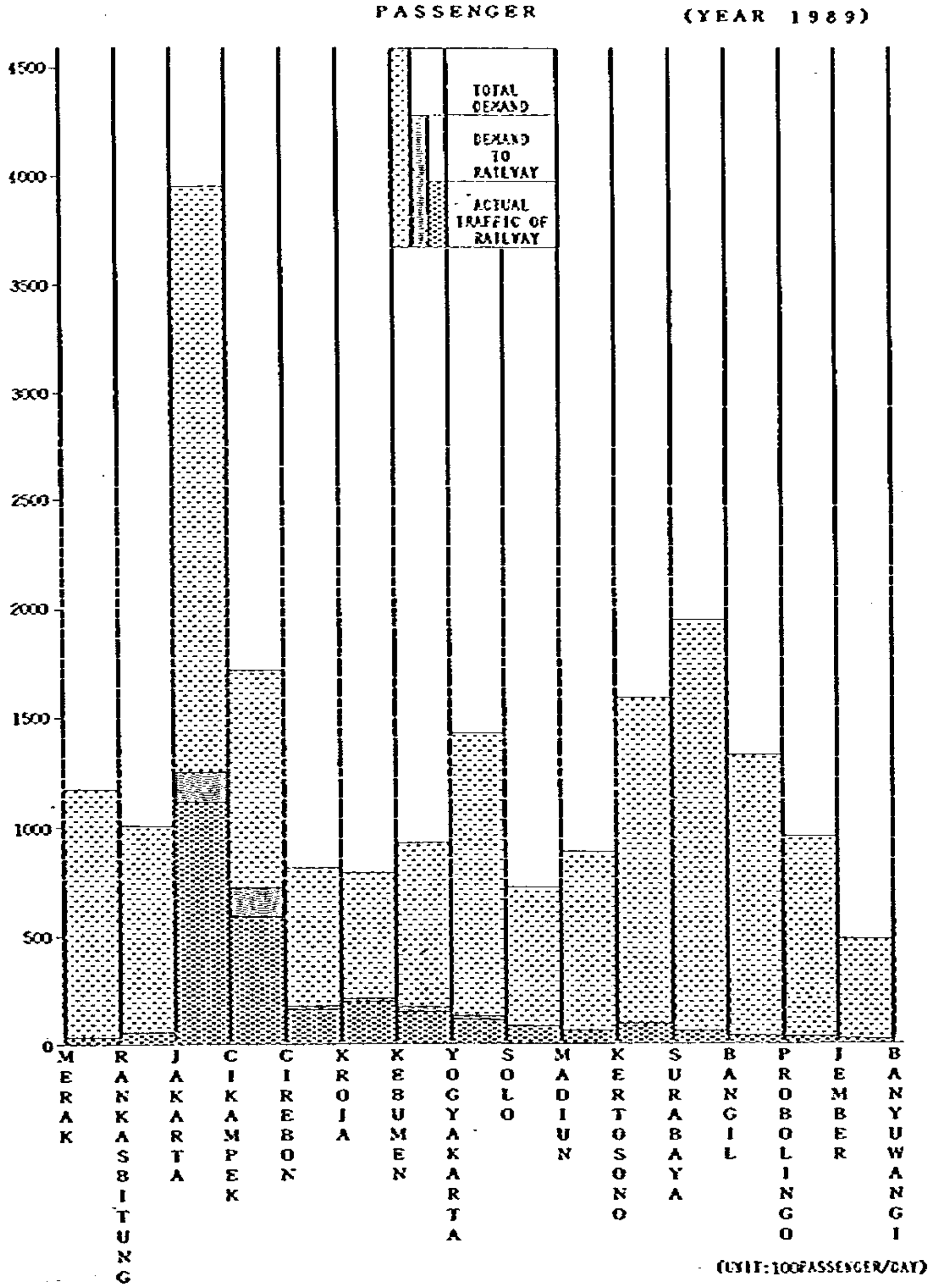
Note: Railway sections to be electrified are "MERAK-RANKASBITUNG-JAKARTA," and "CIREBON-KROJA-YOGYAKARTA-SOLO-MADIUN-KERTOSONO-SURABAYA-BANGIL-PROBOLINGGO."

Fig. 2.3.4 RAILWAY LINK TRAFFIC (Year : 1994)



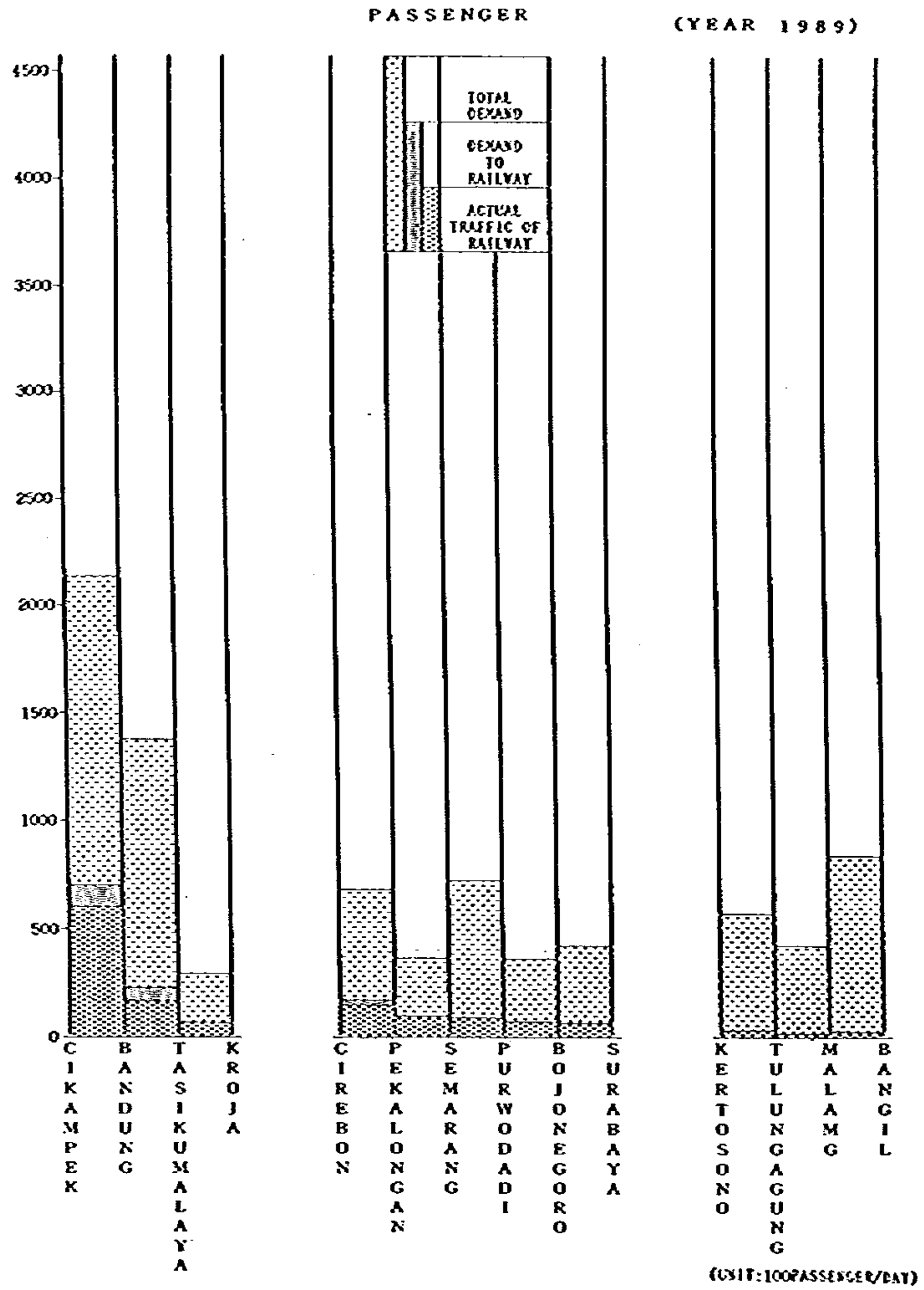
Note: Railway sections to be electrified are "JAKARTA-SUKABUMI-BANDUNG-TASIKMALAYA-KROJA," "CIREBON-SEMARANG-PURWODADI-BOJONEGORO-SURABAYA," "SEMARANG-KEDUNJATI-GUNDIH-SOLO," "PURWODADI-GUNDIH," and "KERTOSONO-TULUNGAGUNG-MALANG-BANGIL-PROBOLINGGO-JEMBER-BANYUWANGI."

Fig. 2.3.5 RAILWAY LINK TRAFFIC (Year : 2002)



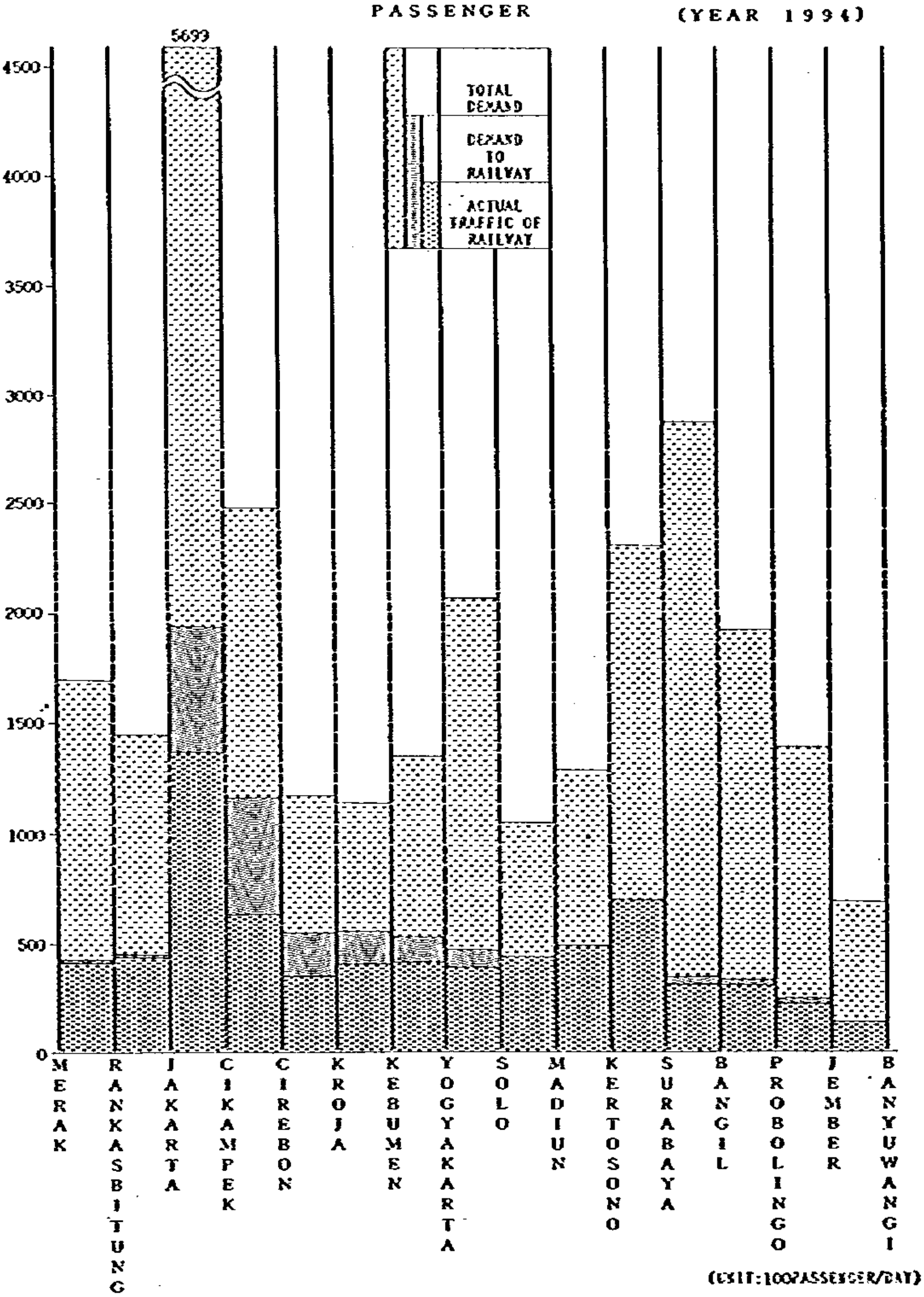
Note : Commuters were excluded.

Fig. 2.3.6 RAILWAY LINK TRAFFIC



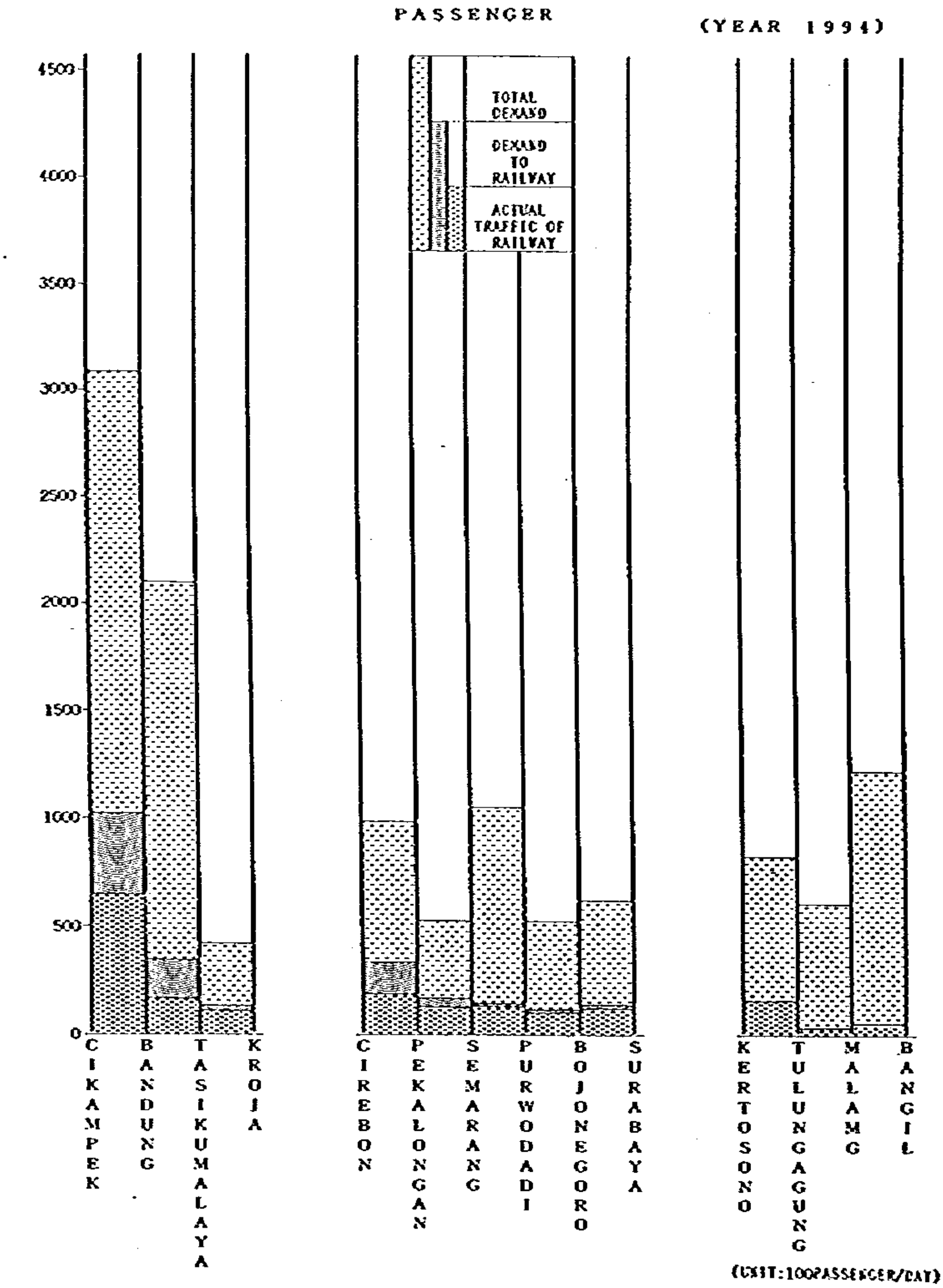
Note : Commuters were excluded.

Fig. 2.3.7 RAILWAY LINK TRAFFIC



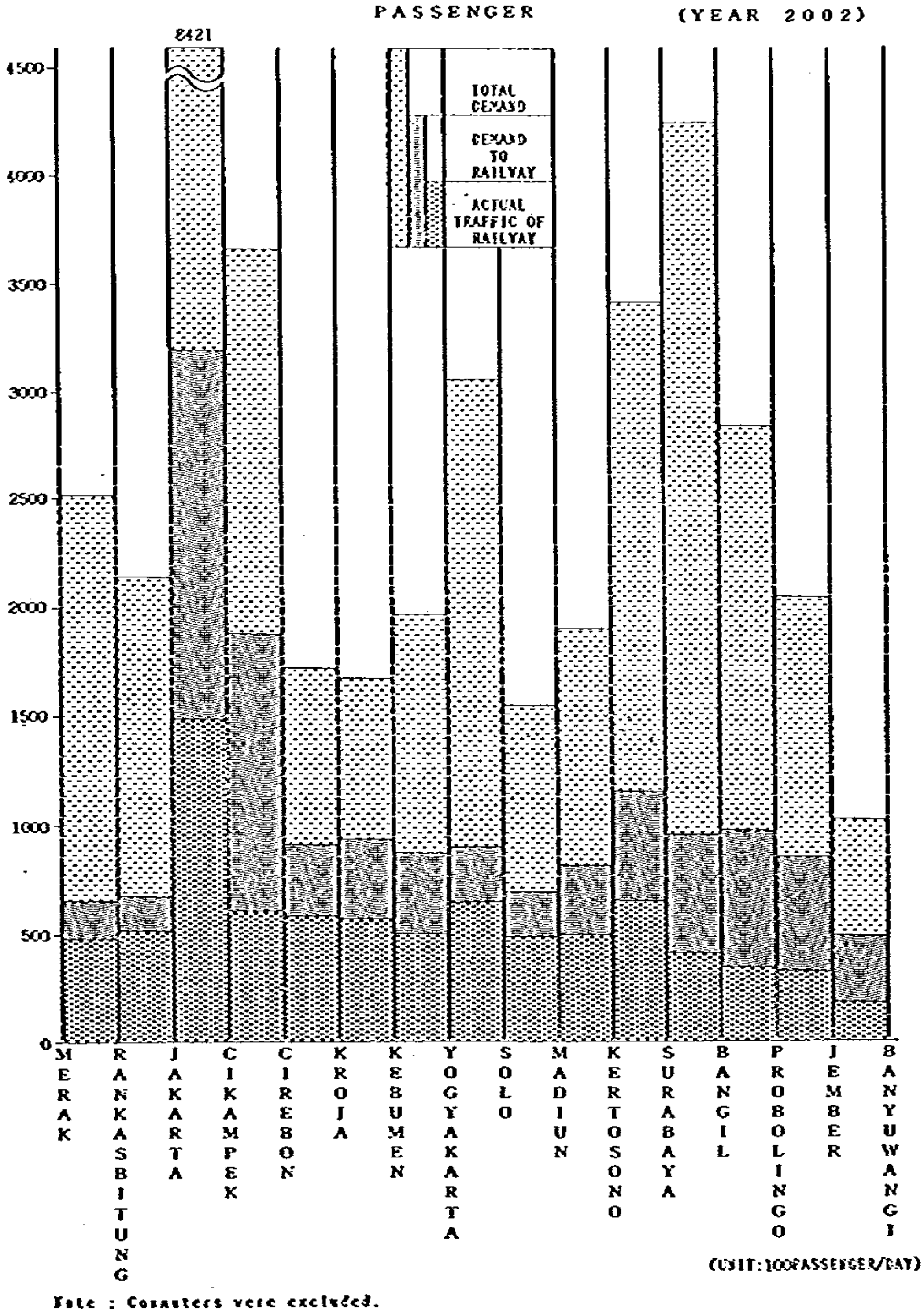
Note : Commuters were excluded.

Fig. 2.3.8 RAILWAY LINK TRAFFIC



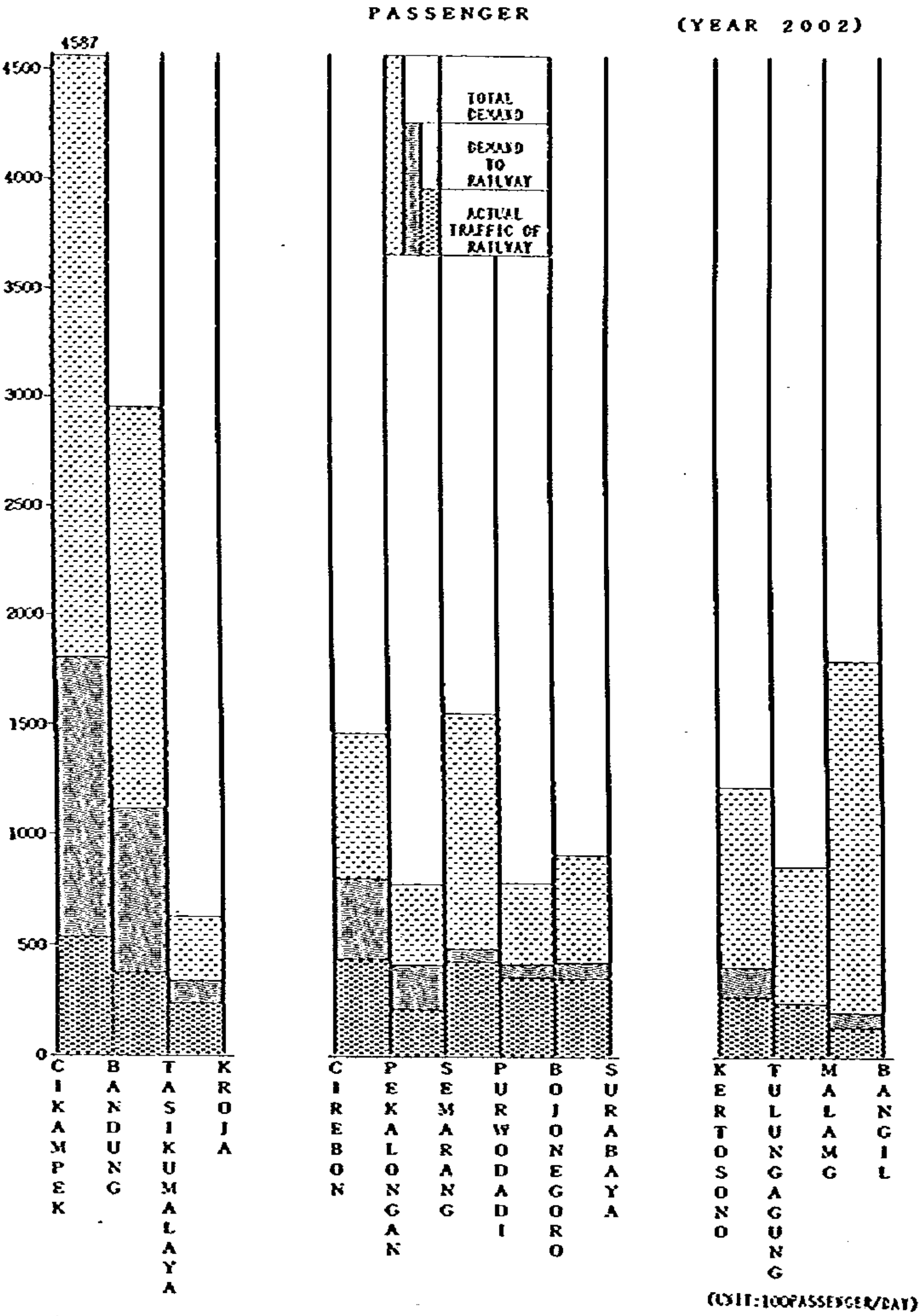
Note : Commuters were excluded.

Fig. 2.3.9 RAILWAY LINK TRAFFIC



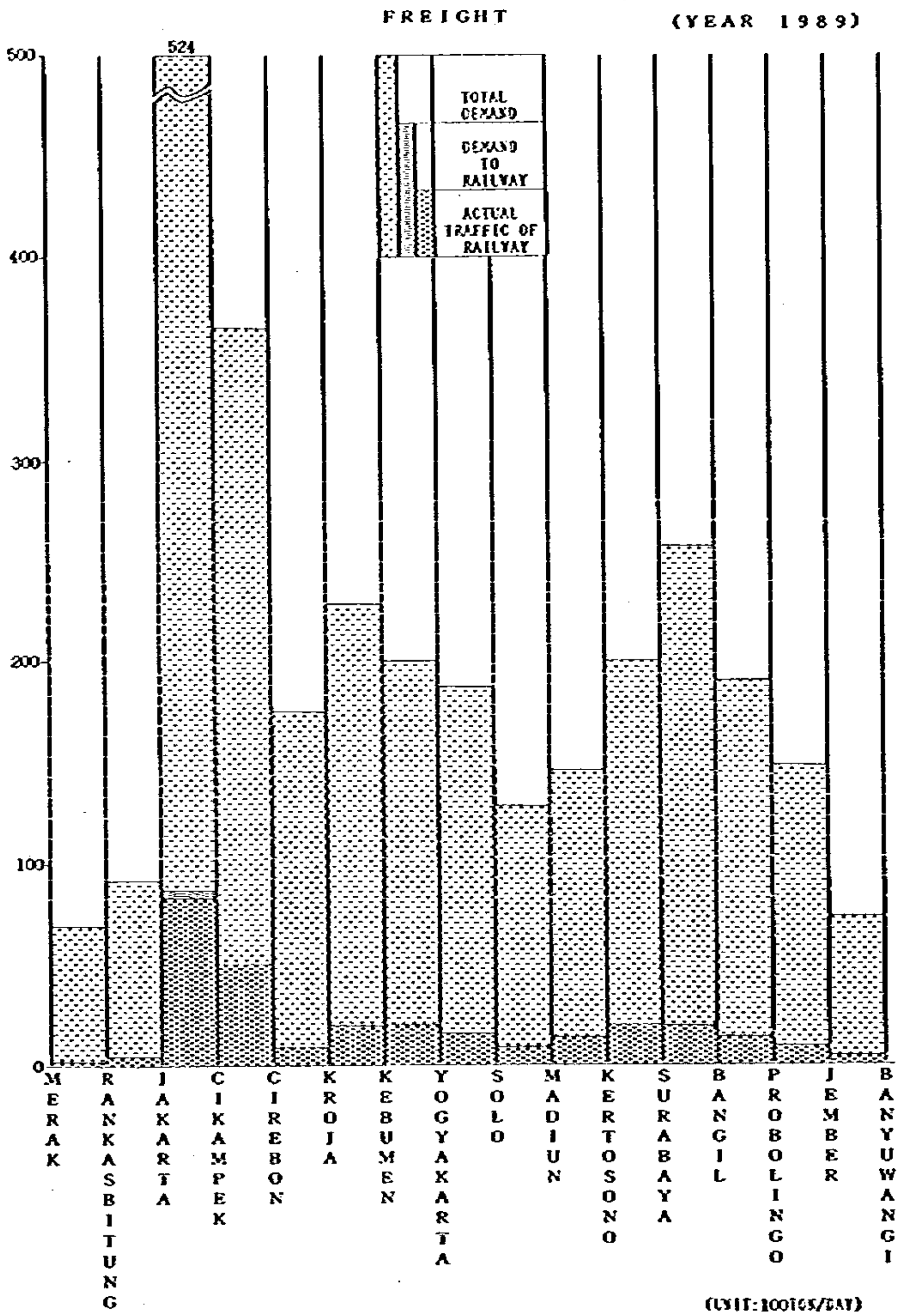
Note : Commuters were excluded.

Fig. 2.3.10 RAILWAY LINK TRAFFIC



Note : Commuters were excluded.

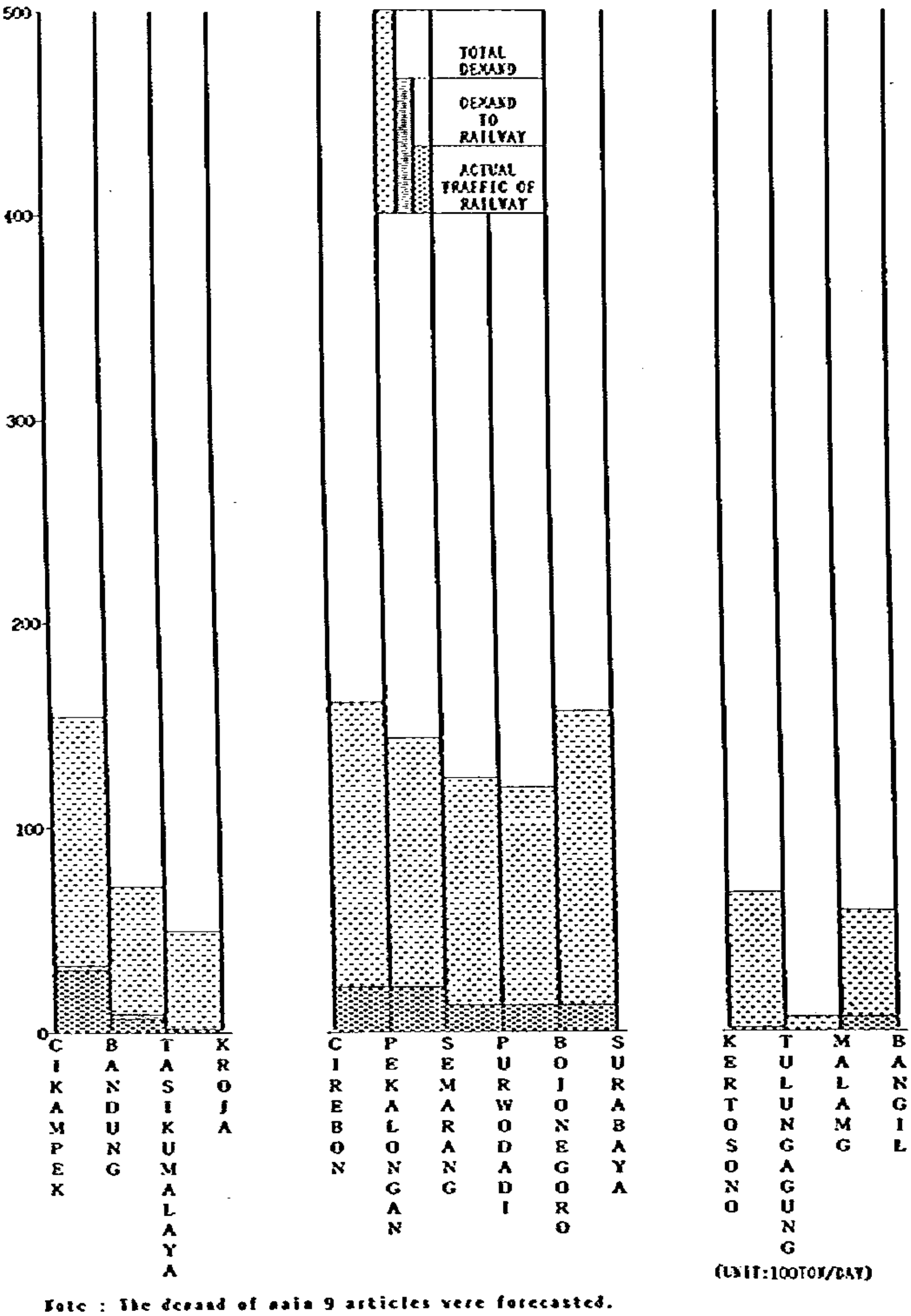
Fig. 2.3.11 RAILWAY LINK TRAFFIC



Note : The demand of main 9 articles were forecasted.

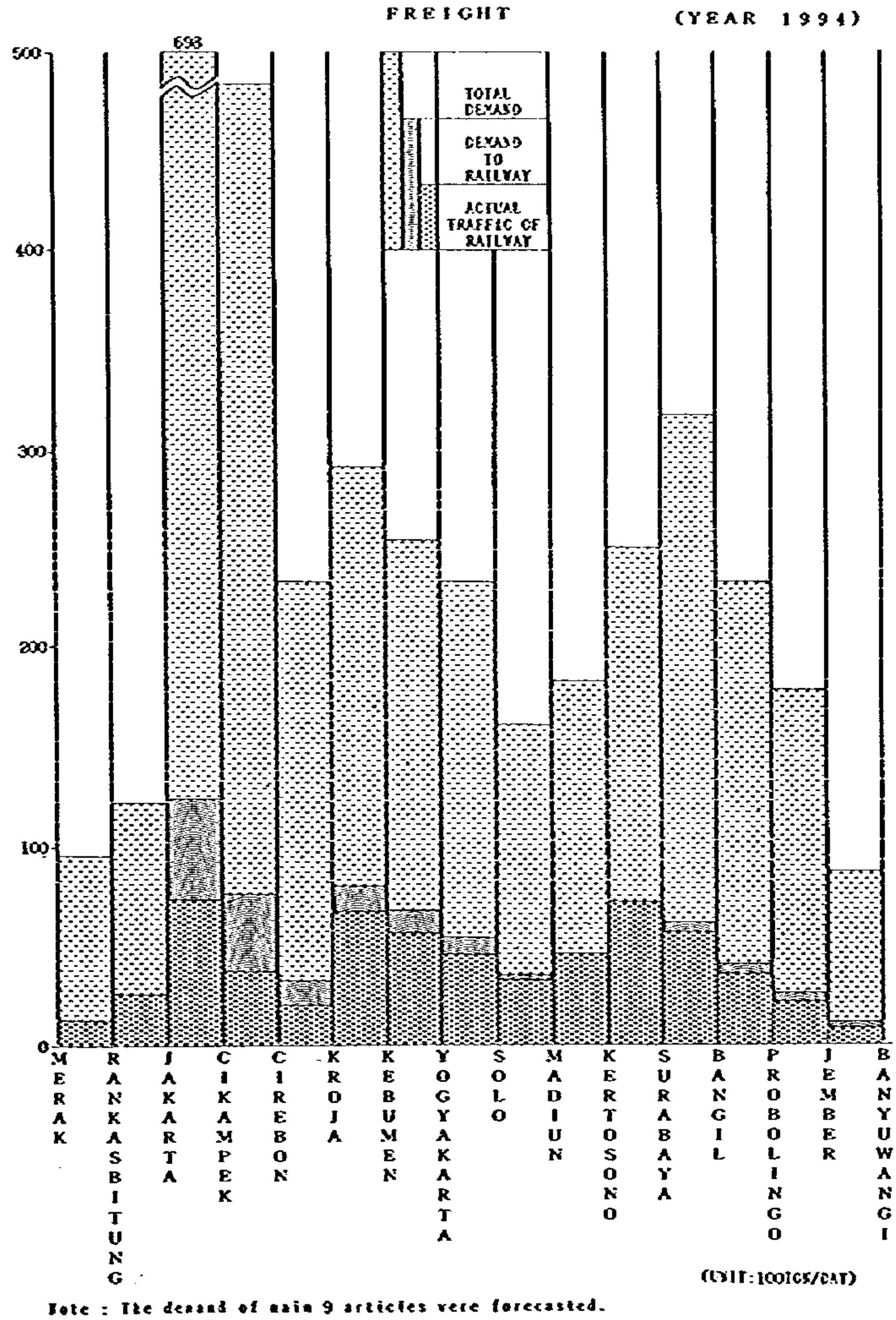
Fig. 2.3.12 RAILWAY LINK TRAFFIC

FREIGHT (YEAR 1989)



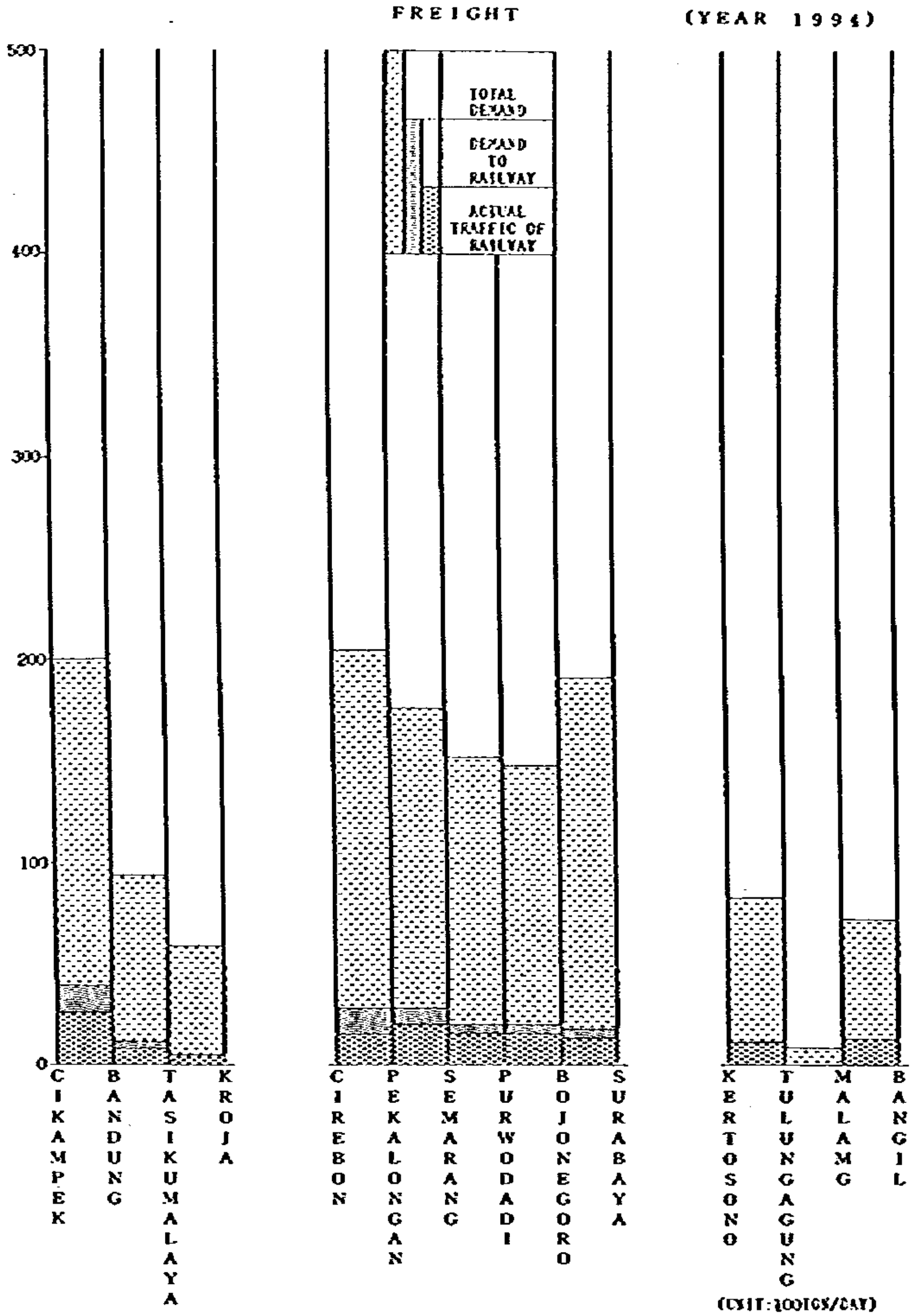
Note : The demand of main 9 articles were forecasted.

Fig. 2.3.13 RAILWAY LINK TRAFFIC



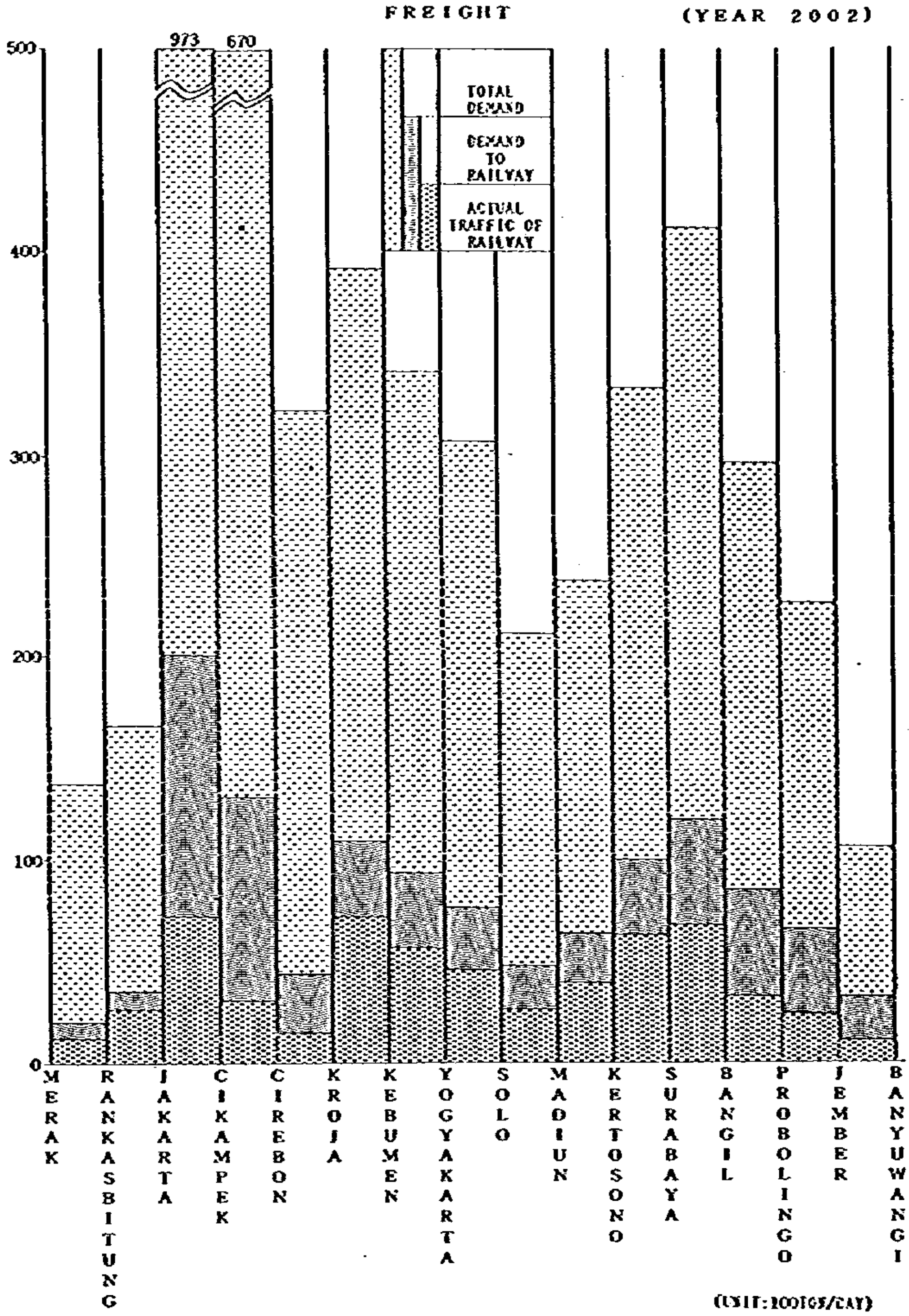
Note : The demand of main 9 articles were forecasted.

Fig. 2.3.14 RAILWAY LINK TRAFFIC



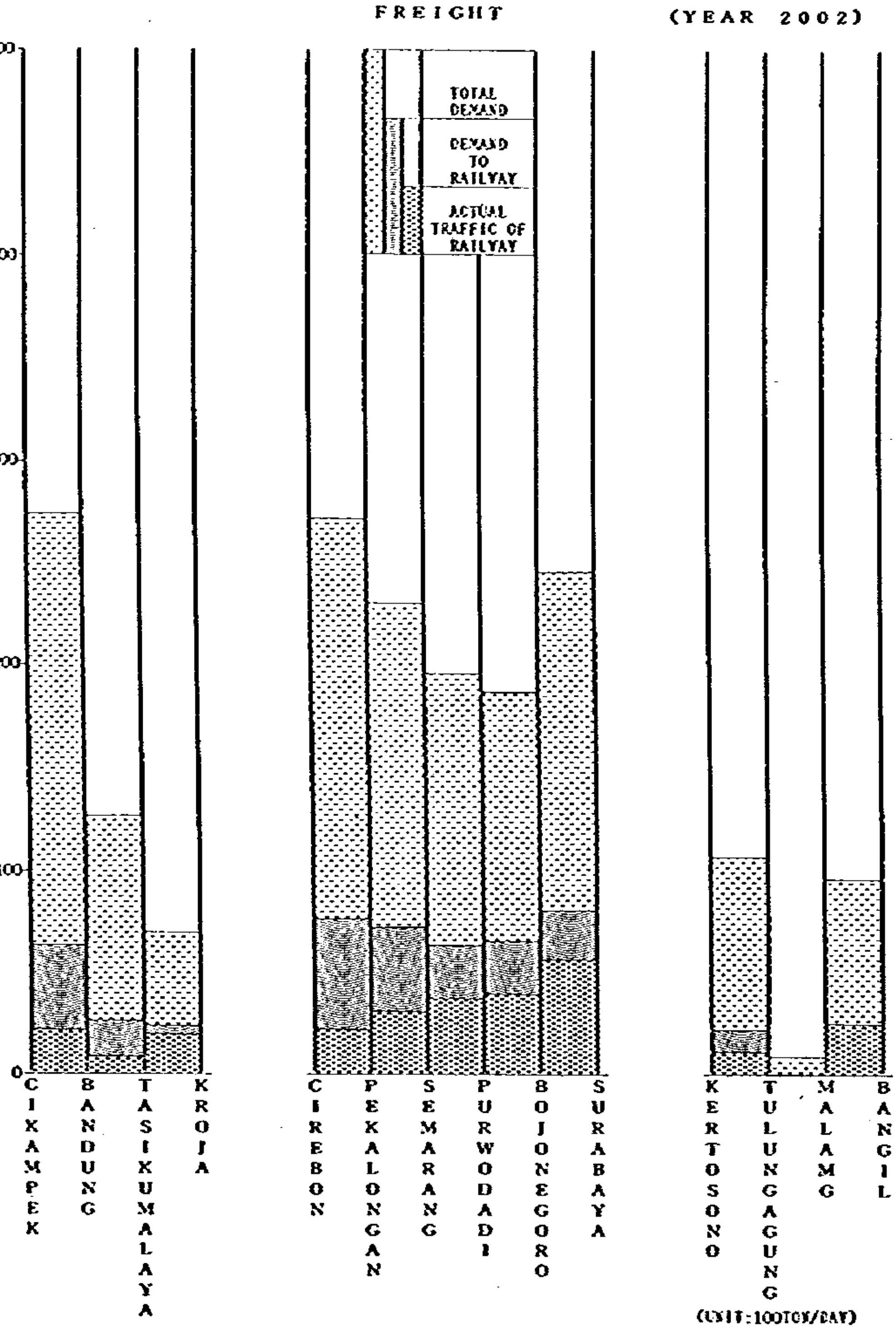
Note : The demand of main 9 articles were forecasted.

Fig. 2.3.15 RAILWAY LINK TRAFFIC



Note : The demand of main 9 articles were forecasted.

Fig. 2.3.16 RAILWAY LINK TRAFFIC



Note : The demand of main 9 articles were forecasted.

Fig. 2.3.17 Railway Link Traffic

TABLE 2.3.27 DAILY VEHICLE LINK TRAFFIC

(YEAR 1989)

LINK NO	RAILWAY TRAINS						HIGHWAY VEHICLES			
	PASSENGER		FREIGHT		TOTAL		BUS		TRUCK	
	WITH OUT	WITH	WITH OUT	WITH	WITH OUT	WITH	WITH OUT	WITH	WITH OUT	WITH
1	3.9	5.1	0.2	0.4	4.1	5.5	1447	1447	144	144
2	6.4	7.8	0.3	0.7	6.7	8.6	3281	3344	1129	1108
3	45.2	175.9	2.1	17.3	47.3	193.2	649	615	670	650
4	5.6	5.7	0.0	0.5	5.7	6.2	10176	7883	4840	4211
5	1.9	1.9	0.0	0.0	1.9	1.9	7737	6113	5902	4816
6	33.7	100.6	2.3	9.9	36.0	110.5	7468	5172	3551	2928
7	5.5	99.7	0.7	6.5	6.2	106.2	2936	2096	1006	1006
8	10.2	32.2	0.4	1.7	10.6	34.0	977	976	602	542
9	12.1	23.8	1.3	4.2	13.4	28.1	157	134	610	514
10	15.7	24.4	0.3	1.5	15.9	25.9	3818	2615	4959	4167
11	8.9	8.9	0.3	0.3	9.1	9.1	1934	1277	761	700
12	10.0	16,3	2.4	4.2	12.3	20.5	5995	5187	2623	2405
13	22.2	28.5	3.0	4.0	25.2	32.5	45	45	170	170
14	11.7	12.7	1.9	2.9	13.5	15.6	1392	1245	2278	2240
15	0.9	0.9	0.4	0.4	1.2	1.2	2859	2394	4596	4141
16	0.9	0.9	0.4	0.4	1.2	1.2	1406	1405	731	730
17	16.7	22.8	2.8	3.8	19.5	26.6	1615	1542	3213	3173
18	1.6	1.6	0.6	0.6	2.2	2.2	2273	1969	4272	3940
19	13.7	17.6	2.6	3.3	16.3	20.8	766	765	445	445
20	0.7	0.7	0.2	0.2	0.9	0.9	3916	3792	2526	2430
21	9.5	10.6	1.9	2.8	11.4	13.3	0	0	0	0
22	11.0	11.2	1.3	1.5	12.3	12.7	0	0	0	0
23	9.2	10.3	1.7	2.6	10.9	12.8	1984	1869	1881	1786
24	9.0	9.0	2.6	2.7	11.6	11.7	1166	1165	200	200
25	8.1	8.5	3.1	3.7	11.2	12.2	2338	2270	2174	2137
26	13.0	13.0	3.9	3.9	16.8	16.8	3350	3350	1918	1918
27	3.9	3.9	0.2	0.3	4.1	4.2	523	590	1984	1875
28	3.0	3.3	1.2	1.2	4.2	4.6	1957	1957	678	605
29	1.8	1.8	0.0	0.0	1.8	1.8	397	397	158	158
30	4.7	4.8	1.7	2.3	6.5	7.1	307	307	158	158
31	4.3	4.4	1.2	1.7	5.5	6.1	1548	1548	1269	1269
32	3.0	3.1	0.4	0.8	3.5	3.8	928	922	841	822
33	0.0	0.0	0.0	0.0	0.0	0.0	506	496	892	875
34	0.0	0.0	0.0	0.0	0.0	0.0	494	494	341	335
35	0.0	0.0	0.0	0.0	0.0	0.0	1701	1701	1375	1375
36	0.0	0.0	0.0	0.0	0.0	0.0	1515	1514	947	944
37	0.0	0.0	0.0	0.0	0.0	0.0	38	38	106	106
38	0.0	0.0	0.0	0.0	0.0	0.0	1725	1725	808	808
39	0.0	0.0	0.0	0.0	0.0	0.0	2132	2132	2290	2290
40	0.0	0.0	0.0	0.0	0.0	0.0	12	12	33	33
41	0.0	0.0	0.0	0.0	0.0	0.0	4463	4463	1965	1965
42	0.0	0.0	0.0	0.0	0.0	0.0	342	342	288	288
43	0.0	0.0	0.0	0.0	0.0	0.0	1796	1787	650	642
44	0.0	0.0	0.0	0.0	0.0	0.0	2443	2443	820	820
45	0.0	0.0	0.0	0.0	0.0	0.0	4505	4504	3581	3494
46	0.0	0.0	0.0	0.0	0.0	0.0	942	942	789	789
47	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
48	0.0	0.0	0.0	0.0	0.0	0.0	3912	3911	3450	3369
49	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
50	0.0	0.0	0.0	0.0	0.0	0.0	1922	1921	1851	1803
51	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
52	0.0	0.0	0.0	0.0	0.0	0.0	152	152	106	106
53	0.0	0.0	0.0	0.0	0.0	0.0	7728	7726	4869	4780

(BEFORE RESTRICTION BY RAILWAY CAPACITY)

Note : 1) Passenger railway trains for commuters were excluded.
2) Freight railway trains for intra zonal pairs were excluded and are only for main 9 articles.

TABLE 2.3.28 DAILY VEHICLE LINK TRAFFIC

(YEAR 1994)

LINK NO	RAILWAY TRAINS						HIGHWAY VEHICLES			
	PASSENGER		FREIGHT		TOTAL		BUS		TRUCK	
	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH
1	5.6	60.8	0.3	2.7	5.9	63.4	2090	1922	187	187
2	9.3	63.1	0.3	5.0	9.6	68.1	4886	3397	1493	1219
3	65.3	272.1	2.5	24.7	67.7	296.8	938	812	827	549
4	8.1	8.3	0.0	0.6	8.2	8.8	14704	11028	6374	5288
5	2.8	2.8	0.0	0.0	2.8	2.8	11180	6543	7676	6028
6	48.7	162.5	2.7	15.2	51.4	177.7	10792	7224	4714	3836
7	7.9	145.2	0.9	8.1	8.8	153.3	3028	3927	1286	1286
8	14.7	49.6	0.4	2.2	15.2	51.8	1412	1410	686	607
9	17.5	47.0	1.5	5.9	19.1	52.9	227	194	753	597
10	22.6	76.4	0.3	6.5	23.0	82.9	5517	3487	6454	5203
11	12.8	18.0	0.3	0.9	13.1	18.9	2794	1802	839	742
12	14.4	24.1	2.8	5.6	17.2	29.7	8663	7225	3437	3074
13	32.1	76.7	3.7	16.0	35.8	92.7	65	51	189	186
14	16.8	19.4	2.2	4.0	19.1	23.4	2012	1478	2890	2657
15	1.3	14.0	0.5	1.2	1.7	15.2	4132	2910	5774	4887
16	1.3	14.0	0.5	1.2	1.7	15.2	2031	1455	833	672
17	24.1	74.2	3.5	13.7	27.6	87.8	2333	1628	3926	2852
18	2.3	15.0	0.8	1.7	3.0	16.7	3285	2362	5287	4575
19	19.9	65.4	3.2	10.7	23.0	76.1	1107	801	527	432
20	1.0	1.0	0.3	0.5	1.3	1.5	5659	4613	3168	2714
21	13.7	16.3	2.3	3.9	16.0	20.2	0	0	0	0
22	15.9	61.7	1.6	7.0	17.5	68.6	0	0	0	0
23	13.3	18.0	2.1	3.6	15.4	21.7	2867	2319	2491	2043
24	13.0	72.3	3.2	9.3	16.2	81.6	1685	1493	240	239
25	11.7	47.9	3.7	12.1	15.4	60.0	3379	2521	2662	1921
26	18.8	97.7	4.7	14.2	23.5	111.9	4841	4311	2241	1765
27	5.7	22.3	0.2	2.2	5.9	24.5	755	713	2345	2151
28	4.4	9.5	1.4	2.6	5.8	12.1	2878	2828	755	710
29	2.6	4.9	0.0	0.0	2.6	5.0	443	443	175	175
30	6.9	46.9	2.1	8.0	8.9	54.9	443	443	175	175
31	6.2	34.4	1.4	5.1	7.6	39.6	2237	1268	1566	1189
32	4.4	18.8	0.5	2.1	4.9	21.0	1340	1050	1019	892
33	0.0	0.0	0.0	0.0	0.0	0.0	731	582	1029	870
34	0.0	0.0	0.0	0.0	0.0	0.0	714	714	412	403
35	0.0	0.0	0.0	0.0	0.0	0.0	2457	1432	1683	1326
36	0.0	0.0	0.0	0.0	0.0	0.0	2189	1552	1151	940
37	0.0	0.0	0.0	0.0	0.0	0.0	56	48	117	117
38	0.0	0.0	0.0	0.0	0.0	0.0	2493	2097	996	843
39	0.0	0.0	0.0	0.0	0.0	0.0	3081	2105	2824	2450
40	0.0	0.0	0.0	0.0	0.0	0.0	17	14	36	36
41	0.0	0.0	0.0	0.0	0.0	0.0	6149	5184	2512	1861
42	0.0	0.0	0.0	0.0	0.0	0.0	494	476	313	394
43	0.0	0.0	0.0	0.0	0.0	0.0	2596	2433	723	623
44	0.0	0.0	0.0	0.0	0.0	0.0	3531	3523	1025	900
45	0.0	0.0	0.0	0.0	0.0	0.0	6510	5497	4300	3658
46	0.0	0.0	0.0	0.0	0.0	0.0	1362	1173	857	766
47	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
48	0.0	0.0	0.0	0.0	0.0	0.0	5653	4806	4046	3561
49	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
50	0.0	0.0	0.0	0.0	0.0	0.0	2777	2344	2121	1899
51	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
52	0.0	0.0	0.0	0.0	0.0	0.0	220	164	118	116
53	0.0	0.0	0.0	0.0	0.0	0.0	11167	10192	5921	4976

(BEFORE RESTRICTION BY RAILWAY CAPACITY)

Note : 1) Passenger railway trains for commuters were excluded.
2) Freight railway trains for intra zonal pairs were excluded and are only for main 9 articles.

TABLE 2.3.29 DAILY VEHICLE LINK TRAFFIC

(YEAR 2002)

LINK NO	RAILWAY TRAINS						HIGHWAY VEHICLES			
	PASSENGER		FREIGHT		TOTAL		BUS		TRUCK	
	WITH OUT	WITH	WITH OUT	WITH	WITH OUT	WITH	WITH OUT	WITH	WITH OUT	WITH
1	8.3	91.0	0.4	3.8	8.7	94.8	3087	2839	252	252
2	13.8	94.5	0.4	7.1	14.2	101.5	7218	4986	2061	1675
3	96.4	447.7	3.1	40.2	99.5	487.9	1386	1197	1930	636
4	12.0	43.1	0.0	6.5	12.1	49.6	21725	14437	8792	6683
5	4.1	16.0	0.0	0.1	4.1	16.1	16518	12192	10465	7664
6	71.9	264.4	3.4	26.3	75.3	290.7	15945	9738	6555	5201
7	11.7	255.1	1.1	12.6	12.8	267.7	4474	3547	1719	1205
8	21.8	157.6	0.6	5.0	22.3	162.6	2087	1725	800	537
9	25.9	113.2	1.9	15.1	27.8	128.3	336	279	911	590
10	33.4	127.3	0.4	8.8	33.9	136.1	8152	4701	8815	6491
11	19.0	48.1	0.4	4.8	19.4	52.9	4128	2313	936	653
12	21.3	59.9	3.4	14.1	24.7	74.1	12800	8218	4714	3976
13	47.4	130.8	4.8	21.9	52.3	152.7	96	48	209	201
14	24.9	69.4	2.9	12.7	27.8	82.1	2973	1639	3811	3103
15	1.9	59.9	0.6	2.1	2.5	62.0	6105	3957	7610	5467
16	1.9	59.9	0.6	2.1	2.5	62.0	3001	1889	984	694
17	35.7	122.3	4.6	18.8	40.2	141.1	3448	2075	5016	3521
18	3.3	62.1	1.0	2.9	4.3	65.0	4853	2544	6854	4985
19	29.3	125.1	4.2	14.9	33.5	140.0	1635	865	650	466
20	1.4	2.2	0.4	0.7	1.8	3.0	8361	5198	4142	3427
21	20.3	69.1	2.9	13.0	23.2	73.1	0	0	0	0
22	23.5	96.2	2.2	9.4	25.7	105.6	0	0	0	0
23	19.6	61.0	2.7	16.3	22.4	77.3	4236	2652	3197	2658
24	19.2	113.8	4.2	12.4	23.4	126.2	2490	1672	295	293
25	17.3	133.4	4.6	24.0	22.0	157.4	4992	3591	3409	2409
26	27.7	161.6	6.2	19.9	33.9	181.5	7153	6297	2707	2084
27	8.4	58.0	0.3	4.2	8.7	62.1	1116	566	2926	1769
28	6.5	31.3	1.8	5.1	8.2	36.4	4179	3668	937	814
29	3.8	35.2	0.0	-0.1	3.8	35.3	655	642	193	191
30	10.1	136.6	2.6	16.9	12.8	153.5	655	642	193	191
31	9.2	119.1	1.8	13.1	11.0	132.2	3305	1864	2027	1528
32	6.5	69.7	0.7	6.3	7.2	76.1	1989	1516	1275	1105
33	0.0	0.0	0.0	0.0	0.0	0.0	1080	518	1227	955
34	0.0	0.0	0.0	0.0	0.0	0.0	1056	698	516	403
35	0.0	0.0	0.0	0.0	0.0	0.0	3631	2048	2157	1654
36	0.0	0.0	0.0	0.0	0.0	0.0	3234	2264	1453	1173
37	0.0	0.0	0.0	0.0	0.0	0.0	82	59	128	127
38	0.0	0.0	0.0	0.0	0.0	0.0	3683	2691	1281	945
39	0.0	0.0	0.0	0.0	0.0	0.0	4552	2657	3648	2640
40	0.0	0.0	0.0	0.0	0.0	0.0	25	16	40	40
41	0.0	0.0	0.0	0.0	0.0	0.0	9528	7263	3363	2372
42	0.0	0.0	0.0	0.0	0.0	0.0	730	480	340	324
43	0.0	0.0	0.0	0.0	0.0	0.0	3835	2700	823	634
44	0.0	0.0	0.0	0.0	0.0	0.0	5217	5145	1339	1002
45	0.0	0.0	0.0	0.0	0.0	0.0	9619	6393	5406	3744
46	0.0	0.0	0.0	0.0	0.0	0.0	2012	1444	939	794
47	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
48	0.0	0.0	0.0	0.0	0.0	0.0	8352	5055	4947	3487
49	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
50	0.0	0.0	0.0	0.0	0.0	0.0	4103	2265	2517	1757
51	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
52	0.0	0.0	0.0	0.0	0.0	0.0	326	184	129	127
53	0.0	0.0	0.0	0.0	0.0	0.0	16499	13461	7484	5273

(BEFORE RESTRICTION BY RAILWAY CAPACITY)

Note : 1) Passenger railway trains for commuters were excluded.

2) Freight railway trains for intra zonal pairs were excluded and are only for main 9 articles.

TABLE 2.3.30 DAILY VEHICLE LINK TRAFFIC

(YEAR 1989)

LINK NO	RAILWAY TRAINS						HIGHWAY VEHICLES			
	PASSENGER		FREIGHT		TOTAL		BUS		TRUCK	
	WITH OUT	WITH	WITH OUT	WITH	WITH OUT	WITH	WITH OUT	WITH	WITH OUT	WITH
1	3.9	5.0	0.2	0.4	4.1	5.3	1447	1447	144	144
2	6.4	7.7	0.3	0.7	6.7	8.3	3381	3348	1129	1112
3	45.2	156.4	2.1	14.8	47.3	171.2	649	645	690	655
4	5.6	5.7	0.0	0.4	5.7	6.1	10176	8181	4840	4283
5	1.9	1.9	0.0	0.0	1.9	1.9	7737	6400	5902	5030
6	33.7	81.9	2.3	7.7	36.0	89.6	7468	5470	3551	3005
7	5.5	85.0	0.7	5.9	6.2	90.9	2096	2096	1006	1006
8	10.2	23.6	0.4	1.2	10.6	24.8	977	976	602	548
9	12.1	20.5	1.3	3.4	13.4	24.0	157	135	640	520
10	15.7	22.0	0.3	1.2	15.9	23.1	3818	2952	4959	4389
11	8.9	8.9	0.3	0.3	9.1	9.1	1934	1461	761	717
12	10.0	14.5	2.4	3.7	12.3	18.2	5995	5486	2623	2484
13	22.2	26.7	3.0	3.7	25.2	30.5	45	45	170	170
14	11.7	12.4	1.9	2.6	13.5	15.0	1392	1286	2298	2256
15	0.9	0.9	0.4	0.4	1.2	1.2	2859	2524	4596	4268
16	0.9	0.9	0.4	0.4	1.2	1.2	1406	1405	731	730
17	16.7	21.1	2.8	3.6	19.5	24.6	1615	1562	3213	3184
18	1.6	1.6	0.6	0.6	2.2	2.2	2273	2054	4272	4033
19	13.7	16.5	2.6	3.1	16.3	19.6	766	766	445	445
20	0.7	0.7	0.2	0.2	0.9	0.9	3916	3827	2526	2457
21	9.5	10.3	1.9	2.5	11.4	12.8	0	0	0	0
22	11.0	11.2	1.3	1.4	12.3	12.6	0	0	0	0
23	9.2	10.0	1.7	2.3	10.9	12.3	1984	1894	1881	1813
24	9.0	9.0	2.6	2.7	11.6	11.7	1166	1166	200	200
25	8.1	8.4	3.1	3.6	11.2	11.9	2338	2289	2174	2148
26	13.0	13.0	3.9	3.9	16.8	16.8	3350	3350	1918	1918
27	3.9	3.9	0.2	0.3	4.1	4.2	523	506	1984	1986
28	3.0	3.3	1.2	1.2	4.2	4.5	1957	1957	628	611
29	1.8	1.8	0.0	0.0	1.8	1.8	397	307	158	158
30	4.7	4.8	1.7	2.2	6.5	7.0	307	307	158	158
31	4.3	4.3	1.2	1.6	5.5	5.9	1548	1548	1269	1269
32	3.0	3.1	0.4	0.7	3.5	3.7	928	923	841	827
33	0.0	0.0	0.0	0.0	0.0	0.0	536	497	872	880
34	0.0	0.0	0.0	0.0	0.0	0.0	494	494	341	337
35	0.0	0.0	0.0	0.0	0.0	0.0	1701	1701	1375	1375
36	0.0	0.0	0.0	0.0	0.0	0.0	1515	1514	947	945
37	0.0	0.0	0.0	0.0	0.0	0.0	38	38	106	106
38	0.0	0.0	0.0	0.0	0.0	0.0	1725	1725	808	808
39	0.0	0.0	0.0	0.0	0.0	0.0	2132	2132	2290	2290
40	0.0	0.0	0.0	0.0	0.0	0.0	12	12	33	33
41	0.0	0.0	0.0	0.0	0.0	0.0	4463	4463	1965	1965
42	0.0	0.0	0.0	0.0	0.0	0.0	342	342	288	288
43	0.0	0.0	0.0	0.0	0.0	0.0	1796	1787	650	644
44	0.0	0.0	0.0	0.0	0.0	0.0	2443	2443	820	820
45	0.0	0.0	0.0	0.0	0.0	0.0	4505	4504	3581	3519
46	0.0	0.0	0.0	0.0	0.0	0.0	942	942	789	789
47	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
48	0.0	0.0	0.0	0.0	0.0	0.0	3912	3911	3458	3392
49	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
50	0.0	0.0	0.0	0.0	0.0	0.0	1922	1921	1851	1816
51	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
52	0.0	0.0	0.0	0.0	0.0	0.0	152	152	106	106
53	0.0	0.0	0.0	0.0	0.0	0.0	7728	7727	4869	4885

(AFTER RESTRICTION BY RAILWAY CAPACITY)

Note : 1) Passenger railway trains for commuters were excluded.
2) Freight railway trains for intra zonal pairs were excluded and are only for main 9 articles.

TABLE 2.3.31 DAILY VEHICLE LINK TRAFFIC

(YEAR 1994)

LINK NO	RAILWAY TRAINS						HIGHWAY VEHICLES			
	PASSENGER		FREIGHT		TOTAL		BUS		TRUCK	
	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH
1	5.6	57.4	0.3	2.4	5.9	61.8	2090	1922	187	187
2	9.3	61.6	0.3	4.7	9.6	66.2	4886	3441	1493	1245
3	65.3	192.4	2.5	15.1	67.7	207.6	938	815	827	573
4	8.1	8.2	0.0	0.5	8.2	8.7	14704	12261	6374	5580
5	2.8	2.8	0.0	0.0	2.8	2.8	11180	9597	7676	6826
6	48.7	88.5	2.7	6.9	51.4	95.3	10772	8458	4714	4151
7	7.9	92.4	0.9	6.0	8.8	98.4	3028	3027	1286	1286
8	14.7	24.1	0.4	0.9	15.2	25.1	1412	1411	686	628
9	17.5	26.1	1.5	2.8	19.1	28.9	227	200	753	622
10	22.6	49.1	0.3	3.7	23.0	52.8	5517	4811	6454	6034
11	12.8	15.6	0.3	0.8	13.1	16.5	2794	2452	839	810
12	14.4	17.3	2.8	3.6	17.2	20.9	8663	8236	3437	3324
13	32.1	56.2	3.7	13.6	35.8	69.8	65	57	189	186
14	16.8	18.0	2.2	2.8	19.1	20.8	2012	1791	2890	2763
15	1.3	14.0	0.5	1.2	1.7	15.2	4132	3747	5774	5186
16	1.3	14.0	0.5	1.2	1.7	15.2	2031	1603	833	641
17	24.1	57.7	3.5	11.3	27.6	69.0	2333	1823	3726	2936
18	2.3	15.0	0.8	1.7	3.0	16.7	3285	2784	5287	5046
19	19.9	54.9	3.2	8.9	23.0	63.8	1107	985	527	432
20	1.0	1.0	0.3	0.5	1.3	1.5	5659	5043	3168	2936
21	13.7	14.9	2.3	2.8	16.0	17.7	0	0	0	0
22	15.9	60.9	1.6	6.2	17.5	67.1	0	0	0	0
23	13.3	16.7	2.1	2.6	15.4	19.3	2867	2645	2401	2265
24	13.0	72.0	3.2	8.9	16.2	80.9	1685	1493	240	239
25	11.7	44.0	3.7	10.8	15.4	54.7	3379	2708	2662	1999
26	18.8	97.4	4.7	14.1	23.5	111.6	4841	4312	2241	1791
27	5.7	22.3	0.2	1.9	5.9	24.2	755	742	2345	2284
28	4.4	8.7	1.4	2.5	5.8	11.2	2828	2828	755	730
29	2.6	4.9	0.0	0.0	2.6	5.0	443	443	175	175
30	6.9	42.9	2.1	6.7	8.9	49.6	443	443	175	175
31	6.2	31.6	1.4	4.1	7.6	35.7	2237	1268	1566	1189
32	4.4	17.3	0.5	1.6	4.9	18.9	1340	1070	1019	945
33	0.0	0.0	0.0	0.0	0.0	0.0	731	598	1029	915
34	0.0	0.0	0.0	0.0	0.0	0.0	714	714	412	409
35	0.0	0.0	0.0	0.0	0.0	0.0	2457	1432	1683	1306
36	0.0	0.0	0.0	0.0	0.0	0.0	2189	1556	1151	950
37	0.0	0.0	0.0	0.0	0.0	0.0	56	48	117	117
38	0.0	0.0	0.0	0.0	0.0	0.0	2493	2097	976	843
39	0.0	0.0	0.0	0.0	0.0	0.0	3081	2106	2824	2450
40	0.0	0.0	0.0	0.0	0.0	0.0	17	14	36	36
41	0.0	0.0	0.0	0.0	0.0	0.0	6449	5184	2512	1861
42	0.0	0.0	0.0	0.0	0.0	0.0	494	477	313	305
43	0.0	0.0	0.0	0.0	0.0	0.0	2596	2451	723	640
44	0.0	0.0	0.0	0.0	0.0	0.0	3531	3523	1025	980
45	0.0	0.0	0.0	0.0	0.0	0.0	6510	5690	4300	3818
46	0.0	0.0	0.0	0.0	0.0	0.0	1362	1191	857	775
47	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
48	0.0	0.0	0.0	0.0	0.0	0.0	5653	4892	4046	3698
49	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
50	0.0	0.0	0.0	0.0	0.0	0.0	2777	2389	2121	1973
51	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
52	0.0	0.0	0.0	0.0	0.0	0.0	220	164	118	116
53	0.0	0.0	0.0	0.0	0.0	0.0	11167	10290	5901	5138

(AFTER RESTRICTION BY RAILWAY CAPACITY)

Note : 1) Passenger railway trains for commuters were excluded.

2) Freight railway trains for intra zonal pairs were excluded and are only for main 9 articles.

TABLE 2.3.32 DAILY VEHICLE LINK TRAFFIC

(YEAR 2002)

LINK NO	RAILWAY TRAINS						HIGHWAY VEHICLES			
	PASSENGER		FREIGHT		TOTAL		BUS		TRUCK	
	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH
1	8.3	67.6	0.4	2.5	8.7	70.0	3087	2379	252	252
2	13.8	72.7	0.4	5.3	14.2	78.0	7218	5629	2061	1818
3	96.4	208.8	3.1	13.9	99.5	222.7	1385	1207	1030	797
4	12.0	43.0	0.0	5.9	12.1	48.8	21725	18761	8792	7586
5	4.1	15.7	0.0	0.0	4.1	15.8	16518	15023	10465	9732
6	71.9	85.4	3.4	5.0	75.3	90.4	15945	14971	6555	6174
7	11.7	77.2	1.1	4.8	12.8	82.0	4474	3547	1719	1265
8	21.8	53.0	0.6	1.6	22.3	54.6	2087	1736	800	638
9	25.9	63.5	1.9	3.9	27.8	67.4	336	314	911	702
10	33.4	82.0	0.4	3.3	33.9	85.4	8152	7910	8815	8653
11	19.0	33.6	0.4	3.9	19.4	37.6	4128	3980	936	914
12	21.3	31.0	3.4	5.5	24.7	36.5	12800	11818	4714	4582
13	47.4	80.8	4.8	14.1	52.3	94.9	96	53	207	202
14	24.9	61.3	2.9	6.9	27.8	68.2	2973	2561	3811	3378
15	1.9	55.8	0.6	1.7	2.5	57.5	6165	5224	7610	7321
16	1.9	55.8	0.6	1.7	2.5	57.5	3801	2002	924	728
17	35.7	70.6	4.6	11.0	40.2	81.6	3418	2847	5016	4021
18	3.3	58.0	1.0	2.3	4.3	60.4	4853	4161	6854	6534
19	29.3	90.4	4.2	8.7	33.5	99.0	1635	1024	650	521
20	1.4	2.2	0.4	0.6	1.8	2.9	8361	6141	4142	3949
21	20.3	52.1	2.9	7.7	23.2	59.7	0	0	0	0
22	23.5	67.5	2.2	5.1	25.7	72.6	0	0	0	0
23	19.6	50.3	2.7	11.1	22.4	61.4	4236	3446	3197	3135
24	19.2	69.7	4.2	7.8	23.4	77.5	2490	1672	295	293
25	17.3	57.6	4.6	12.8	22.0	70.4	4992	4326	3109	2853
26	27.7	91.0	6.2	12.6	33.9	103.6	7153	6503	2707	2361
27	8.4	39.1	0.3	2.0	8.7	41.1	1116	733	2985	2433
28	6.5	19.5	1.8	4.8	8.2	24.3	4179	3670	937	989
29	3.8	34.6	0.0	0.1	3.8	34.7	655	642	193	192
30	10.1	48.0	2.6	6.0	12.8	54.0	655	642	193	192
31	9.2	45.5	1.8	4.3	11.0	49.8	3305	2687	2027	1785
32	6.5	25.6	0.7	1.9	7.2	27.5	1980	1560	1275	1225
33	0.0	0.0	0.0	0.0	0.0	0.0	1880	655	1227	1145
34	0.0	0.0	0.0	0.0	0.0	0.0	1456	678	516	430
35	0.0	0.0	0.0	0.0	0.0	0.0	3631	2865	2157	1913
36	0.0	0.0	0.0	0.0	0.0	0.0	3234	2698	1453	1324
37	0.0	0.0	0.0	0.0	0.0	0.0	82	62	128	128
38	0.0	0.0	0.0	0.0	0.0	0.0	3683	3201	1281	1119
39	0.0	0.0	0.0	0.0	0.0	0.0	4552	3694	3618	2920
40	0.0	0.0	0.0	0.0	0.0	0.0	25	21	40	40
41	0.0	0.0	0.0	0.0	0.0	0.0	9528	8441	3363	2887
42	0.0	0.0	0.0	0.0	0.0	0.0	730	503	340	335
43	0.0	0.0	0.0	0.0	0.0	0.0	3835	2883	823	765
44	0.0	0.0	0.0	0.0	0.0	0.0	5217	5147	1339	1082
45	0.0	0.0	0.0	0.0	0.0	0.0	9619	8654	5486	5026
46	0.0	0.0	0.0	0.0	0.0	0.0	2012	1842	939	895
47	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
48	0.0	0.0	0.0	0.0	0.0	0.0	8352	7264	4947	4619
49	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
50	0.0	0.0	0.0	0.0	0.0	0.0	4193	3530	2517	2357
51	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
52	0.0	0.0	0.0	0.0	0.0	0.0	326	257	129	128
53	0.0	0.0	0.0	0.0	0.0	0.0	16493	15544	7484	6554

(AFTER RESTRICTION BY RAILWAY CAPACITY)

Note : 1) Passenger railway trains for commuters were excluded.
2) Freight railway trains for intra zonal pairs were excluded and are only for main 9 articles.

TABLE 2.3.33 EVALUATION FACTORS

(YEAR 1989)

ARTICLE	TOTAL TIME SAVING OF (UNIT 1000HOURS)		TOTAL RAILWAY PASSENGER (OR TON) KM OF (UNIT 10000PASSENGER OR TON KMS)	
	DIVERTED TRAFFIC	NORMAL TRAFFIC	"WITHOUT "	"WITH"
PASSENGER	12797	45261	752585	1486977
RICE	0	93	1956	4042
MAIZE	0	542	7994	13305
SUGAR	0	58	737	1469
SALT	0	120	1283	1798
PAPER	0	6	66	309
STEEL	0	182	2240	3653
PETROLEUM PRODUCTS	0	356	15661	32690
FERTILIZER	0	1031	14835	19714
CEMENT	0	146	15757	45306
TOTAL	12797	47806	60528	123486

REDUCTION IN HIGHWAY TRAFFIC (10000 VEHICLE KMS) "BUS " = 28351.2 "TRUCK " = 15006.82

(YEAR 1994)

ARTICLE	TOTAL TIME SAVING OF (UNIT 1000HOURS)		TOTAL RAILWAY PASSENGER (OR TON) KM OF (UNIT 10000PASSENGER OR TON KMS)	
	DIVERTED TRAFFIC	NORMAL TRAFFIC	"WITHOUT "	"WITH"
PASSENGER	49399	144247	1087486	2336067
RICE	0	288	2176	8225
MAIZE	0	763	8174	16294
SUGAR	0	124	841	2729
SALT	0	146	1382	1979
PAPER	0	9	86	492
STEEL	0	354	3272	5315
PETROLEUM PRODUCTS	0	2168	18458	69846
FERTILIZER	0	2777	18396	44624
CEMENT	0	2631	20774	71531
TOTAL	49399	153507	73558	221035

REDUCTION IN HIGHWAY TRAFFIC (10000 VEHICLE KMS) "BUS " = 70111.06 "TRUCK " = 33594.04

(YEAR 2002)

ARTICLE	TOTAL TIME SAVING OF (UNIT 1000HOURS)		TOTAL RAILWAY PASSENGER (OR TON) KM OF (UNIT 10000PASSENGER OR TON KMS)	
	DIVERTED TRAFFIC	NORMAL TRAFFIC	"WITHOUT "	"WITH"
PASSENGER	55859	362184	1606770	4258565
RICE	0	470	2398	8356
MAIZE	0	1597	8415	15430
SUGAR	0	196	1002	3068
SALT	0	291	1548	2065
PAPER	0	20	119	327
STEEL	0	547	4922	6164
PETROLEUM PRODUCTS	0	4027	22932	85095
FERTILIZER	0	4982	24032	71770
CEMENT	0	5441	26692	76087
TOTAL	55859	380155	94060	268373

REDUCTION IN HIGHWAY TRAFFIC (10000 VEHICLE KMS) "BUS " = 98259.42 "TRUCK " = 39411.14

(AFTER RESTRICTIONS BY RAILWAY CAPACITY)

Note : Total of the column "TOTAL RAILWAY PASSENGER (OR TON) KM OF " is only the total of FREIGHT.

CHAPTER 3 TRAIN OPERATION PROGRAM

CHAPTER 3 TRAIN OPERATION PROGRAM

3.1 Present Status

3.1.1 Train Operation

(1) Train operation route

The present operation routes for express passenger trains and high-speed passenger trains (based on the train diagram revised on May 27, 1982) are shown in Fig. 3.1.1. The routes primarily set major trains connecting the 3 large cities of Jakarta, Bandung and Surabaya, as well as many trains connecting such cities as Semarang, Yogyakarta, Solo and Blitar, etc., with which the above 3 large cities are also connected.

Fig. 3.1.2 shows the operations routes of BT and TRS freight trains. The routes set four (4) express freight trains, namely BT 1 and 2 the connecting Jakarta and Surabaya and BT 3 and 4 running on the Merak line. Passenger trains connecting Jakarta and Surabaya primarily run on the south line, but freight trains are scheduled to run primarily on the north line. Major freight terminals are established at Cipinang, Semarang, Surabaya, Bandung, Cilacap, Solo and Merak.

(2) No. of trains

The number of trains classified by the Link No. set forth in the Forecast of Traffic Demand (based on the train diagram revised on May 27, 1982) is shown in Table 3.1.1.

While the number of passenger and freight trains, including nonregular trains, which run on the south line connecting Jakarta, Kroya and Surabaya is about 35, the number of trains running on the north line connecting Jakarta, Semarang and Surabaya is about 25. From this fact, it is known that passengers and goods are primarily transported on the south line. The line between Jakarta and Bandung has become an important transport section despite its steep slope, since about 30 trains are scheduled on it. In addition, those railway lines which have a relatively large number of trains, about 20 each, include the Jakarta and Rangkasbitung, Jakarta and Sukabumi and Surabaya and Jember lines.

Classified by type of trains, scheduled passenger trains are primarily composed of express and fast trains and the number of ordinary (non-express) trains is small. In the freight train category, only 4 express freight trains are scheduled. Many nonregular trains are scheduled and they comprise about 1/5 to 1/3 of the total number of passenger and freight trains.

Most ordinary trains are mixed trains.

(3) No. of cars of composed trains and traction weights

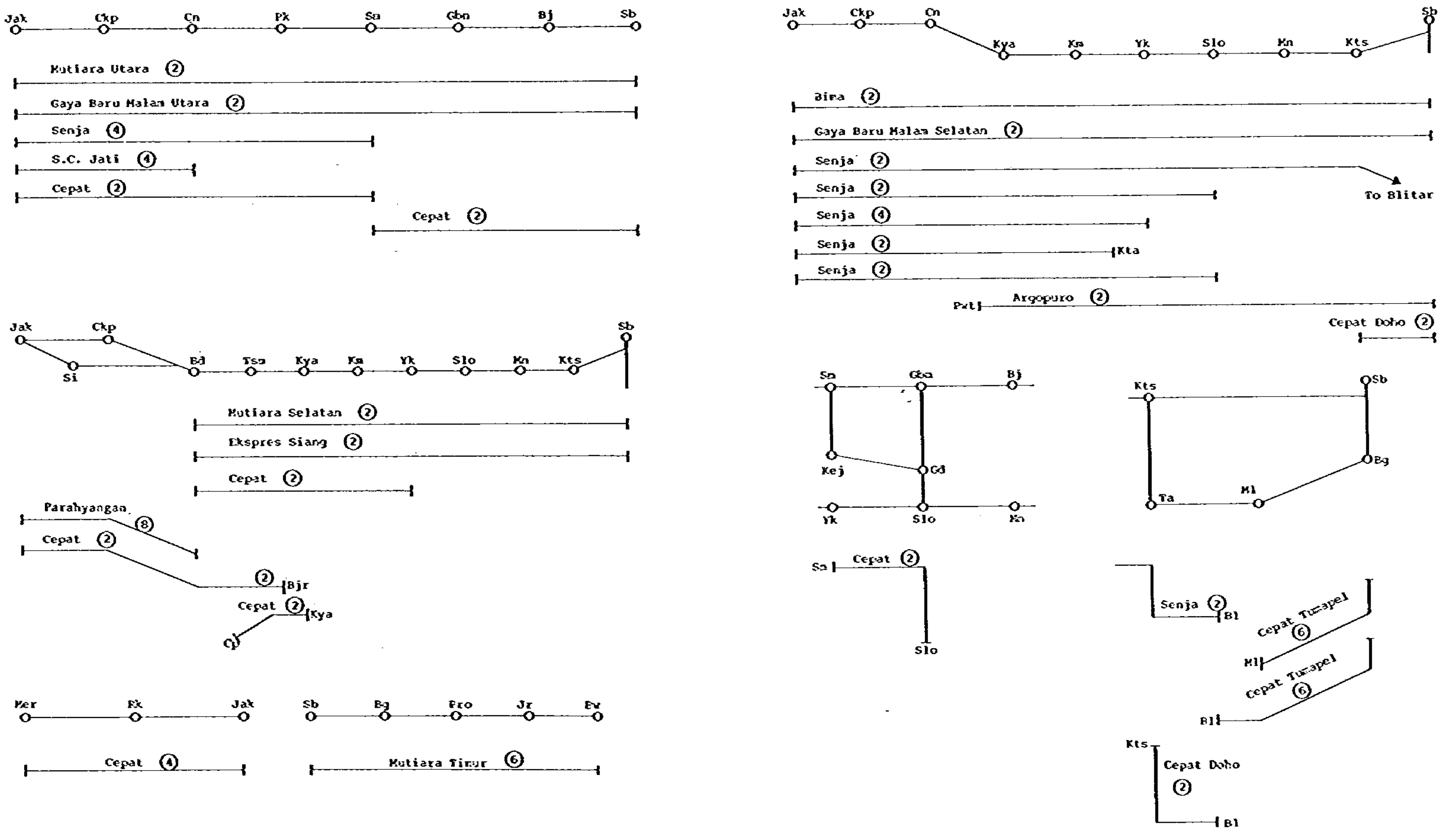
Table 3.1.2 shows the number of cars of trains and the traction weight of each train. The maximum number of cars of trains is 11 cars and the maximum train weight is 420t. The minimums are 4 cars and 140t. Most ordinary passenger trains have an operating distance of less than 150km and they are composed of a small number of cars, from 1 to 4.

The traction weight of freight trains is from 300 to 1,000 tons and many freight trains are about 500 tons. Since the power of a diesel locomotive is relatively small, some trains running on slopes tract half of the normal weight rated for that type of train.

(4) Running time and running speed

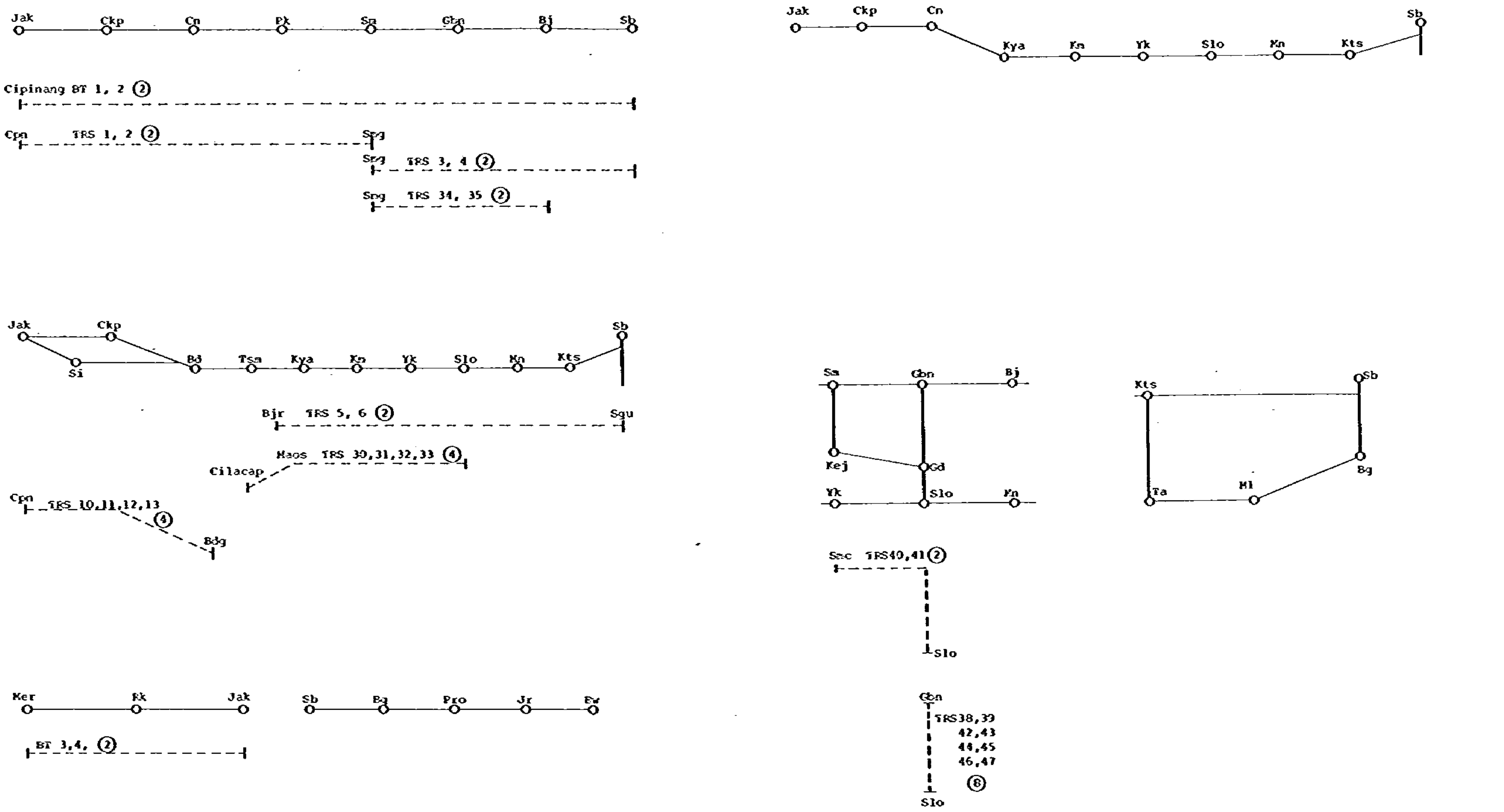
The maximum running speed of the current trains is limited to 40 to 80 km/h, depending on the section of track. For instance, in the case of the north line, the section between Jakarta and Pekalongan is 80 km/h, but the section between Semarang and Surabaya is limited to 60 km/h. The scheduled speeds of the current trains are likewise low because the maximum speed of trains is limited to a low speed, most lines are single track, stopping time is long, the power of the locomotives is small, etc.

Table 3.1.3 shows the scheduled running speeds of major express and fast passenger trains, express freight trains. The scheduled speed of one of the representative trains, Bima, is 50 km/h; other trains run at about 40 km/h. An express freight train, BT 1, runs at a speed of less than 30 km/h. Since express trains running between Jakarta and Surabaya or between Bandung and Surabaya take about 16 hours, it is



Note: (1) For instance, ⑥ means the number of trains in both directions per day.

Fig. 3.1.1 Operation Routes of Express and Fast Passenger Trains



Note: (1) For instance, ② means the number of trains in both directions per day.

Fig. 3.1.2 Operation Routes of Freight Trains (BT, TRS train)

Table 3.1.1 Number of Trains by Section (May, 1982)

Link No.	Section	Passenger train				Freight train			Work train	Total	Remarks
		Express	Fast	Ordinary	Sub-total	Express	Ordinary	Sub-total			
1	Merak ∿ Rangkasbitung	0	4	4	8	2	2	4	2	14	
2	Rangkasbitung ∿ Jakarta	0	8	4	12	2	6	8	0	20	(1) Each figure shows the number of trains in both directions per day.
3	Jakarta ∿ Cikampek	30(4)	4	12	46(4)	2	2	4	0	50(4)	
4	Jakarta ∿ Sukabumi	0	8	8	16	0	4(2)	4(2)	0	20(2)	
5	Sukabumi ∿ Bandung	0	0	6	6	0	4(2)	4(2)	0	10(2)	
6	Cikampek ∿ Cirebon	32(6)	4	2	38(6)	2	6(3)	8(3)	0	46(9)	(2) Figures in parentheses show the number of nonregular trains included.
7	Cikampek ∿ Bandung	17(7)	0	8	25(7)	0	4	4	2	31(7)	
8	Bandung ∿ Tasikumalaya	4	4	4(2)	12(2)	0	4	4	2(2)	18(4)	
9	Cirebon ∿ Pekalongan	14(6)	2	2	18(6)	2	6(2)	8(2)	0	26(8)	
10	Cirebon ∿ Kroya	20(6)	4	0	24(6)	0	6(2)	6(2)	2	32(8)	
11	Tasikumalaya ∿ Kroya	4	4	4	12	0	5	5	0	17	
12	Pekalongan ∿ Semarang	14(6)	2	2	18(6)	2	6(2)	8(2)	0	26(8)	
13	Kroya ∿ Kebumen	23(5)	6	2	31(5)	0	8(2)	8(2)	0	39(7)	
14	Semarang ∿ Gambringan	10(6)	4	4	18(6)	2	6(2)	8(2)	0	26(8)	
15	Semarang ∿ Kedungjati	0	0	2	2	0	2	2	0	4	
16	Kedungjati ∿ Gundih	0	0	4	4	0	0	0	0	4	
17	Kebumen ∿ Yogyakarta	21(5)	6	2	29(5)	0	8(2)	8(2)	0	37(7)	
18	Gundih ∿ Solo	2(2)	2	0	4(2)	0	10	10	0	14(2)	
19	Yogyakarta ∿ Solo	19(5)	4	3(1)	26(6)	0	6	6	0	32(6)	
20	Gambringan ∿ Gundih	2(2)	2	0	4(2)	0	8(2)	8(2)	0	12(4)	
21	Gambringan ∿ Bojonegoro	8(4)	2	4	14(4)	2	8(2)	10(2)	0	24(6)	
22	Solo ∿ Madiun	15(5)	2	4	21(5)	0	8	8	0	29(5)	
23	Bojonegoro ∿ Surabaya	8(4)	2	2	12(4)	2	6(2)	8(2)	0	20(6)	
24	Madiun ∿ Kertosono	15(5)	2	2	19(5)	0	8	8	0	27(5)	
25	Surabaya ∿ Bangil	4	16(2)	0	20(2)	0	11(5)	11(5)	0	31(7)	
26	Surabaya ∿ Kertosono	13(5)	4	8	25(5)	0	12(2)	12(2)	0	37(7)	
27	Kertosono ∿ Tulungagung	2	2	6	10	0	4(2)	4(2)	0	14(2)	
28	Bangil ∿ Malang	0	14(2)	0	14(2)	0	10	10	0	24(2)	
29	Malang ∿ Tulungagung	0	6	0	6	0	4(2)	4(2)	0	10(2)	
30	Bangil ∿ Probolinggo	4	2	0	6	0	8(4)	8(4)	0	14(4)	
31	Probolinggo ∿ Jember	4	2	2	8	0	14(2)	14(2)	0	22(2)	
32	Jember ∿ Banyuwangi	4	0	4	8	0	5(3)	5(3)	0	13(2)	

Table 3.1.2 No. of Cars of Major Trains and Passenger Car Depots

Passenger train depot	Name of train	Train operating section	Operating distance	Number of composed trains used	Number of cars composed	Train weight	No. of cars of depot
			km			t	
Jakarta Kota	Bima	Sgu~Jak	825	2	9	355	
	Mutiara Utara	Sbi~Jak	725	2	8	420	
	Senja Kta	Kta~Pse	447	1	9	324	
	Senja Ek Slo	Slo~Gmr	570	2	6	215	
	Cepat	Tbs~Mer	142	1	6	215	
	Cepat	Jak~Mer	152	1	6	215	
	Sub-total						122
Cirebon	Gunung Jati	Cn~Jak	219	2	7	252	
	Sub-total						19
Bandung	Mutiara S	Sb~Bd	699	2	9	365	
	Parahyangan	Bd~Jak	173	2	7	266	
	Parahyangan	Bd~Gmr	165	1	8	291	
	Parahyangan	Bd~Jak	173	1	7	256	
	Cepat	Bd~Yk	385	2	9	315	
	Cepat	Bd~Bjr	321	2	8	280	
	Sub-total						120
Semarang Tawang	Senja EK Smt	Smt~Pse	439	2	9	335	
	Senja UT Smt	Smt~Pse	439	2	6	224	
	Cepat	Tgk~Smt~Pse	449	2	7	265	
	Cepat	Smt~Sbi	280	2	6	210	
	Pandanaran	Yk~Slo~Smc	173	1	4	159	
	Sub-total						86
Yogyakarta	Senja Ek Yk	Yk~Gmr	512	2	11	420	
	Senja UT Slo	Slo~Gmr	571	2	9	420	
	Cepat	Tgk~Slo	550	2	8	420	
	Sub-total						80
Madiun	Tatar	Bl~Gmr	829	2	11	394	
	(Cadangan)	Mn~Bl	163	1	4	143	
	Sub-total						39
Sidotopo	GBM/Utara	Sbi~Pse	719	2	11	395	
	GBM/Selatan	Sgu~Gmr	835	2	10	358	
	Ekspres Siang	Sb~Bd	699	2	8	286	
	Mutiara T	Sb~Bw	300	2	6	217	
	Dobo	Bl~Kts~Sb	180	1	4	144	
	Tumapel	Ml~Sb	169	1	4	144	
	Tumapel	Sb~Ml	169	1	4	144	
	Tumapel	Ml~Sb	55	1	4	144	
	Sub-total						132
Jember	Argopuro	Pwt~Sb~Jr	675	1	8	287	
	Argopuro	Jr~Sb~Pwt	675	1	8	287	
	Sub-total						23
TOTAL							629

Table 3.1.3 Scheduled Running Speeds of Major Trains

Name of train	Operating section	Distance of Section (km)	Time required (hour, min)	Scheduled running Speed(km/h)
Bima	Jak ∿ Sgu	829.8	16^{h} 30^{m}	50.3
Mutiara II	Jak ∿ Sbi	725.6	15 30	46.8
Gaya Baru Malam Utara	Jak ∿ Sbi	725.6	15 30	46.8
Gaya Baru Malam Selatam I	Jak ∿ Sb	829.8	19 10	43.2
Cepat Semarang-tawang	Smt ∿ Sbi	280.0	7 20	38.2
Mutiara Selatan I	Bd ∿ Sb	699.5	16 20	42.8
Ekspres Siang Bandung II	Bd ∿ Sb	699.5	16 55	41.3
Ekspres Tatar Maja I	Gmr ∿ Bl	835.2	19 45	42.3
Cepat Argopuro	Pwt ∿ Jr	668.5	17 10	39.0
Cepat Doho	Sb ∿ Bl	166.5	5 20	31.4
Ekspres Mutiara Timur Siang	Sb ∿ Bw	300.1	8 00	37.5
Tumapel	Sb ∿ Bl	166.5	4 40	35.8
Parahyangan	Jak ∿ Bd	174.5	3 40	47.2
BT I (Freight train)	Sbi ∿ Cpn	711.5	26 00	27.4
TRS I (Freight train)	Smg ∿ Cpn	429.8	25 40	16.7

impossible to have them run daytime and they are composed as night trains.

Since freight cars to be used for ordinary freight trains are not equipped with pneumatic brakes, the maximum running speed of a freight train is limited to 45 km/h. One brake man assigned to every several cars operates a hand brake.

(5) Present situation of train operation

Since diesel locomotives are in short supply, the number of ordinary passenger trains which are cancelled is large. The number of cancelled freight trains is also large and only a small portion of the ordinary freight trains scheduled in the train diagram is operated.

The number of running delays of long-distance trains is very large and such delays are an everyday occurrence.

Table 3.1.4 shows the delayed arrival and departure times of major express trains recorded at Jakarta Station, and figures shown in the table indicate the average delay in minutes per day during such periods as January to March and April to June, 1982. As known from the table, a delay of more than 100 minutes is not rare. Since this chart shows the average delays during a 3 month period, a large number of delays depend on the day. It is considered that most delayed trains departing from Jakarta is due to their delay in arriving at the station. As an exception, the delays of Parahyangan, the express train between Jakarta and Bandung, are rare. A train arriving at Jakarta is normally delayed between Prupuk and Jakarta in about the same degree as its delay in passing Prupuk, which is the boundary of the south line of the Western Regional Office.

Table 3.1.5 shows delays of express trains which departed from and arrived at Jakarta, recorded before and after Lebaran on July 22 and 23, 1982. The delay of trains in one week before and after Lebaran is large.

(6) Operation accident

Table 3.1.6 shows accidents of train operations of the Central Office which occurred from 1974 to 1981 classified by year and type of accident. The number of serious train accidents (collisions, derailments and train fires) is almost the same for every year. The number

Table 3.1.4 (1) Delay Times at Arriving Terminals
(Jakarta Kota Station)

Trains			Average Time in Delay (min/day)	
No.	Name	Operating Section	Jan. ∿ Mar. 1982	Apr. ∿ Jun. 1982
1	BIMA I	Sgu ∿ Jak	71	70
3	MUT. UT. I	Sbi ∿ Jak	90	60
5	MUT. SEL. I	Sb ∿ Bd	12	34
7	GBM. UT. I	Sbi ∿ Pse	166	150
9	GBM. SEL. I	Sb ∿ Gmr	170	154
11	Ekspress siang	Sb ∿ Bd	31	15
13	Senja	Bl ∿ Gmr	204	115
15	"	Slo ∿ Gmr	156	70
17	"	Slo ∿ Gmr	149	98
19	"	Yk ∿ Gmr	132	115
21	"	Kta ∿ Pse	148	95
23	"	Smt ∿ Pse	99	63
25	"	Smt ∿ Pse	141	149
27	S. G. Jati I	Cn ∿ Jak	60	44
29	" III	Cn ∿ Jak	30	18
31	Parahyangan I	Bd ∿ Jak	7	3
33	" III	Bd ∿ Jak	7	6
35	" V	Bd ∿ Gmr	8	3
37	" VII	Bd ∿ Jak	10	9
103	Cepat	Smt ∿ Pse	201	74
121	"	Slo ∿ Pse	92	69
141	"	Yk ∿ Bd	12	14
209	"	Bjr ∿ Mri	31	40

Table 3.1.4 (2) Delay Times at Departing Terminals (Jakarta Kota Station)

Trains			Average Time in Delay (min/day)	
No.	Name	Operating Section	Jan. ∿ Mar. 1982	∿ Apr. ∿ Jun. 1982
2	BIMA II	Jak ∿ Sgu	19	9
4	MUT. UT II	Jak ∿ Sbi	47	26
6	MUT. SEL II	Bd ∿ Sb	2	6
8	GBM. UT II	Pse ∿ Sbi	94	68
10	GBM. SEL II	Gmr ∿ Sb	75	50
12	Ekspres siang	Bd ∿ Sb	1	7
14	Senja	Gmr ∿ Bl	102	54
16	"	Gmr ∿ Slo	78	47
18	"	Gmr ∿ Slo	40	37
20	"	Gmr ∿ Yk	102	57
22	"	Pse ∿ Kta	72	38
24	"	Pse ∿ Smt	50	46
26	"	Pse ∿ Smt	68	57
28	S.G. Jati II	Jak ∿ Cn	43	23
30	" IV	Jak ∿ Cn	19	16
32	Parahyangan II	Jak ∿ Bd	2	4
34	" IV	Jak ∿ Bd	6	3
36	" VI	Jak ∿ Bd	5	5
38	" VIII	Gmr ∿ Bd	11	5
102	Cepat	Tpk ∿ Smt	131	79
120	"	Tpk ∿ Slo	147	65
140	"	Bd ∿ Yk	5	10
206	"	Mri ∿ Bjr	27	18

Table 3.1.5 (1) Delay Times at Arriving Terminals before and after Lebaran (Jakarta Kota Station)

Trains			Average time in delay (min/day)			
No.	Name	Operating section	1∿14 Jul. 1982 Normal trans-portation	15∿21 Jul. 1982 Pre-lebaran Trans-portation	22,23 Jul. 1982 Lebaran trans-portation	24∿31 Jul. 1982 Aft-lebaran trans-portation
1	BIMA I	Sgu ∿ Jak	70	94	200	143
3	MUT.UT. I	Sbi ∿ Jak	49	58	63	62
5	MUT.SEL. I	Sb ∿ Bd	40	70	108	11
7	GBM.UT. I	Sbi ∿ Pse	143	132	103	192
9	GBM.SEL. I	Sb ∿ Gmr	146	229	219	297
11	Ekspress siang	Sb ∿ Bd	12	34	0	34
13	Senja	Bl ∿ Gmr	139	176	216	298
15	"	Slo ∿ Gmr	89	149	157	169
17	"	Slo ∿ Gmr	148	243	299	269
19	"	Yk ∿ Gmr	136	220	155	191
21	"	Kta ∿ Pse	78	170	83	214
23	"	Smt ∿ Pse	71	80	129	92
25	"	Smt ∿ Pse	109	100	216	139
27	S.G. Jati I	Cn ∿ Jak	33	38	26	38
29	" III	Cn ∿ Jak	13	50	104	57
31	Parahyangan I	Bd ∿ Jak	6	20	-4	12
33	" III	Bd ∿ Jak	6	3	9	14
35	" V	Bd ∿ Gmr	1	3	11	13
37	" VII	Bd ∿ Jak	7	9	12	13
103	Cepat	Smt ∿ Pse	24	115	96	89
121	"	Slo ∿ Pse	68	165	136	132
141	"	Yk ∿ Bd	17	18	13	82
209	"	Bjr ∿ Mri	32	38	41	142

Table 3.1.5 (2) Delay Times at Departing Terminals before and after Lebaran (Jakarta Kota Station)

Trains			Average time in delay (min/day)			
No.	Name	Operating section	1∿14 Jul. 1982 Normal transportation	15∿21 Jul. 1982 Pre-lebaran transportation	22,23 Jul. 1982 Lebaran transportation	24∿31 Jul. 1982 Aft-lebaran transportation
2	BIMA II	Jak ∿ Sgu	14	21	60	11
4	MUT.UT. II	Jak ∿ Sbi	9	32	19	46
6	MUT.SEL. II	Bd ∿ Sb	11	12	14	16
8	GBM.UT. II	Pse ∿ Sbi	32	99	23	69
10	GBM.SEL. II	Gmr ∿ Sb	43	91	67	108
12	Ekspress siang	Bd ∿ Sb	6	18	14	8
14	Senja	Gmr ∿ Bl	54	94	67	91
16	"	Gmr ∿ Slo	13	37	13	49
18	"	Gmr ∿ Slo	31	116	149	57
20	"	Gmr ∿ Yk	85	69	62	75
22	"	Pse ∿ Kta	35	95	104	120
24	"	Pse ∿ Smt	74	84	36	86
26	"	Pse ∿ Smt	76	94	135	72
28	S.G.Jati II	Jak ∿ Cn	10	56	55	39
30	" IV	Jak ∿ Cn	5	20	26	29
32	Parahyangan II	Jak ∿ Bd	0	2	0	0
34	" IV	Jak ∿ Bd	2	14	2	4
36	" VI	Jak ∿ Bd	2	14	0	14
38	" VIII	Gmr ∿ Bd	5	15	1	21
102	Cepat	Tpk ∿ Smt	66	108	65	128
120	"	Tpk ∿ Slo	73	181	150	140
140	"	Bd ∿ Yk	3	22	13	12
206	"	Mri ∿ Bjr	30	54	50	37

Table 3.1.6 Number of Train Operation Accidents by Year (Central Regional Office)

Code	Type of operation accident	Year							
		1974	1975	1976	1977	1978	1979	1980	1981
a	Train collisions (between stations)	1	2	0	1	0	0	1	.1
b	" (within station yard, excluding shunting)	4	3	1	1	2	0	0	2
c	Train derailment (within station)	10	15	15	28	26	28	14	13
d	Train derailment (within station yard, excluding shunting)	4	10	7	12	8	5	14	7
e	Train fire	0	2	0	2	0	2	1	0
f	Vehicles collision during shunting	3	2	1	1	2	1	0	0
g1	Vehicle derailment (during shunting) passenger car	2	6	5	4	4	7	6	3
g2	Vehicle derailment freight car	24	27	22	25	34	33	13	22
g3	Vehicle derailment locomotive	21	17	10	13	10	9	7	8
h	Railway crossing accident	13	21	30	29	38	34	26	16
i	Bodily injury	100	86	98	86	96	85	85	46
j	Animal injury	4	7	4	2	5	2	5	0
k1	Broken wheel tire (locomotive)	0	0	1	0	0	0	1	0
k2	Broken wheel axle (locomotive)	0	0	0	2	0	0	0	0
k3	Broken coupler (locomotive)	2	2	0	0	0	0	0	0
k4	Broken spring (locomotive)	3	0	0	0	0	0	0	0
k5	Broken wheel tire (passenger and freight car)	5	0	0	0	1	0	1	0
k6	Broken wheel axle (passenger and freight car)	1	0	0	0	1	0	0	0
k7	Broken coupler (passenger and freight car)	40	23	18	6	6	3	10	5
k8	Broken spring (passenger and freight car)	47	0	0	0	0	0	11	0
k9	Other vehicle problems	98	74	67	67	33	12	22	6
l	Steam of SL failed	45	30	16	3	12	2	1	3
m	Broken firing chamber of SL	45	31	62	19	1	0	9	2
n	Trouble in electric system of DL	70	45	81	99	63	44	93	22
o	Trouble in mechanical system of DL	103	135	206	243	214	232	196	225
p	Trouble in motive power transmission of DL	31	17	37	39	4	7	12	9
q	Electric facilities (substation, transmission line, etc.)	1	5	1	4	0	0	11	0
r	Trouble in signal facilities	1	1	0	0	0	0	0	0
s	Broken rails or other structures	10	3	2	2	0	0	1	2
t	Landslide, flood, others	23	4	5	7	49	0	10	10
u	Ignoring of signal	3	6	7	6	7	3	4	5
v1	Other problems attributable to PJKA employees	27	29	19	23	17	20	18	9
v2	Other problems attributable to persons other than PJKA employees	80	44	51	68	52	42	52	55
	Total	824	651	766	796	684	571	607	471

of vehicle problems from Code K1 to P is very large and they comprise about 60% of all accidents, but the number of accidents in 1981 considerably decreases. In addition, the number of derailments of vehicles during shunting and cases of bodily injury is large.

3.1.2 Operation Center

The organization of the operation center is divided into 3 stages, namely Head Office, Regional Office and Inspection. Fig. 3.1.3 shows the organizational chart of the operation center and Fig. 3.1.4 shows the range of responsibility of each inspection center.

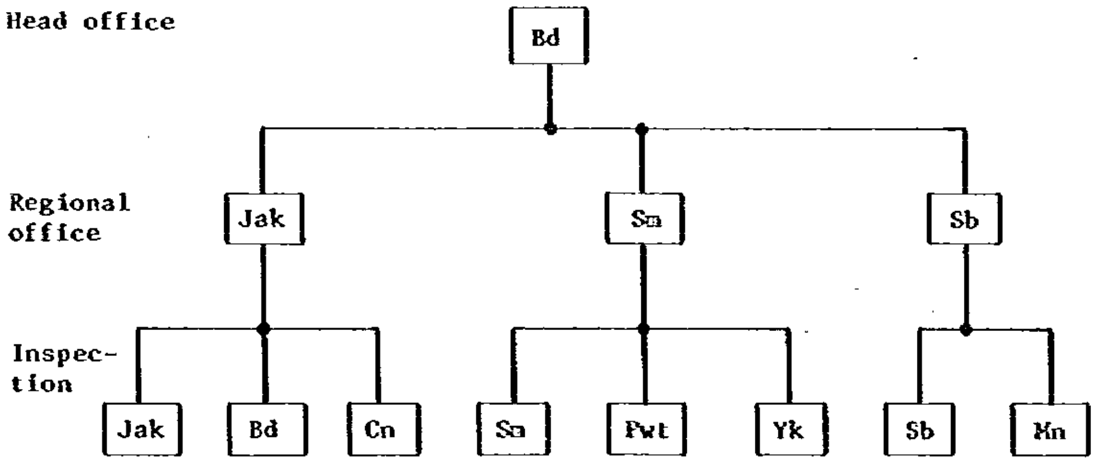


Fig. 3.1.3 Organization of Operation Center

Some section of railway lines to be electrified under this project are not covered by any operation center and a section between Bandung and Banjar is being planned.

The operation center of the Head Office consolidates reports (train delays, the number of locomotives, passenger and freight cars used, operating accidents, etc.) from all Regional Offices and reports the operating condition to the Director. The operation center of each Regional Office receives reports on the operating condition of trains and the number of cars used from major stations. The operation center

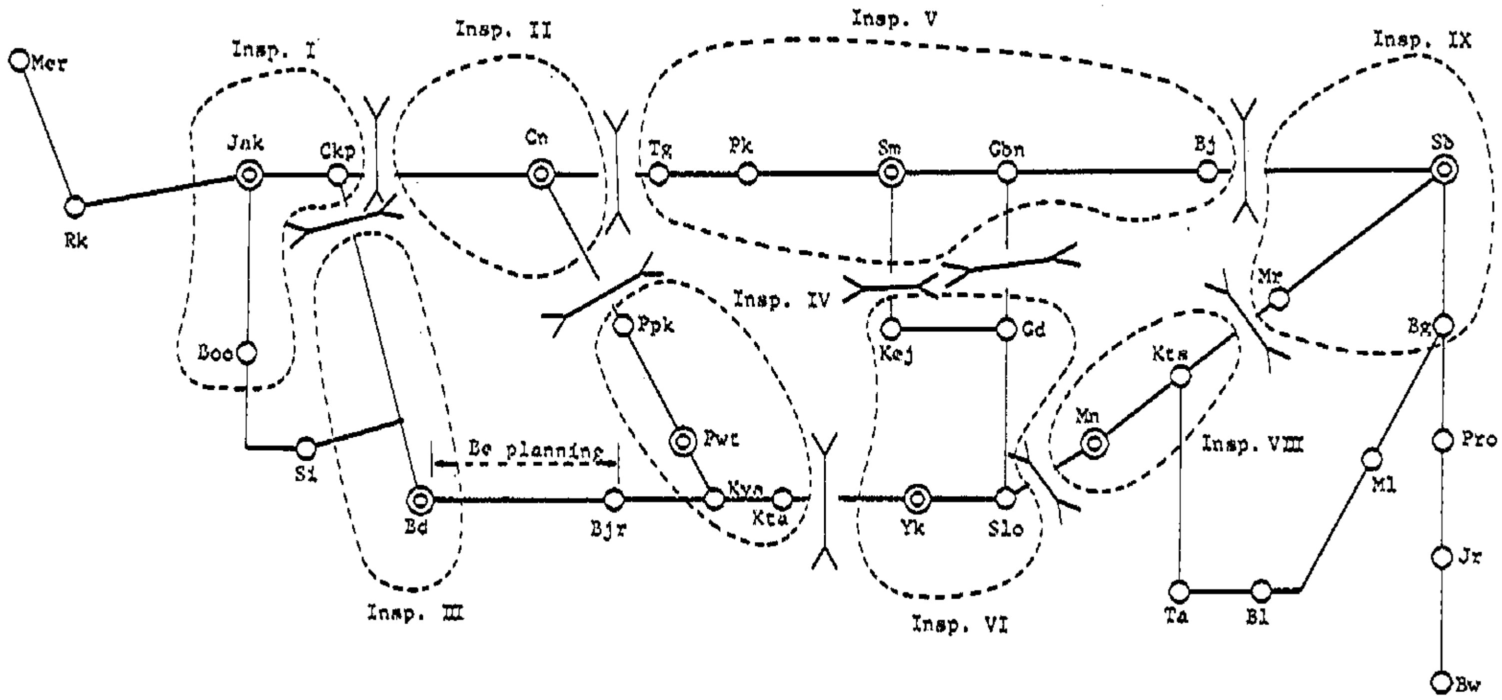


Fig. 3.1.4 Service Area of Train Dispatchers by Inspection

of each Inspection office monitors the operating condition of trains and takes necessary actions for the recovery of delayed trains and the adjustment of train operations.

3.1.3 Vehicles

Most locomotives are diesels. Some steam locomotives are also used, but they are mostly used for shunting. Electric locomotives were once used in the JABOTABEK area, but all of them are now discarded.

(1) Depot of diesel locomotives and No. of locomotives

Table 3.1.7 shows the number of diesel locomotives assigned to each depot and the number of vehicles used by each depot. Representative depots are Jatinegara, Bandung and Sidotopo and major locomotives are BB303, BB304 and CC201. The total number of these main locomotives is 68, and their rate of use (No. of vehicles used/No. of vehicles assigned) is about 90% which is considerably higher than that of other types of locomotives. Generally the number of days that a faulty locomotive stays in the workshop is large due to the shortage of parts, etc. For instance, the rate of use of a CC200 locomotive is only 55%.

(2) No. of km covered by diesel locomotives

Table 3.1.8 shows the average No. of kilometers per day covered by the main diesel locomotives. The average No. of km covered by the CC201 is about 450 km/day, that of the BB304 is about 400 km/day and that of the BB303 is about 290 km/day.

Table 3.1.9 shows the average No. of km covered by locomotives of representative depots by type of operation and the maximum No. of km is 725 km/day. The reserve rate of locomotives is about 20%.

(3) Running time of diesel locomotive

Table 3.1.10 shows the running times of the CC201 diesel locomotives classified by rostering No. An average running time of one vehicle per day is 13 to 14 hours.

Table 3.1.7 No. of Diesel Locomotive by Depot

Depot \ Type	CC200 1600HP	BB200 875	BB201 1425	BB301 1500	BB303 1000	BB304 1500	CC201 1950	BB300 680	C300 350	D300 340	D301 340
Cirebon (Cn)	22 12									4 3	3 3
Semarang-poncol (Smc)		26 21						1 0		11 9	5 5
Yogyakarta (Yk)			11 8								8 6
Jatinegara (Jng)				12 8			18 17				
Bandung (Bd)				4 3			18 16	4 0		11 10	
Sidotopo (Sdt)				32 17	3 3	11 10					13 9
Tanahabang (ThS)					8 7			3 3	20 17		
Jember (Jr)					10 9			1 0			8 6
Cilacap (Cp)								2 2			
Purwokerto (Pwt)										3 2	6 4
Purwakarta (Pwk)											5 4
Surabaya-pasarturi (SbI)											15 2
Rembang (Rb)											12 10
Kasal (Ksl)											2 2
Total No. of locomotive assigned	22	26	11	48	21	11	36	11	20	29	75
Rate of use (%)	54.5	80.8	71.7	58.3	90.4	90.9	91.7	45.0	85.0	76.9	

Note: Figures in the upper column show the number of locomotive assigned and figures in the lower column show the number of locomotive used as of Mar. 19, 1982.

Table 3.1.8 Average Running km Covered by One Diesel Locomotive per Day

Type of locomotive	Depot	Running km	No. of locomotives Assigned	No. of locomotives Used	Average running km assigned	Average running km used
		km/day			km/day	km/day
CC201	Jatinegara	8,534	18	14	474.1	609.6
	Bandung	7,588	18	15	422.0	506.0
	Sub-total (average)	16,122	36	29	447.8	555.9
BB304	Sidotopo	4,384	11	8	398.0	548.0
BB303	Tanah Abang	2,409	8	6	301.1	401.5
	Jember	2,597	10	8	259.3	324.6
	Sidotopo	1,014	3	2	338.0	507.0
	Sub-total (average)	6,020	21	16	286.7	376.3

Table 3.1.9 Running km Covered by Diesel Locomotive

(Train diagram revised May 27, 1982)

Type of DL	Depot	No. of locomotives used and No. reserved		Running km	Average running km per day	
					Used	Assigned
				km		
CC201	Jatinegara	Used	6	3,396	566	
		"	4	2,668	667	
		"	4	2,470	617.5	
		Reserved	4			
		Sub-total	18	8,534	609.6	474.1
CC201	Bandung	Used	3	1,540	513.3	
		"	1	486	486	
		"	6	2,850	475	
		"	5	2,707	541.4	
		Reserved	3			
		Sub-total	18	7,583	505.5	421.3
BB304	Sidotopo	Used	3	1,286	428.7	
		"	2	1,438	719	
		"	2	1,450	725	
		"	1	210	210	
		Reserved	3			
		Sub-total	11	4,384	548	398.5
	Total	Assigned	47	20,501	554.1	436.2
		Used	37			
		Reserved	10			
		Reserved rate	21.3%			

Table 3.1.10 Running Times of Diesel Locomotive
(Train Diagram revised May 27, 1982)

(1) Jatinegara depot (CC201)

Rostering No.	Running time hour	Running km km	Rostering No.	Running time hour	Running km km
1	13.5	466	8	18.2	773
2	11.5	398	9	12.1	628
3	15.5	681	10	16.2	494
4	12.5	618	12	16.8	799
5	16.5	829	13	13.0	499
6	8.5	404	14	12.1	644
7	17.0	773	15	16.5	528
Total running time		199.9 hours	Average running time of one per day		13.3 hours
Total running km		8,534 km	Average speed		42.7 km/hr

(2) Bandung depot (CC201)

Rostering No.	Running time hour	Running km km	Rostering No.	Running time hour	Running km km
1	12.0	519	9	11.2	333
2	12.5	429	10	17.5	347
3	15.8	592	11	17.5	346
4	13.8	486	12	12.5	397
5	17.0	699	13	16.3	627
6	16.5	449	14	17.7	584
7	18.8	652	15	11.0	430
8	11.8	370	15A	7.5	328
Total running time		229.4 hours	Average running time of one per day		14.3 hours
Total running km		7,588 km	Average speed		33.1 km/hr

(4) Passenger cars and freight cars

Passenger car depots and the number of passenger cars for high class trains are shown in Table 3.1.2. The number of passenger cars in 1980 was 906, comprising 34 first class, 109 second class and 563 third class passenger cars. The number of passenger cars slightly increased in the past 5 years.

The number of freight cars in 1980 is 4115 and about a half of them are box cars. The number of freight cars decreased by half in the past 5 years.

3.1.4 Depot and Station

(1) Organization of depot

Fig. 3.1.5 shows the organizational chart of Purwokerto Locomotive Depot. Fig. 3.1.6 also shows the organization of Jakarta Kota Passenger Car Depot.

(2) Inspection of vehicle at depot

The items of inspection for diesel locomotives to be carried out at a depot, the number of inspection staff and the number of days required for inspections are shown in Table 3.1.11. The frequency of inspection varies for the electric and the mechanical diesel locomotive. A depot is able to carry out annual inspection of locomotives, and higher grade inspections and the repairing of locomotives are carried out at Yogyakarta workshop.

The daily, monthly, four monthly and yearly check of passenger cars are carried out at a depot, and high grade inspections such as two yearly and four yearly check is carried out at a workshop.

The inspection of freight cars is divided into 2 kinds, the daily check and two yearly overhaul to be carried out at a workshop. The daily check of freight cars is conducted by a supervisor of the depot and a brakeman who is assigned to the freight train. The inspection consists of the replacement of simple parts and oiling. When the brakeman finds a car that needs to be repaired, he reports it to the supervisor and sends the car to a workshop.

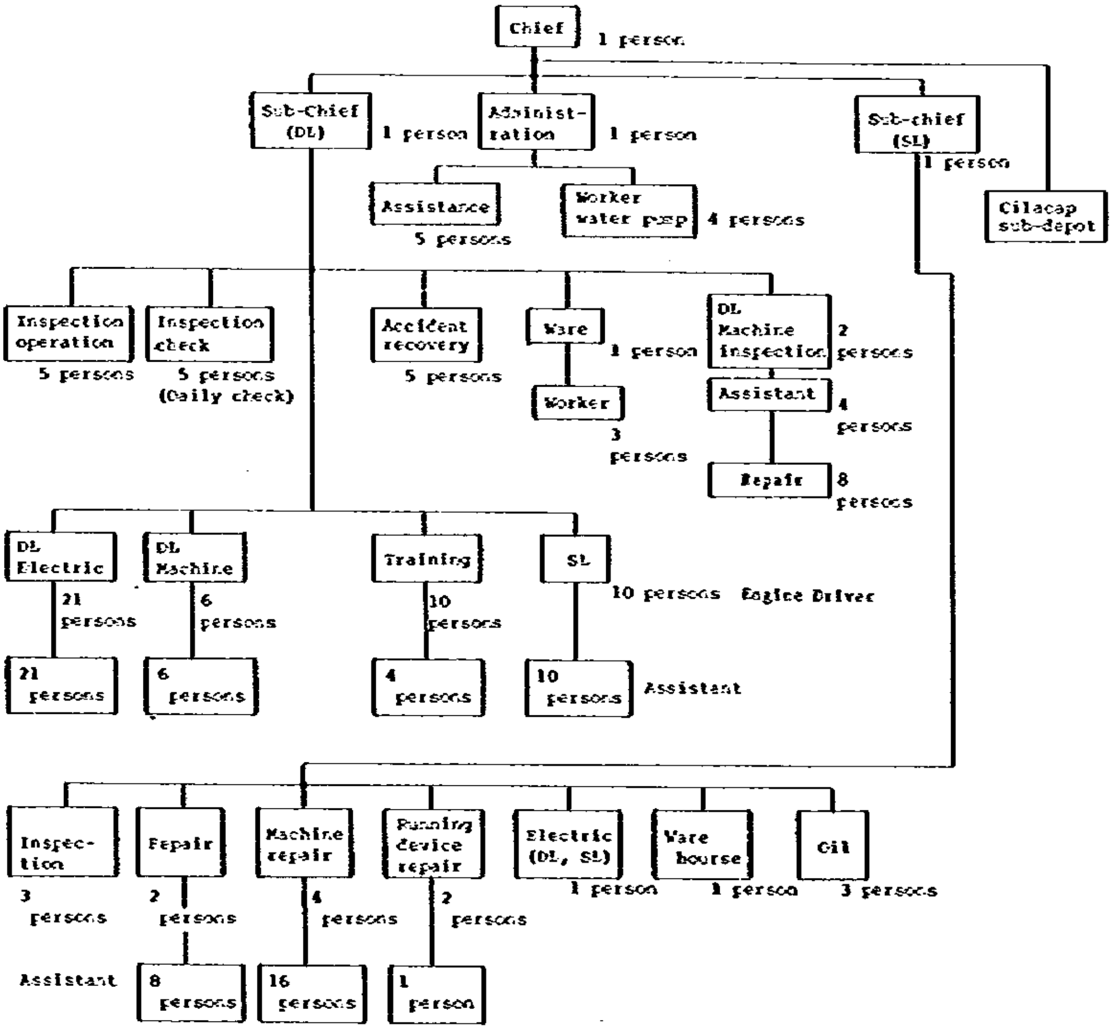


Fig. 3.1.5 Organization of Locomotive Depot (DL, SL) (Purwokerto Depot)

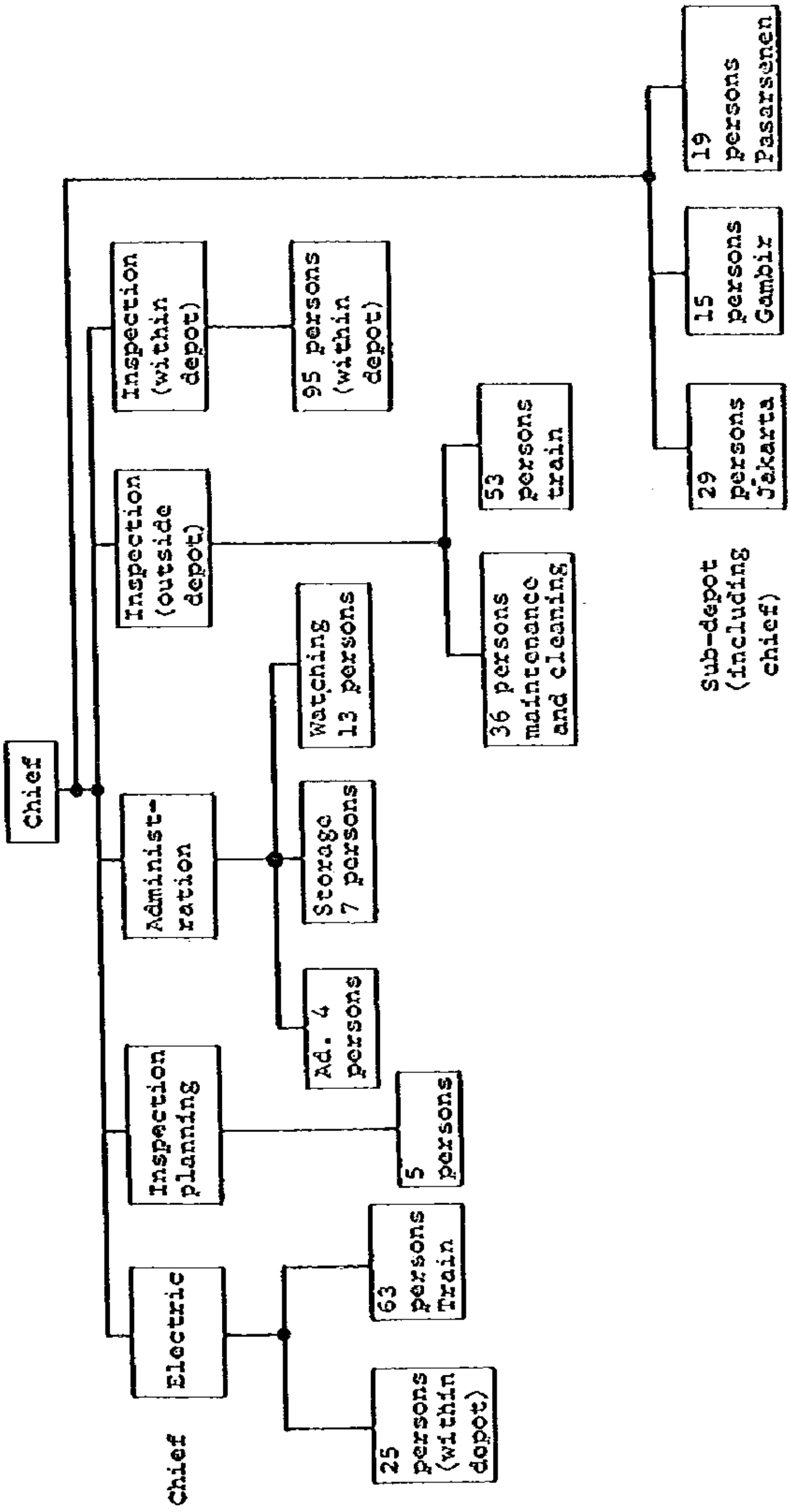


Fig. 3.1.6 Organization of Passenger Car Depot (Jakarta Kota Depot)

Table 3.1.11 Inspection of Diesel Locomotives at Depot

Type of DL	Type of inspection	Inspector		No. of days required (approximate)
		Chief	Staff	
Diesel electric locomotive	Daily check	1	9	2 hours
	Monthly check	2	18	1 day
	Three monthly check	3	17	2
	Six monthly check	3	17	5
	Yearly check	3	17	10∿15
Diesel mechanical locomotive	250 hour check	1	7	1
	500 "	1	7	1
	1,000 "	2	8	1
	2,000	2	13	3
	3,000	3	17	5

(3) Organization and staff of station

Fig. 3.1.7 shows the organization chart of Surabayapasarturi Station, a large station. Fig. 3.1.8 also shows the organization chart of the train operation staffs of the same station.

Table 3.1.12 shows the approximate number of employees of stations classified by rank, and the percentage of train operation staff to the total number of employees of each station.

Table 3.1.12 Rank of Station and Percentage of Train Operation Staff

Rank of station	Percentage of train operation staff	Total No. of station employee (approximate)
Big	% 40 ∿ 50	persons 100 ∿ 200
I	50 ∿ 60	70 ∿ 80
II	80	40
III	90	30
IV, V	100	6 ∿ 15

3.1.5 Duties of Locomotive Crews and Other Employees

(1) Locomotive crew

A locomotive is operated by a pair: an engine driver and an assistant. The conditions of their work are shown in Table 3.1.13. The number of working hours per week is 38 to 49 and the average working hours per one unit of duty is 5.5 to 7 hours.

(2) Conductor

Table 3.1.14 shows the duties of conductors. The number of working hours for one unit of duty is 5.5 to 11 hours.

(3) Brakeman and other workers

Table 3.1.15 shows the duties of electricity operators and brakemen. An electricity operator is assigned to ride on the train to service and maintain electrical devices on the train. A brakeman

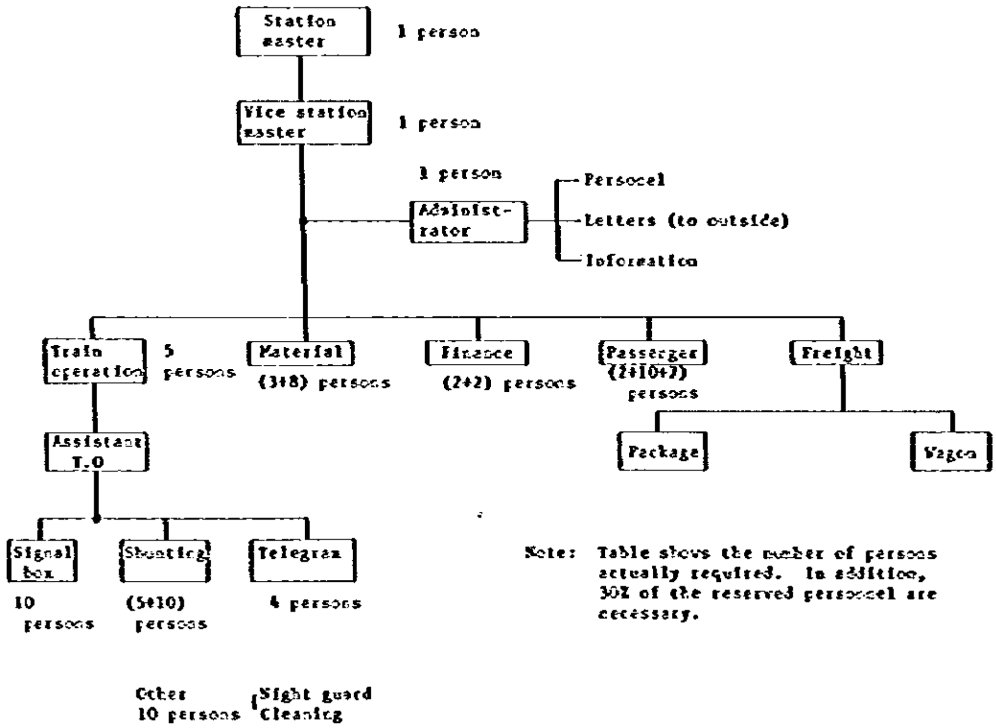


Fig. 3.1.7 Organization of a Large Station (Surabayapasarturi Station)

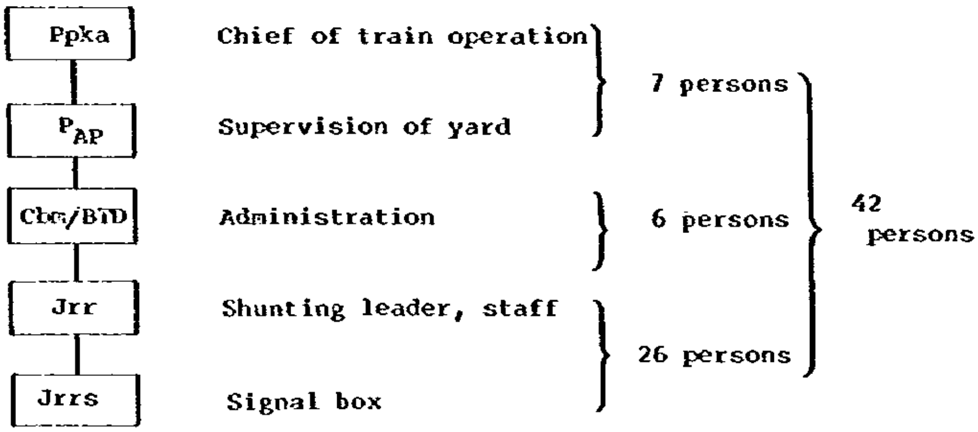


Fig. 3.1.8 Organization of Operation Staff of Station (Surabayapasarturi Station)

Table 3.1.13 Duties of Locomotive Crew

Depot	Type of locomotive	Working hours		No. of trains			No. of km running	Average working hours for one unit of duty
		Total	Hours per week	On duty	Reserved	Total		
Sidotopo	BB304	115.5	44.9	18	2	20	1,865	6.42 hr
Cirebon	CC201 BB304 Other	242	37.6	45	7	52	4,614	5.38
Malang	DL, SL	119.5	49.2	17	5	22	-	7.03
Purwokerto	BB301 CC201 Other	113.5	39.7	20	3	23	1,950	5.68
Purwokerto	Small size DL	53	46.3	8	1	9	-	6.63
Purwokerto	SL	47	41.1	8	1	9	-	5.88
Kroya	BB201 CC201, SL	118	48.6	17	3	20	-	6.94
Cilacap	Small size DL, SL	144	43.5	23	3	26	-	5.54
Kroya	SL, BB201	76	41.0	11	2	13	304	6.91

Note: (1) Working hours include preparation time. Preparation time is one hour before and after actual duty.
(2) Reserved rate is 15%.
(3) An engine driver and an assistant form a pair.

Table 3.1.14 (1) Duties of Conductor

LIN RAYA

Inspection	Name of conductor depot	No. of units of duty			Duty hour		Range of riding duty
		On duty	Off duty	Total	Total	Average	
8	Madiun	21	7	28	hr 180.0	8.57	Yk, Slo. Kts
8	Kertosono	12	4	16	98.5	8.21	Bl, Mn, Sdt
9	Surabaya Kota	49	15	64	388.25	7.92	Slo, Kts, Bl, Jg
9	Sb pasarturi	28	8	36	182.5	6.52	Smt, Cu, Bj
10	Bangil	5	2	7	36.25	7.25	Sb, Ml,
10	Malang	13	4	17	83.5	6.42	Sb, Psi, Bg
10	Blitar	13	4	17	119.5	9.19	Kts, Sb.
11	Probolinggo	8	3	11	59.75	7.47	Kk, Jr, Sdt, Sb
11	Klakah	7	3	10	48.75	6.96	Jr, Pb, Psr,
11	Jember	16	5	21	139.25	8.70	Sb, Bw, Kbr, Pnr
11	Kalibaru	3	2	5	22.75	7.58	Jr, Bw
11	Banyuwangi	2	1	3	10.5	5.25	Jr, Kbr

Table 3.1.14 (2)

LIN CABANG (Conductor)

Inspection	Name of conductor depot	No. of units of duty			Duty hour		Range of riding duty
		On duty	Off duty	Total	Total	Average	
8	Ponorogo	6	2	8	hr 50.75	8.46	Slh, Mn,
8	Paro	1	1	2	9.15	9.15	Kd,
9	Babat	5	2	7	39.5	7.90	Tn,
9	Wonokromokota	2	1	3	22.0	11.0	Kap, Be
9	Kamal	3	1	4	18.5	6.17	Bkl, Bkp
9	Pamokasan	3	1	4	31.0	10.33	Kml
10	Malangjagalan	2	1	3	19.5	9.75	Gdl, Dpt, Mlj

Table 3.1.15 Duties of Electricity Operator and Brakeman

(1) Electricity operator

Depot	Total working hours	Weekly average working hours	No. of operators		Average working hours for one unit of duty	
			On duty	Reserved		
Malang	35	49.0	5	2	7.0	
Purwokerto	42.5	49.5	9	1	10.2	← Break maintenance
Purwokerto	69	44.5	11	1	6.3	← Air condition maintenance

(2) Duties of Brakeman

Depot	Total working hours	Weekly average working hours	No. of operators		Average working hours for one unit of duty
			On duty	Reserved	
Malang	21	49.0	3	1	7.0
	52	45.5	25	8	6.5
Purwokerto	197	42.7	33	5	6.0
Kroya	379.25	37.45	66	10	5.7
Kutoarjo	168	40.0	30	5	5.6
Cilacap	66	40.0	12	2	5.5

Note:
1. Brakemen belong to a passenger & freight car depot.
2. One brakeman is assigned to every 6 cars, in other words, one man works on a 120 ton train and 5 men work on a 600 ton train.
3. The maximum speed of a train is 45 km/h.

is assigned to every 6 freight cars of a train and he operates the hand brakes of those cars when the train makes a stop, because freight cars are not equipped with pneumatic brakes.

(4) Education of locomotive operator

Fig. 3.1.9 shows the courses of training of locomotive crews. A trainee is required to receive training for 6 months to become an assistant and an assistant is further required to receive training for a period of 3 months to become an engine driver.

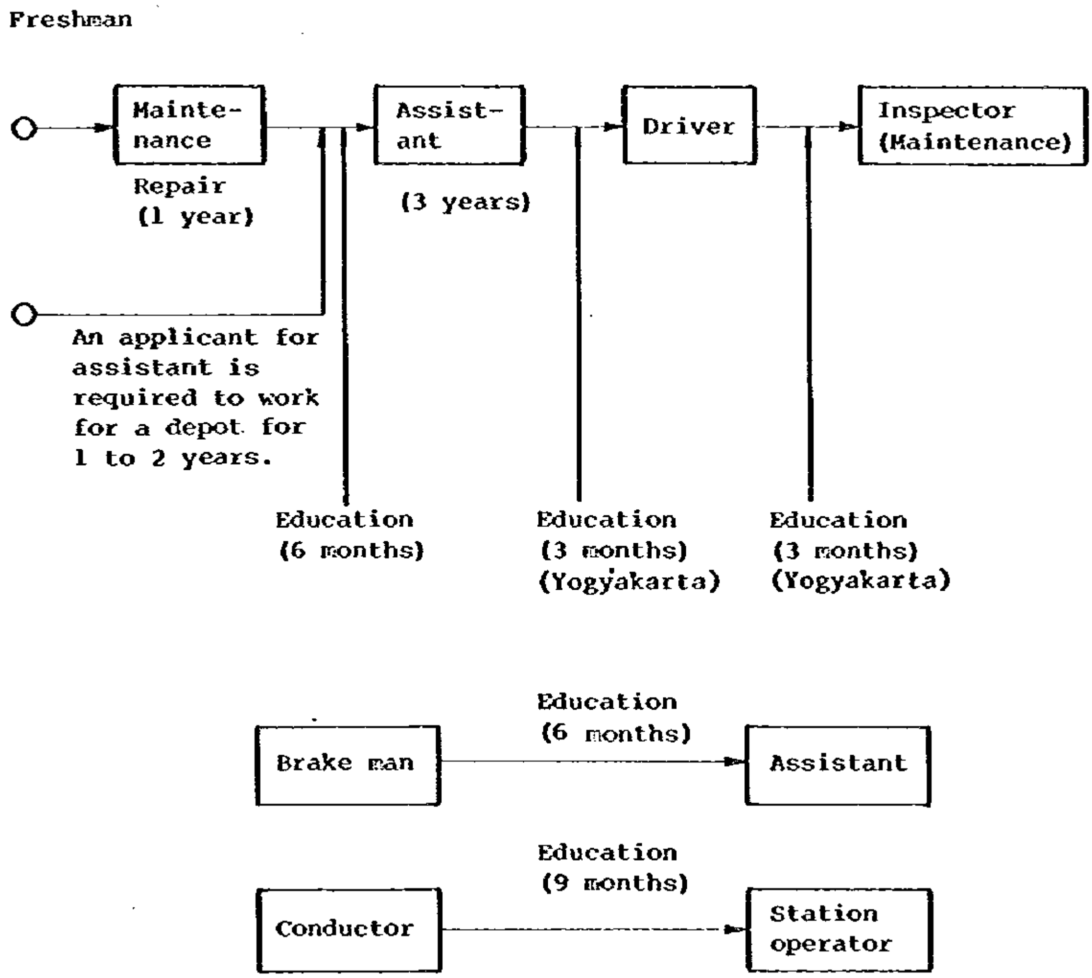


Fig. 3.1.9 Education of Locomotive Crew

3.1.6 Problems Regarding the Operation of Trains

The present condition of train operations and their problems stated above can be summarized as follows:

(1) The running speed is low

The maximum running speed of a train is determined by the section. The best section is rated at 80 km/h but sections of 40 km/h are common. The maximum scheduled running speed is 50 km/h and many trains, even if they are high grade, run at a speed less than 45 km/h. Such low running speeds are attributable to the following reasons:

1) The maintenance condition of tracks is very poor and the vibration of a train (especially vertical motion) is great.

2) The limited passing speed of a turnout is low.

3) Slow-moving sections are numerous and these restriction last for a long time. Slow moving speeds are also low.

4) Most freight trains are not equipped with pneumatic brakes and the maximum running speed of such trains is limited to 45 km/h.

5) Since a engine driver relies on the head light to confirm signals at night, the distance of signal confirmation is short and the speed of a train is thus limited.

(2) The trains delays are large

The delays of long distance passenger trains and freight trains are large, and a delay of more than 100 min is common. It is considered that such large delays are attributable to the following reasons:

1) The number of diesel locomotive problems (especially mechanical trouble) is large.

2) Due to the shortage of vehicles, the congestion of ordinary trains is severe, and the stopping time of such trains becomes longer than scheduled as passengers normally carry much luggage.

3) Sometimes the signal handling at a station may be delayed, a train is forced to stop outside the station and the delay of the train becomes larger.

4) The functions of a train operation center are not fully organized and maintained yet; therefore, effective countermeasures for the recovery of delays are not taken.

5) Since most of major lines are single track, the delay of a train causes other trains to be further delayed.

6) Some intermediate stations have rail tracks which cannot be used and some turnouts are also cannot be used. Due to this, surplus shunting operations are required to change trains and the delay of trains thereby increases.

7) Due to the shortage of facilities, pass-by trains cannot enter a station at the same time.

8) Most speedmeters of locomotives are broken, therefore engine drivers control the speed of their trains by their senses.

9) It seems that employees who are engaged in the operation of trains are hardly aware of the importance of guaranteed of scheduling of trains.

(3) The number of passenger trains is low

Compared to the number of passengers, the number of passenger trains and train cars is very small. Due to this, the congestion of a train is severe, caused by the shortage of vehicles. Especially because of the shortage of diesel locomotives, many passenger trains and freight trains are forced to cancel their operation.

(4) Safety of train operation is low

Under the block system which is being used at present, especially due to the communication system, there is a strong possibility of train accidents when employees handle of control devices incorrectly. In fact, there are many train accidents, and derailments of train and cars.

The problems and defects we have pointed out above have considerably weakened the competitive force of the present railway service against road and air traffic services.

In order to expand the share of the railway service in transporting passengers and cargos, it is necessary to solve those problems stated above and also take the following countermeasures:

(1) Enhancement of image of railway

1) It is necessary to prohibit ordinary people from entering the railway lines and rail tracks inside station compounds. This is absolutely necessary to secure the safe operation of trains and prevent bodily accidents.

2) We notice that many unused rails, warehouses, steam locomotive water tanks, water supply poles, old freight cars, scrap bridges, etc. are discarded in the compounds of many stations, and abandoned steam locomotives, other vehicles, turnouts, water supply tanks, etc. are also simply left in vehicles depots. Since these abandoned vehicles, facilities and other materials considerably mar the image of the railway service, they should be put in order and cleared up. This will also enhance the morale railway employees.

(2) Regular operation of trains

The regular operation of trains is one of fundamentals for gaining the confidence of passengers and shippers and improving the efficiency of railway service. They will trust the railway all related work in connection with the operation of trains can be carried out as scheduled. It is recommended that every effort be made to solve those problems stated in the section of "Delay of train", to reinforce the system of train operations and to secure the regular operation of trains by reeducating locomotive crews, conductors and station employees.

(3) Shortening of running time of trains

It is very important to shorten the running time of a train to reinforce the competitive power of the railway service. It is necessary to shorten the running time of the present trains by taking such countermeasures as the improvement of rail tracks and line configurations, raise of average speed by the introduction of high grade vehicles, etc., shortening of blocking time of trains by the introduction of modernized blocking systems, realization of simultaneous entry of pass-by trains into station yard, shortening of rehabilitation period of slow-moving section and setting up of a multi stage system for slow-moving speed, etc.

(4) Stepped-up operation of trains

It is necessary to increase the number of trains, even if on local lines, to expand the share of the railway service. Under present conditions, it is possible to increase the number of passengers by simply increasing the number of trains.

One of the serious problems which hampers the stepped-up operation of trains is the grave shortage of vehicles and especially the shortage of diesel locomotives. Except for a certain limited section, the line capacity of the present facilities still has some room, therefore it is necessary to make efforts to reduce the number of vehicles which are inspected or repaired by procuring parts of vehicles timely and efficiently, and to reduce the number of days required for inspection and repair of vehicles.

(5) Securing safe operation of trains

The securing of safety is a basis for gaining the confidence of passengers and shippers for the railway service. Fortunately the evaluation of railway service safety is higher than that of route bus service. However, there is a problem in securing the safe operation of trains under the present signal facilities if the number of trains is increased in the future. Therefore, it is necessary to introduce modernized blocking systems.

(6) Others

It is important to take the following countermeasures for improving passenger services:

1) Reinforcement of connection with road traffic

Securing and maintaining a square in front of a station; extension of bus lines into station squares.

2) Improvement of customer reception facility

Ticket window, ticket gate facilities, maintenance of waiting rooms, of platforms of large stations and of railway bridges.

3) Mechanization of cargo handling

4) Execution of land container transport (Marine container transport is being planned)

3.1.7 Problems of Locomotive and Car Depot

The present condition and problems of locomotive and car depots are as follows:

(1) Since the number of diesel locomotives which are kept in a repair plant is large, the number of locomotives which can be actually used is limited. In the case of a large, old diesel locomotives, 20% to 50% of all these vehicles are kept in a workshop for repairing at any one time. This is because the number of days required for repairing is very large.

(2) Since the shortage of parts is serious, the efficiency of inspection and repairing is poor.

(3) Scrapped locomotives and passenger cars are abandoned in inspection shed of depots and station yards.

(4) The maintenance and cleaning of the floor of a inspection shed in a depot, inspecting and repairing machines and inspection pits are poor.

3.2 Train Operation Program After Electrification

3.2.1 Flowchart of operation program

Fig. 3.2.1 shows the procedures for preparing a train operation program and its relation with other programs. The preparation of a program is roughly divided into the following steps:

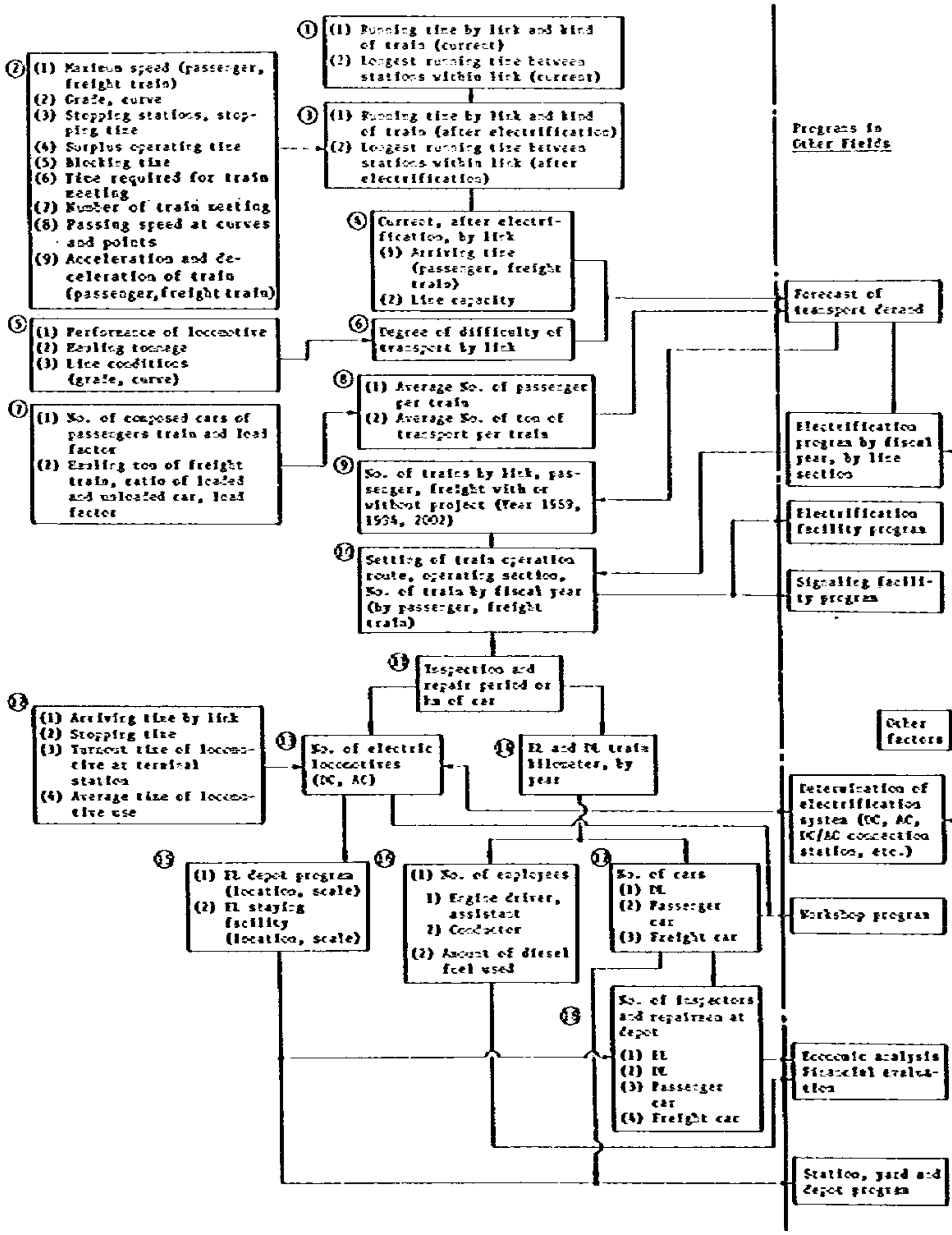


Fig. 3.2.1 Flow Chart for Preparing Train Operation Program

(1) Preparation of materials related to necessary operations for forecast of transport demand

The running time of link and the line capacity of the present system and that of a new system after electrification are to be obtained. The present data can be obtained from the train diagram, but data concerning a new system after electrification must be obtained by calculations based on maximum speed, line conditions, operating conditions, etc. as shown in the figure. An average number of passengers per train is to be obtained from the number of composed cars and average load factor. The average number of tons of transport is to be obtained from the traction weight of the freight train, the ratio of loaded and unloaded cars in a train and load factor.

(2) Establishing trains

The number of trains by link, whether or not the project is implemented can be obtained from the forecast of transport demand, and the running section of a train and the number of trains to be operated are determined based on this. The yearly electrification projects should be taken into consideration in preparing this program.

(3) Calculation of number of cars and personnel

As the number of trains to be operated is determined, so the number of electric locomotives (DC, AC), diesel locomotives, passenger cars and freight cars can be obtained. Based on this, the number of engine drivers, assistants, conductors, inspectors and repairemen for each type of car can be obtained. These data are used in preparing station, yard and depot programs, workshop programs and economic analysis, etc.

3.2.2 Train Operation

(1) Prerequisites for preparation of train operation program

In preparing a train operation program after electrification, we considered the following prerequisites:

1) Electrification system

a) JABOTABEK area uses DC system, and Merak line is to be permanently electrified by DC system in view of its location and distance.

b) Krawang Station will be used as a DC/AC connecting station until end of 1993. Long distance trains will be hauled by AC electric locomotives east of Krawang station and by DC electric locomotives west of the station.

c) Since a new double track line becomes necessary for long distance trains in 1994, a new double track line will be constructed between Krawang and Manggarai and electrified by AC system. Consequently, a long distance train will be hauled by an AC electric locomotive until Manggarai and the necessity for changing the locomotive at Krawang station will be eliminated. In the same period, a new Cibinong freight line will be constructed and electrified by AC system. Freight trains will enter the new freight line at Cakung station and be started from and terminated at Tanjungpriuk station. Those DC electric locomotives which will be used by Bekasi line until 1993 will be transferred to the Merak line, which will be electrified at that time.

2) All lines will be single-track electrified except the section between Jakarta and Cikampek which has been converted to double track line.

3) The maximum operating speed will be 100 km/h. The maximum passing speed on curved sections will be as follows:

$$V = 4.3\sqrt{R}$$

Where V = Maximum passing speed (km/h), and
R = Radius of curvature (m)

4) The block system will be the tokenless block system and signals will be the color lamp system.

(2) Running time and running speed

A train operation curve (i.e., a chart showing how the running speed, running time and other changing operating conditions of a train in conjunction with the progression of the train) is normally prepared to accurately obtain the running time of a train. However, in preparing the master plan of this project, a train operation curve was not prepared, and approximate running time was obtained by the following calculation:

1) Acceleration and deceleration of train

The average acceleration and average deceleration of trains on a level section are determined as follows:

Kind of train	Average acceleration	Average deceleration
Passenger train	1.0 km/h/s	1.5 km/h/s
Freight train	0.5	0.75

2) Maximum running speed

The maximum running speed of a passenger train is set at 100 km/h and that of a freight train at 85 km/h. In calculating the running time of a train, the maximum speed was reduced by 5km to 95 and 80 km/h respectively.

3) Curve

The passing speed of a curve was set as $V=4.3\sqrt{R}$.

According to this equation, the maximum passing speed of curves will be as shown in the following table:

Radius of curvature (m)	Passing speed (km/h)
150	50
200	60
250	65
300	70
350	80
400	85
450	90
500	95
550	100
600	105

The above was calculated by assuming the existence of curves (location, radius, length) by section based on the results of the field survey.

4) Grade

Where grades are steep, approximate size and distance of the grade were obtained, based on the results of the field survey. Running time and speed were calculated on the assumption that a train is to be operated at a balanced grade speed to be determined by the performance of an electric locomotive.

5) By the above methods, an approximate estimated running time of a train can be obtained, but actual trains are normally required to run at slower speeds, due to maintenance work on rail tracks, etc., and thus a margin of 5% is added to the estimated running time of a train as surplus time.

6) Stopping time

The stations where express trains stop were determined, and the stopping time of a train was set 5 minutes at a major station, 3 min at a medium station and 1 min. at an intermediate station. A freight train will stop at such stations where an express train stops and its stopping time was set 30 min. In addition to the time of deceleration and acceleration for making a stop at a station, a stopping time of 2 min is added to its stopping time for passing-by another train. An express train has priority and it passes another train about every 6 stations and an ordinary train passes by about every 3 stations.

Based on the above prerequisites, acceleration time for leaving a station, deceleration time for stopping at a station, deceleration time, acceleration time and passing time for curves, running time of a grade, and running time at a maximum speed are separately calculated. The running time of a train can be obtained by adding a surplus time, stopping time and passing-by time to a total time calculated as stated above.

Running times of trains by section thus obtained are shown in Table 3.2.1. The running time of a train includes the stopping time at midway stations within a section, but it does not include the stopping time at terminal stations of the section. An ordinary passenger train is assumed to stop at all stations.

The running time of a train after electrification is shown in Table 3.2.2. The running speed is represented by an average speed. The average speed is obtained as follows:

$$\underset{(km/h)}{\text{Average speed}} = \frac{\text{Section distance (km)}}{\text{Section running time excluding stopping time (hr)}}$$

The tables can be further classified by line conditions as shown below:

Line condition	Average speed of passenger train (km/h)	
	Express	Ordinary
(1) Section where grade is small, radius of curvature is large	83∿90	62∿76
(2) Section where grade is small, radius of curvature is small	71∿90	60∿74
(3) Section of where grade is large	55∿88	50∿69

(3) Train program classified by electrification stage

1) Stages of electrification

The stages of electrification (section to be electrified and year of starting operation) are determined as follows:

Year of opening electrified section	New electrified section
1988	Manggarai∿Cikampek Cikampek∿Cirebon
1989	Cikampek∿Kiaracondong
1991	Cirebon∿Yogyakarta
1992	Yogyakarta∿Solojebres
1994	Manggarai∿Krawang AC dual tracks installed Serpong∿Merak

Year of opening electrified section	New electrified section
1995	Solojebres ∿ Surabayakota
1996	Surabayakota ∿ Probolinggo
2003	Cirebon ∿ Surabayapasarturi Bandung ∿ Kroya Probolinggo ∿ Jember Semaranggudang ∿ Kedungjati ∿ Solobalapan Gambringan ∿ Gundih Bogor ∿ Sukabumi
2008	Jember ∿ Banyuwangi Kertosono ∿ Malang ∿ Bangil Sukabumi ∿ Padalarang

2) Transport demand of electrified year

The forecast of transport demand was calculated by using 'maximum speed of 100 km/h after capacity check' and by assuming that electrification would be concentrated in the 3 years of 1989, 1994 and 2002, and that electrified sections would not be opened in those years shown in the preceding table. Consequently, in devising a train program for each stage of electrification, we must consider how to handle transport demand during the intermediate years. In this plan, we treated the problem as follows:

a) As for the number of trains of sections already electrified, the figure for intermediate years was obtained by connecting the number of trains of 1994 and that of 1989, or that of 2002 and that of 1994 with a straight line.

b) If the method of a) above is used for a section which is not electrified yet, the number of trains would become excessively large. Therefore it was assumed that the number of trains in 1989 would be shifted to 1993 and that in 1994 would be shifted to 2002.

Table 3.2.1 (1) Running Time of Train by Section After Electrification (max. speed 100 km/h)

Node No.	Section	Railway line				Running time (min)
		Distance	Grade	Radius of curvature	Kind of train	
① ~ ②	Merak ~ Rangkasbitung	68,625 Inter-mediate station (7)	6‰	300m	Express	50
					Ordinary	69
					Freight	62
② ~ ③	Rangkasbitung ~ Jakarta	83,097 (12)	8	200	Express	67
					Ordinary	108
					Freight	112
③ ~ ④	Jakarta ~ Cikampek	84,746 (20)	5	540	Express	74
					Ordinary	120
					Freight	144
③ ~ ⑤	Jakarta ~ Sukabumi	111,844 (17)	25	150	Express	130
					Ordinary	167
					Freight	175
④ ~ ⑥	Cikampek ~ Bandung	89,727 (16)	16	200	Express	88
					Ordinary	126
					Freight	96
⑤ ~ ⑥	Sukabumi ~ Bandung	97,961 (16)	33	150	Express	108
					Ordinary	146
					Freight	128
④ ~ ⑦	Cikampek ~ Cirebon	135,161 (18)	3	500	Express	97
					Ordinary	146
					Freight	121
⑦ ~ ⑨	Cirebon ~ Kroya	157,954 (20)	14	300	Express	117
					Ordinary	179
					Freight	204
⑦ ~ ⑩	Cirebon ~ Pekalongan	135,993 (15)	5	300	Express	105
					Ordinary	142
					Freight	149

Table 3.2.1 (2)

Node No.	Section	Railway line			Kind of train	Running time (min)
		Distance	Grade	Radius of curvature		
⑥ ~ ⑧	Bandung ~ Tasikmalaya	115,059 (15)	25	150	Express	116
					Ordinary	147
					Freight	173
⑧ ~ ⑨	Tasikmalaya ~ Kroya	132,583 (18)	10	150	Express	100
					Ordinary	147
					Freight	151
⑩ ~ ⑫	Pekalongan ~ Semarangponcol	87,980 (11)	7	400	Express	66
					Ordinary	92
					Freight	80
⑨ ~ ⑪	Kroya ~ Kebumen	47,956 (8)	5	450	Express	34
					Ordinary	59
					Freight	44
⑪ ~ ⑭	Kebumen ~ Yogyakarta	91,762 (13)	5	300	Express	72
					Ordinary	105
					Freight	113
⑫ ~ ㉖	Semarang ~ Kedungjati	36,750 Intermediate station (4)	9	400	Express	31
					Ordinary	43
					Freight	50
⑫ ~ ⑬	Semarang ~ Gambringan	60,309 (7)	5	300	Express	43
					Ordinary	62
					Freight	53
⑬ ~ ㉗	Gambringan ~ Gundih	9,915 (0)	5	400	Express	7
					Ordinary	8
					Freight	8
㉖ ~ ㉗	Kedungjati ~ Gundih	31,726 (3)	9	400	Express	21
					Ordinary	32
					Freight	27

Table 3.2.1 (3)

Node No.	Section	Railway line			Kind of train	Running time (min)
		Distance	Grade	Radius of curvature		
⑮ ～ ㉗	Gundih ～ Solobalapan	41,957 Inter-mediate station (4)	9	400	Express	29
					Ordinary	41
					Freight	36
⑭ ～ ⑮	Yogyakarta ～ Solobalapan	59,238 (11)	11	-	Express	46
					Ordinary	77
					Freight	61
⑮ ～ ⑯	Solobalapan ～ Madium	96,937 (12)	5	900	Express	70
					Ordinary	102
					Freight	87
⑬ ～ ⑰	Gambringun ～ Bojonegoro	114,856 (11)	5	300	Express	87
					Ordinary	116
					Freight	133
⑰ ～ ⑱	Bojonegoro ～ Surabaya Pasarturi	104,802 (15)	6	300	Express	84
					Ordinary	123
					Freight	130
⑯ ～ ⑲	Madium ～ Kertosono	68,895 (8)	7	500	Express	49
					Ordinary	72
					Freight	62
⑱ ～ ㉑	Surabayakota ～ Bangil	46,739 (8)	5	700	Express	36
					Ordinary	59
					Freight	46
⑲ ～ ⑱	Kertosono ～ Surabaya	87,109 (13)	5	800	Express	66
					Ordinary	101
					Freight	78
⑲ ～ ⑳	Kertosono ～ Tulungaggung	58,659 (8)	5	400	Express	42
					Ordinary	66
					Freight	54

Table 3.2.1 (4)

Node No.	Section	Railway line			Kind of train	Running time (min)
		Distance	Grade	Radius of curvature		
⑳ ~ ㉒	Tulungaggung ~ Malang	104,426 Inter-mediate station (14)	16	200	Express Ordinary Freight	88 127 139
㉑ ~ ㉒	Bangil ~ Malang	49,234 (6)	21	300	Express Ordinary Freight	45 61 55
㉑ ~ ㉓	Bangil ~ Probolinggo	54,413 (4)	6	600	Express Ordinary Freight	37 49 46
㉓ ~ ㉔	Probolinggo ~ Jember	95,834 (11)	15	200	Express Ordinary Freight	80 109 127
㉔ ~ ㉕	Jember ~ Banyuwangi	103,141 (14)	18	300	Express Ordinary Freight	89 126 141

Table 3.2.2 (1) Comparison of Running Time (Maximum speed of 120 km/h and 100 km/h)

1. Sections of which grade is small and radius of curvature is large

Node No.	Section	Line condition			Net running time (min)					Average speed (km/h)					Ratio of average speed (100/120)	
		Distance (km)	Maximum grade (‰)	Minimum radius (m)	Express Maximum 120km/h	Express Maximum 100km/h	Ordinary 120	Ordinary 100	Freight	Express Maximum 120km/h	Express Maximum 100km/h	Ordinary 120	Ordinary 100	Freight	Express	Ordinary
③~④	Jakarta – Cikampek	84,746	5	540	53	60	83	84	72	95.9	84.7	61.3	60.5	70.6	0.88	0.99
④~⑦	Cikampek – Cirebon	135,161	5	500	77	91	107	116	109	105.3	89.1	75.8	69.9	74.4	0.85	0.92
⑨~⑪	Kroya – Kebumen	47,956	5	450	27	32	42	45	38	106.6	89.9	68.5	63.9	75.7	0.84	0.93
⑬~⑮	Solobalapan – Madiun	96,937	5	900	55	66	75	82	79	105.7	88.1	77.5	70.9	73.6	0.83	0.91
⑮~⑲	Madiun – Kertosono	68,895	7	500	40	47	53	58	56	103.3	88.0	78.0	71.3	73.8	0.85	0.91
⑱~㉑	Surabayakota – Bangil	46,739	5	700	30	34	43	45	40	93.5	82.5	65.2	62.3	70.1	0.88	0.96
⑲~⑱	Kertosono – Surabayakota	87,109	5	800	53	62	75	80	70	98.6	84.3	69.7	65.3	74.7	0.85	0.94
㉑~㉓	Bangil – Probolinggo	54,413	6	600	31	37	38	43	44	105.3	88.2	85.9	75.9	74.2	0.84	0.88
														Average	0.85	0.93

Note: (1) The above figures were calculated by using maximum running speed of 115 and 95 km/h for passenger train and 80 km/h for freight train (each reduced by 5 km/h)

(2) Net running time is obtained by adding 5% of surplus to a calculated time. Unit is minute and fractions of 5 and over was counted as a unit and the rest was cut away.

Table 3.2.2 (2)

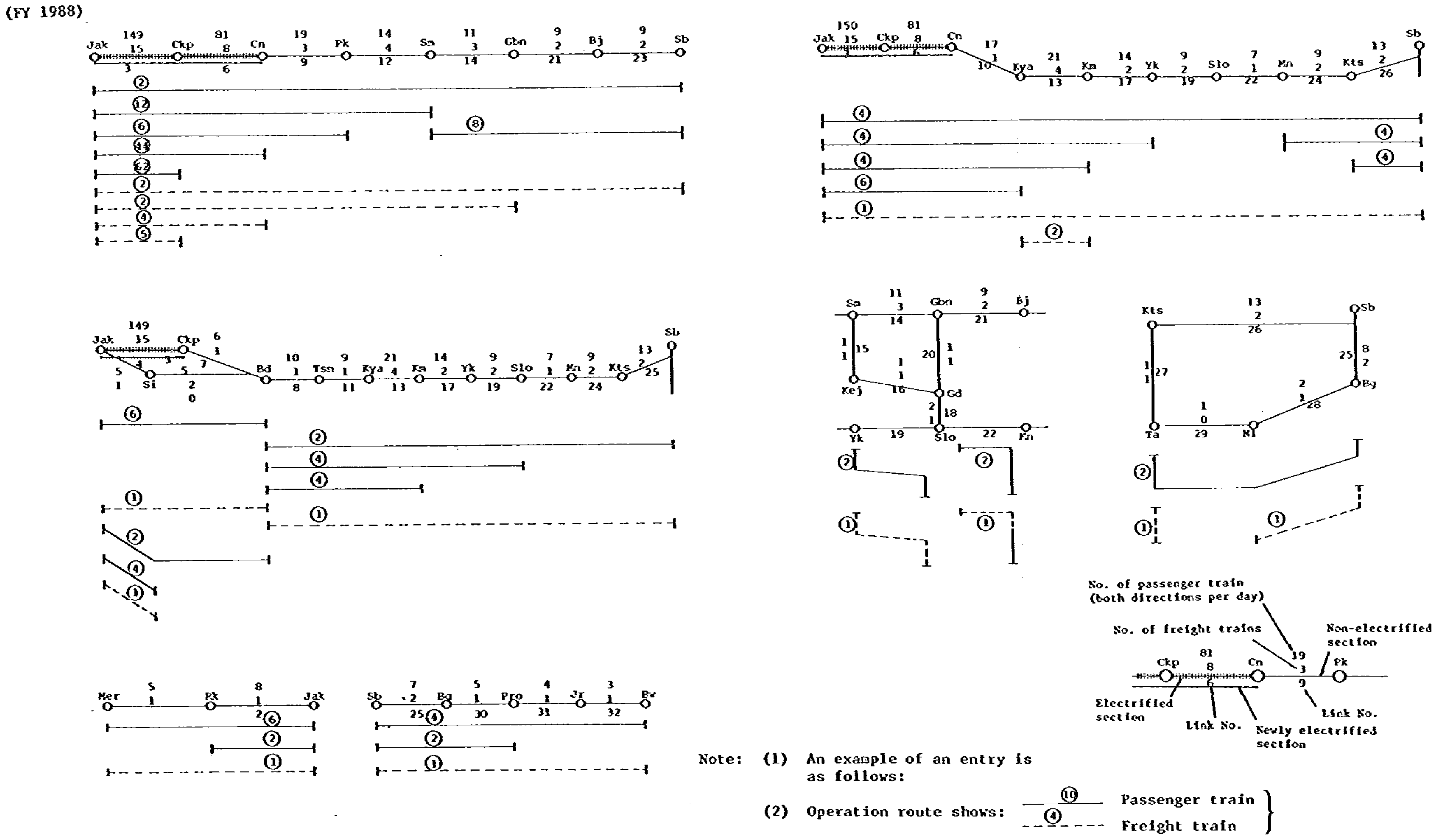
2. Section of which grade is small and radius of curvature is small (less than 400m)

Node No.	Section	Line condition			Net running time (min)					Average speed (km/h)					Ratio of average speed (100/120)	
		Distance (km)	Maximum grade (%)	Minimum radius (m)	Express Maximum 120km/h	Express Maximum 100km/h	Ordinary 120	Ordinary 100	Freight	Express Maximum 120km/h	Express Maximum 100km/h	Ordinary 120	Ordinary 100	Freight	Express	Ordinary
(1)～(2)	Merak Rangkasbitung	68,625	6	300	42	48	54	58	58	98.0	85.8	76.3	71.0	71.0	0.88	0.93
(2)～(3)	Rangkasbitung Jakarta	83,097	8	200	57	60	79	80	74	87.5	83.1	63.1	62.3	67.4	0.95	0.99
[illegible]	Cirebon Pekalongan	135,993	5	300	84	96	107	115	109	97.1	85.0	76.3	71.0	74.9	0.88	0.93
[illegible]	Pekalongan Semarangponcol	87,980	7	400	52	60	68	74	72	101.5	88.0	77.6	71.3	73.3	0.87	0.92
[illegible]	Kebumen Yogyakarta	91,762	5	300	57	65	78	82	75	96.6	84.7	70.6	67.1	73.4	0.88	0.95
[illegible]	Semarang Kedungjati	36,750	9	400	26	31	34	37	48	84.8	71.1	64.9	59.6	45.9	0.84	0.92
[illegible]	Semarang Gambringan	60,309	5	300	35	41	48	51	49	103.4	88.3	75.4	71.0	73.8	0.85	0.94
[illegible]	Gambringan Gundih	9,915	5	400	6	7	7	8	8	99.2	85.0	85.0	74.4	74.4	0.86	0.88
[illegible]	Kudungjati Gundih	31,726	9	400	18	21	25	27	25	105.8	90.6	76.1	70.5	76.1	0.86	0.93
[illegible]	Gundih Solobalapan	41,957	9	400	25	29	32	35	34	100.7	86.8	78.7	71.9	74.0	0.86	0.91
[illegible]	Gambringan Bojonegoro	114,856	5	300	70	80	88	95	95	98.4	86.1	78.3	72.5	72.5	0.88	0.93
[illegible]	Bojonegoro Surabaya-pasarturi	104,802	6	300	63	75	87	94	88	104.4	83.8	72.3	66.9	71.5	0.86	0.93
[illegible]	Kertosono Tulungagung	58,639	5	400	34	40	49	52	48	103.5	88.0	71.8	67.7	73.3	0.85	0.93
														Average	0.87	0.93

Table 3.2.2 (3)

3. Section of which grade is large

Node No.	Section	Line condition: Distance (km)	Line condition: Maximum grade (‰)	Line condition: Minimum radius (m)	Net running time (min): Express Maximum 120km/h	Net running time (min): Express Maximum 100km/h	Net running time (min): Ordinary 120	Net running time (min): Ordinary 100	Net running time (min): Freight	Average speed (km/h): Express Maximum 120km/h	Average speed (km/h): Express Maximum 100km/h	Average speed (km/h): Ordinary 120	Average speed (km/h): Ordinary 100	Average speed (km/h): Freight	Ratio of average speed (100/120): Express	Ratio of average speed (100/120): Ordinary
3~5	Jakarta ~ Sukabumi	111,844	25	150	112	121	126	135	133	59.9	55.5	53.3	49.7	50.5	0.93	0.93
4~6	Cikampek ~ Bandung	89,727	16	200	78	82	100	101	86	69.0	65.7	53.8	53.3	62.6	0.95	0.99
5~6	Sukabumi ~ Bandung	97,961	33	150	98	99	117	117	118	60.0	59.4	50.2	50.2	49.8	0.99	1.00
7~9	Cirebon ~ Kroya	157,954	14	300	104	108	135	138	160	91.1	87.8	70.2	68.7	59.2	0.96	0.98
6~8	Bandung ~ Tasikmalaya	115,059	25	150	103	107	120	120	133	67.0	64.5	57.5	57.5	51.9	0.96	1.00
8~9	Tasikmalaya ~ Kroya	132,583	10	150	78	91	107	115	109	102.0	87.4	74.3	69.2	73.0	0.86	0.93
14~15	Yogyakarta ~ Solobalapan	59,238	11	-	37	42	56	58	53	96.1	84.6	63.5	61.3	67.1	0.88	0.97
20~22	Tulungaggung ~ Malang	104,426	16	200	73	81	95	99	99	85.8	77.4	66.0	63.3	63.3	0.90	0.96
21~22	Bangil ~ Malang	49,234	21	300	40	43	50	51	51	73.9	68.7	59.1	57.9	57.9	0.93	0.98
23~24	Probolinggo ~ Jember	95,834	15	200	65	73	83	87	89	88.5	78.8	69.3	66.1	64.6	0.89	0.95
24~25	Jember ~ Banyuwangi	103,141	18	300	75	82	97	99	101	82.5	75.5	63.8	62.5	61.3	0.91	0.98
														Average	0.92	0.97



Note: (1) An example of an entry is as follows:

(2) Operation route shows: Passenger train / Freight train

Fig. 3.2.2 (1) Train Operation Route and Number of Trains
(Maximum speed 100 km/h, after capacity check)

(FY 1989)

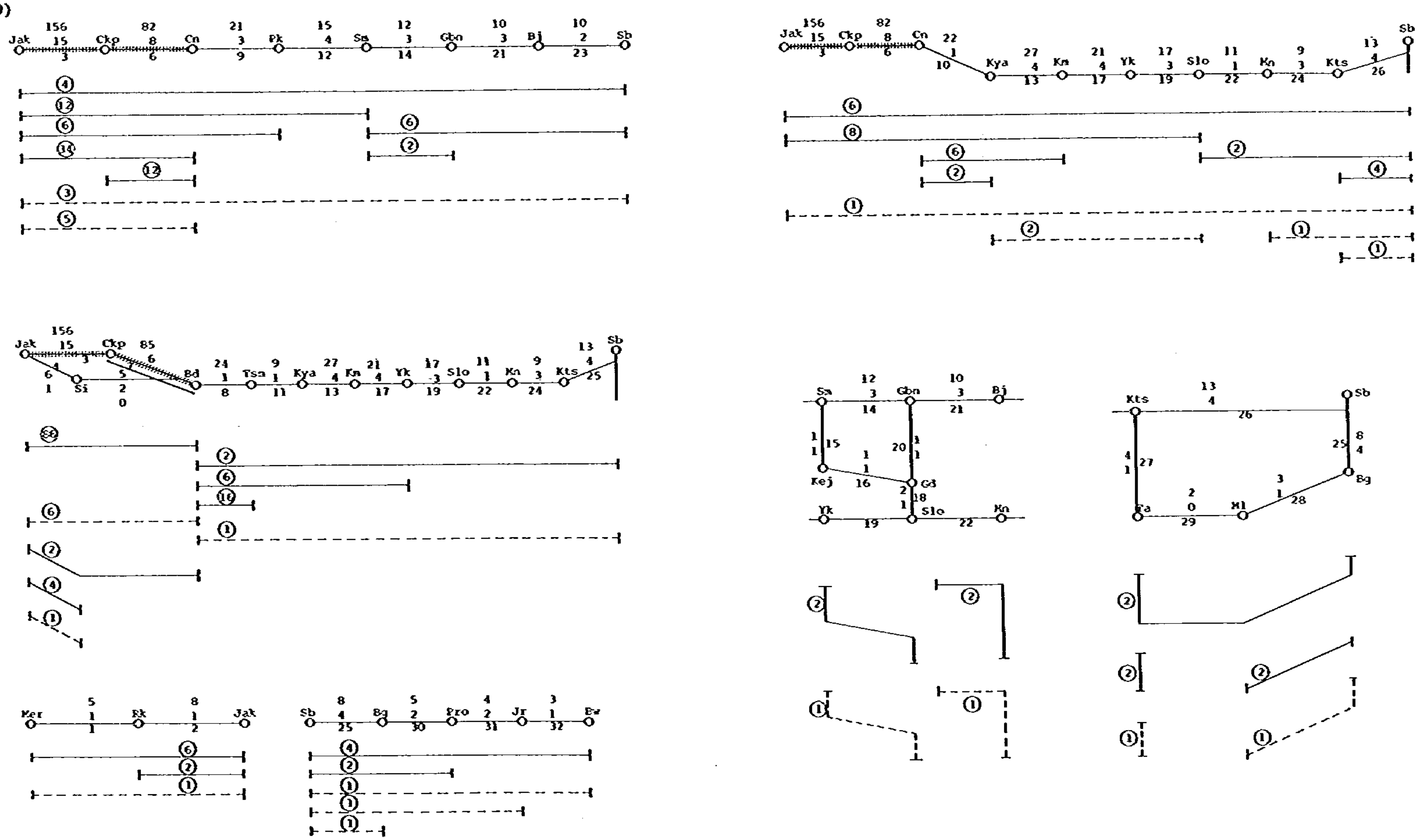


Fig. 3.2.2 (2)

(FY 1991)

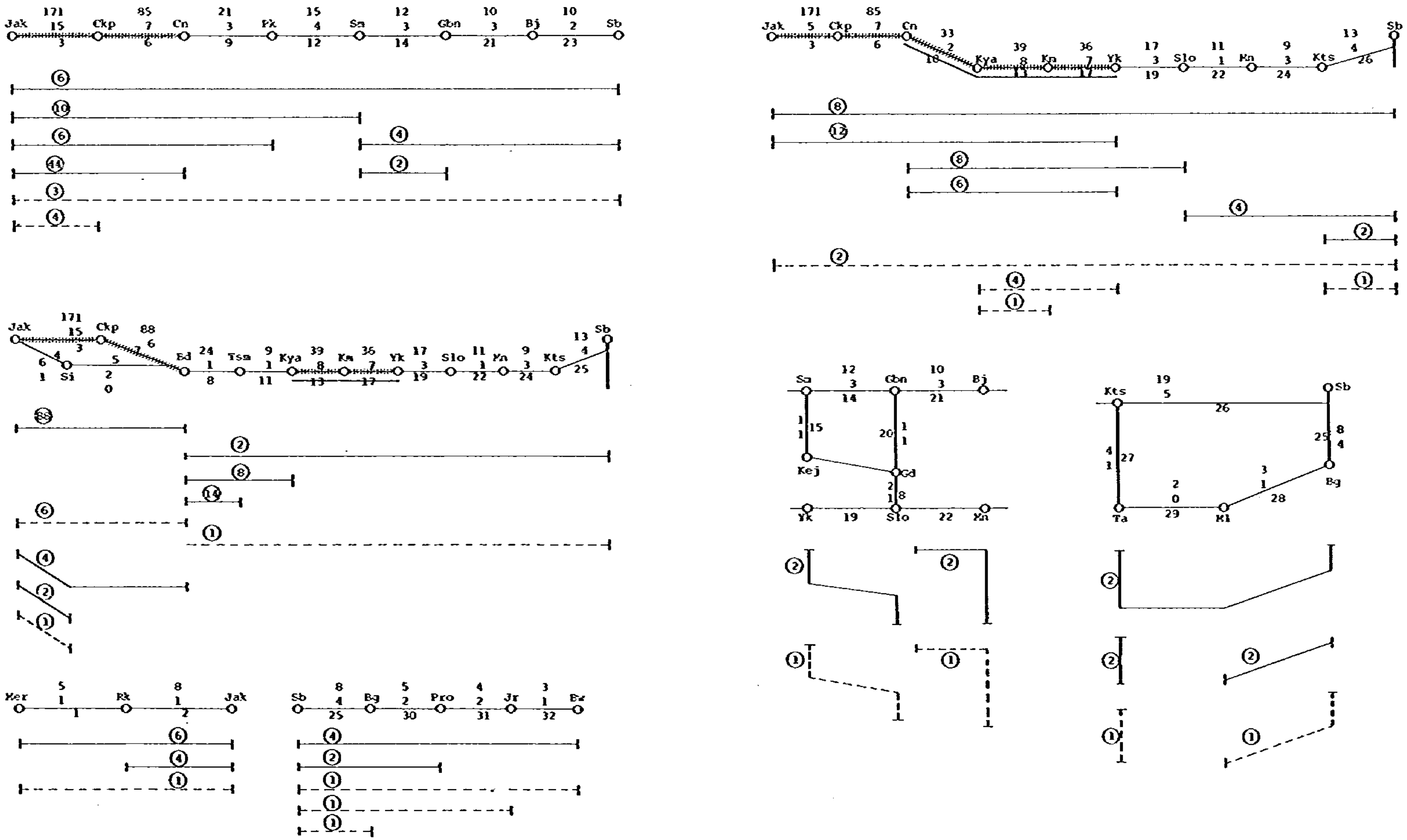


Fig. 3.2.2 (3)

(FY 1992)

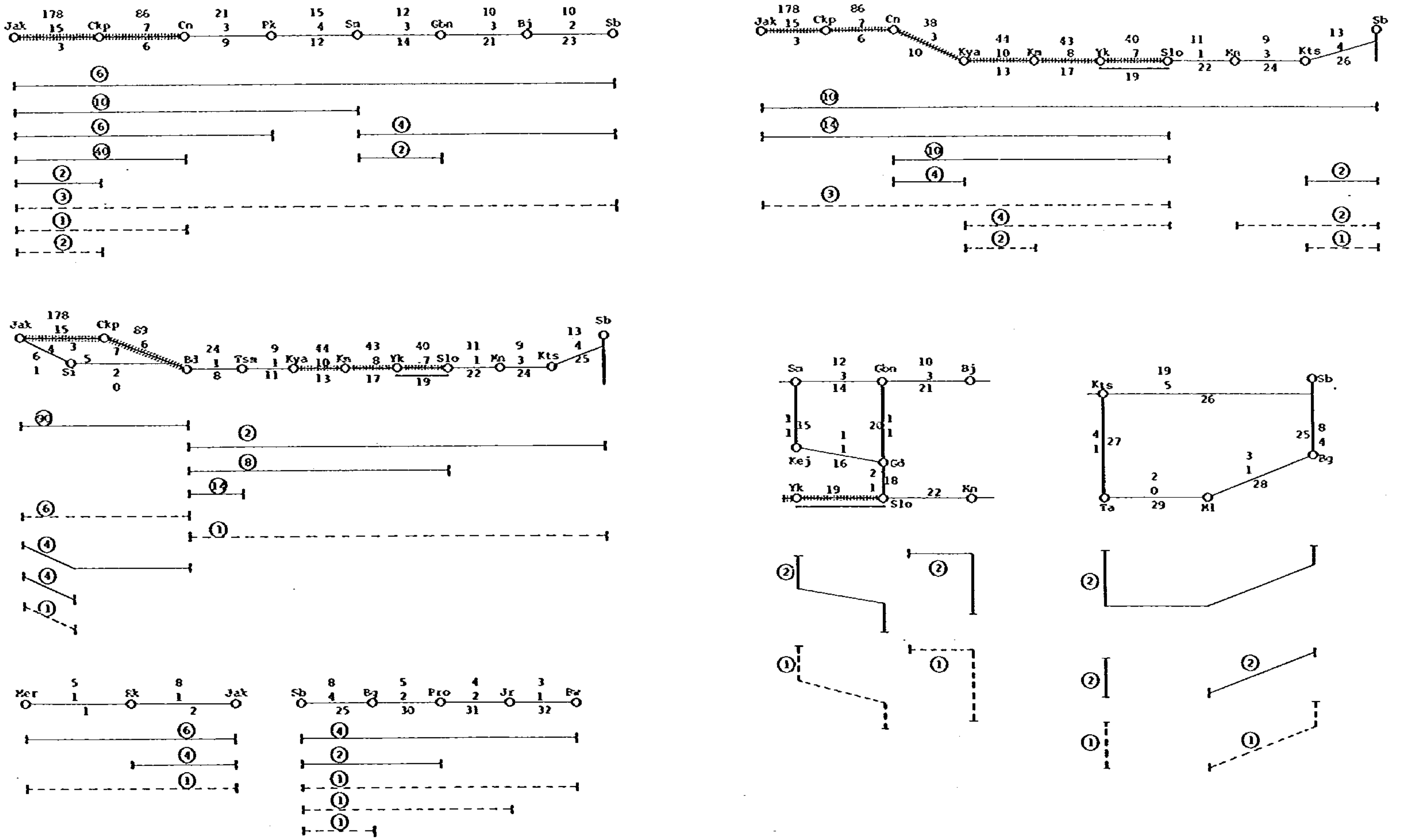


Fig. 3.2.2 (4)

(FY 1994)

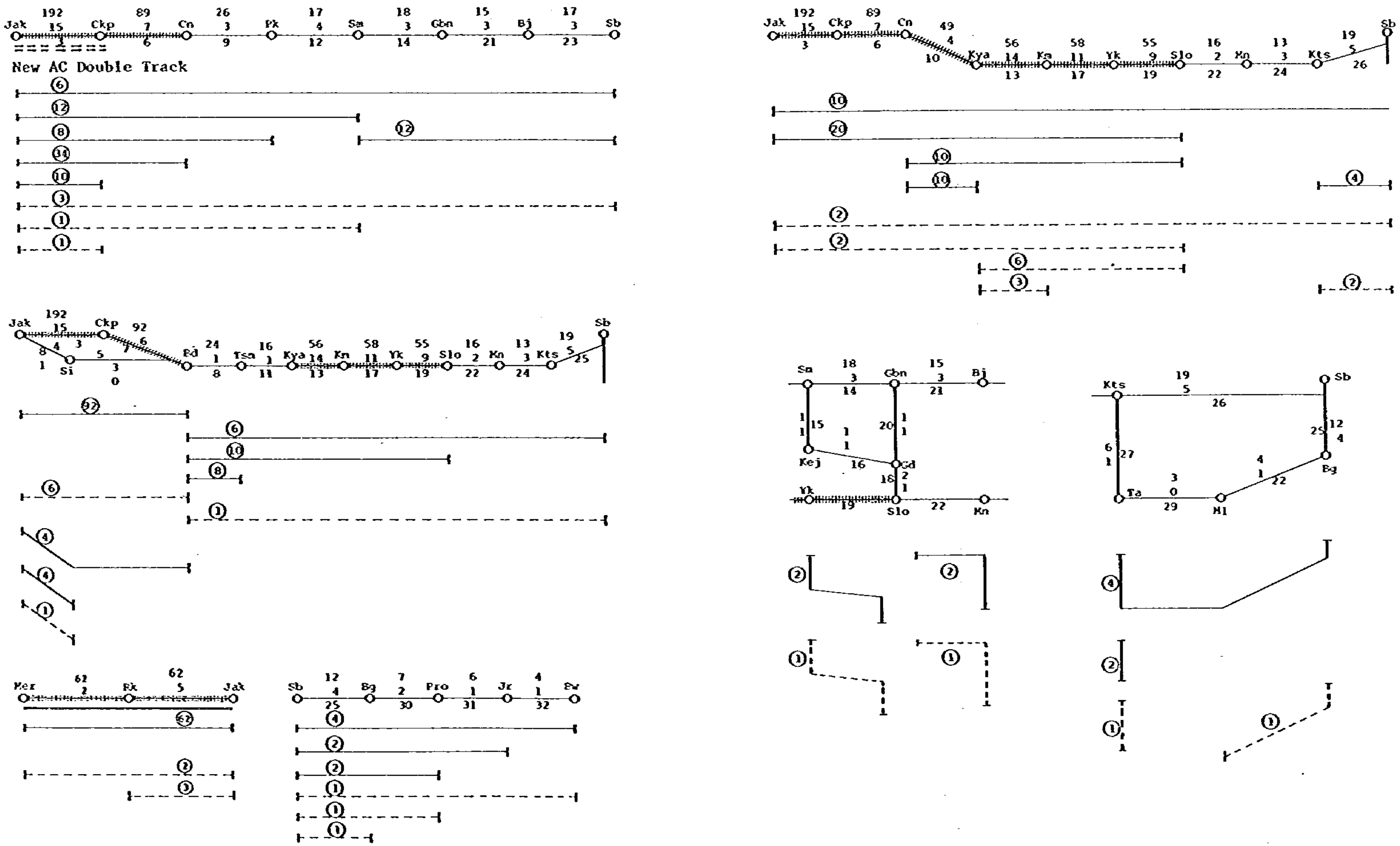


Fig. 3.2.2 (5)

(FY 1995)

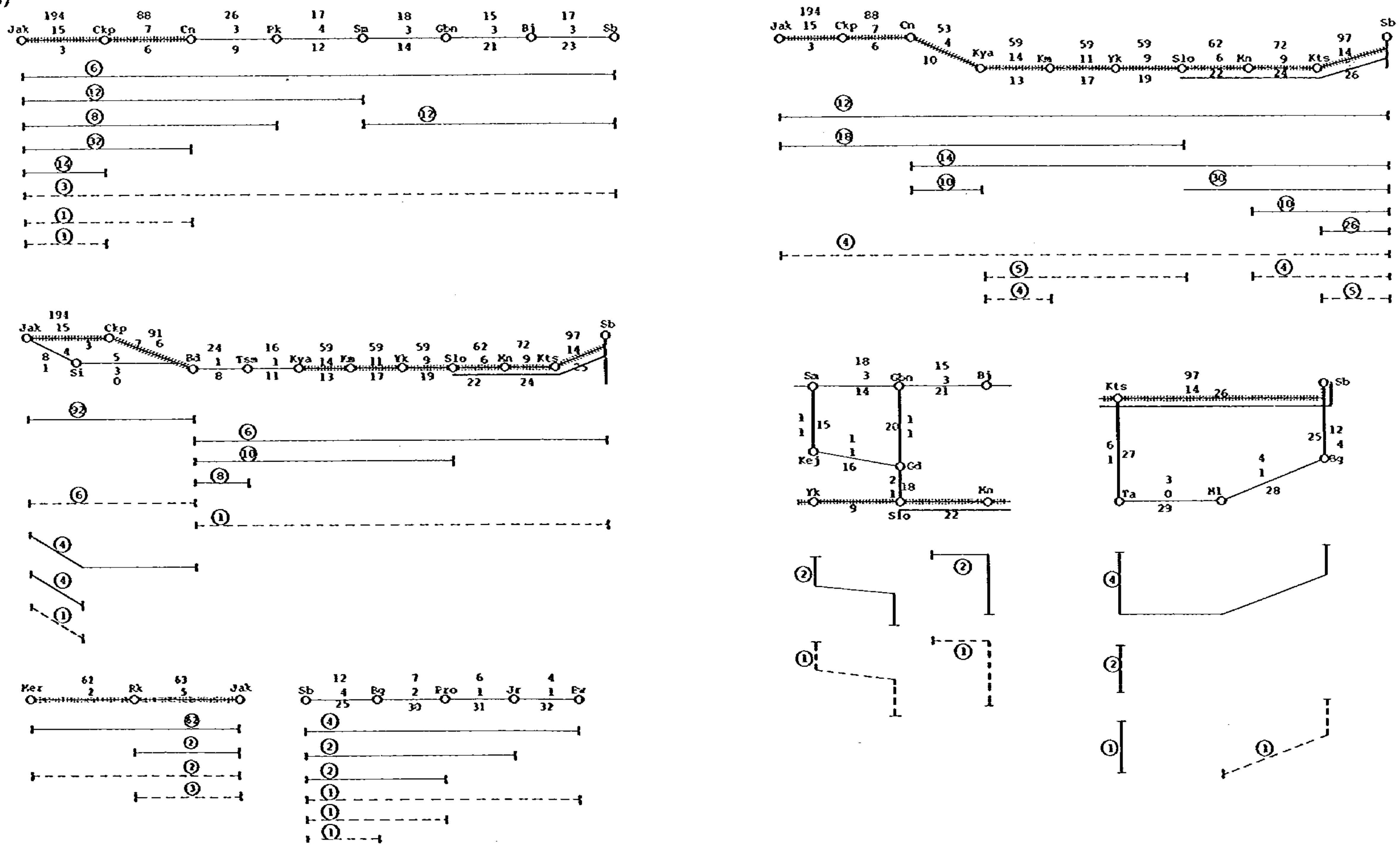


Fig. 3.2.2 (6)

(FY 1993)

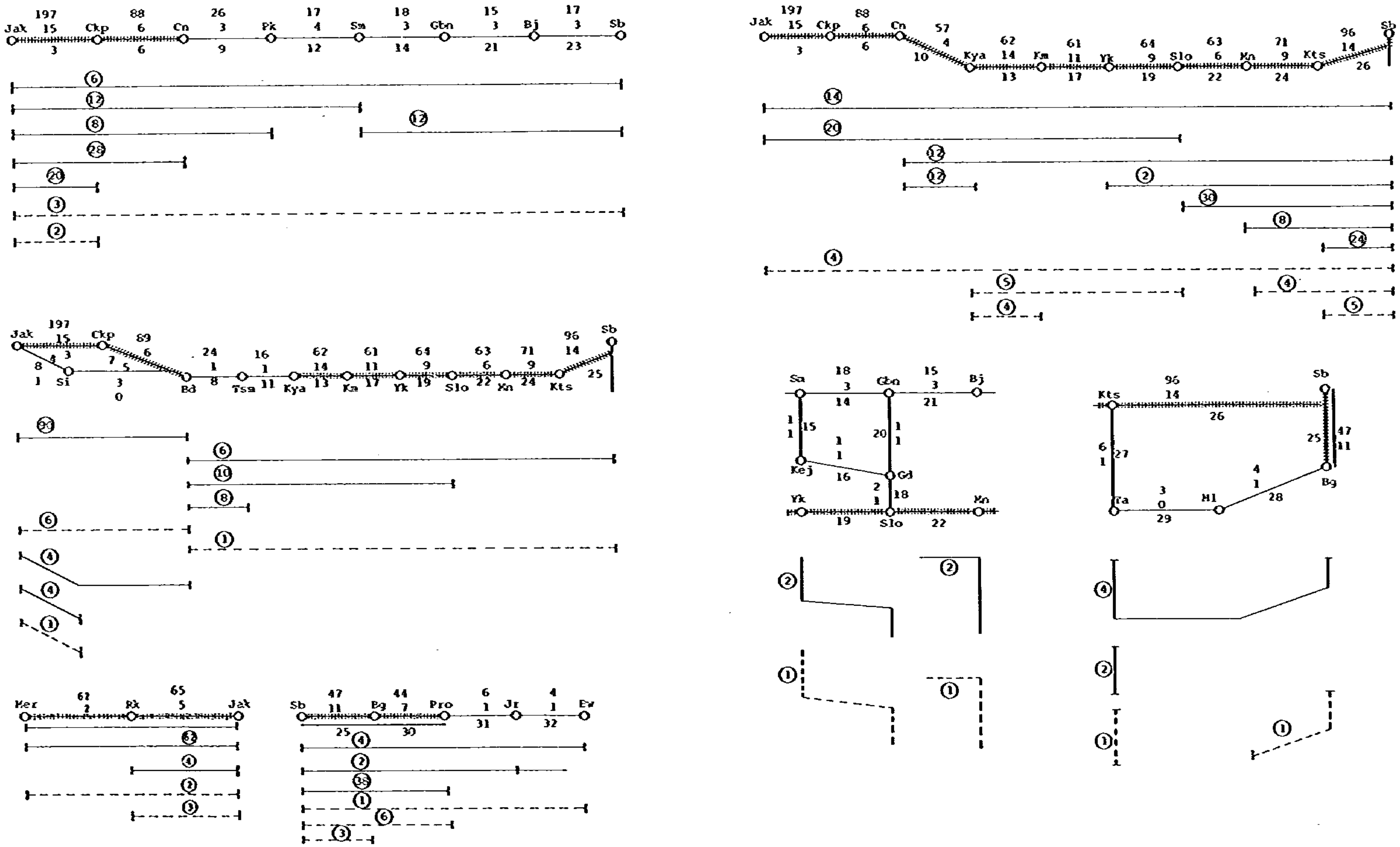


Fig. 3.2.2 (7)

(FY 1998)

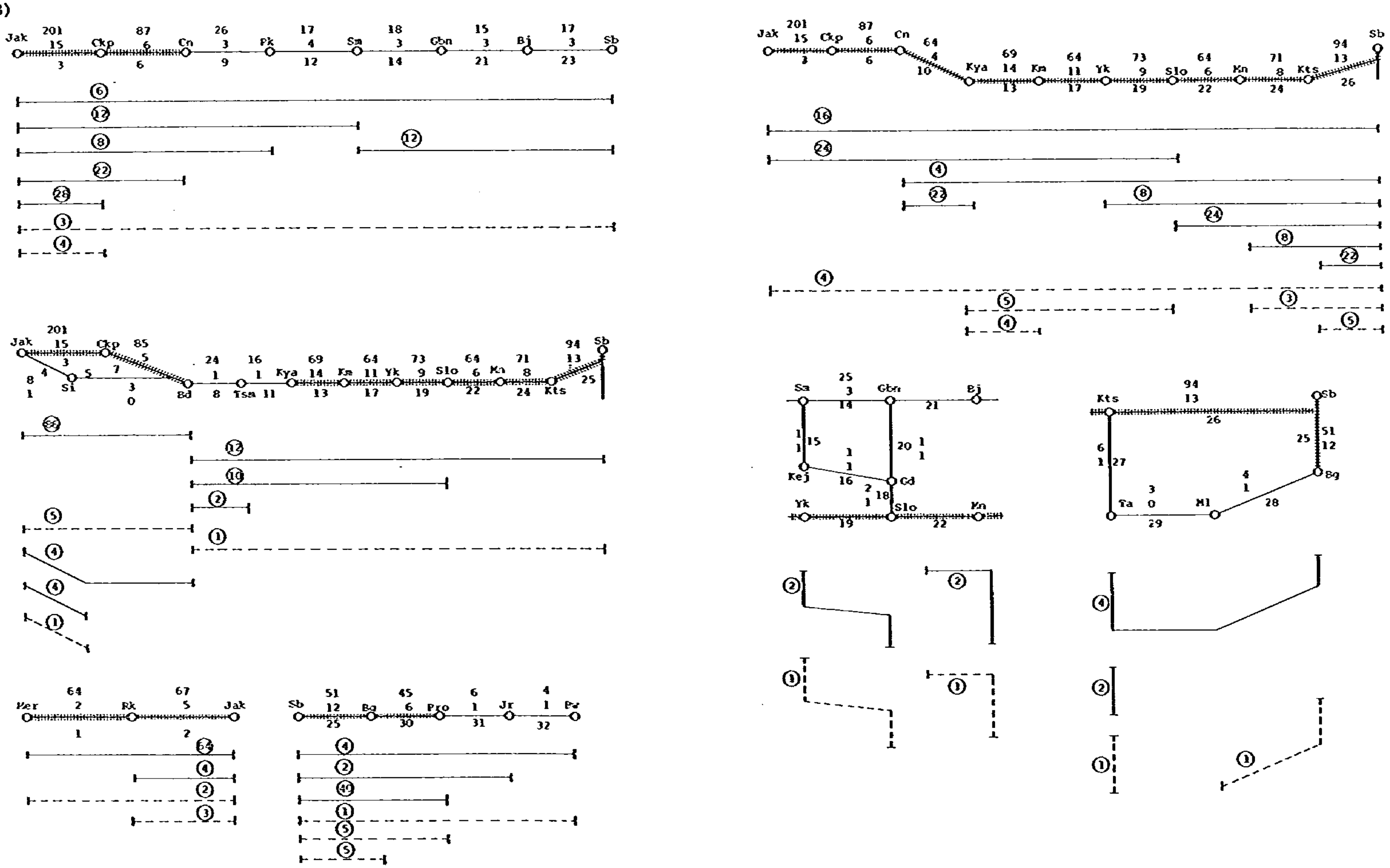


Fig. 3.2.2 (8)

(FY 2003)

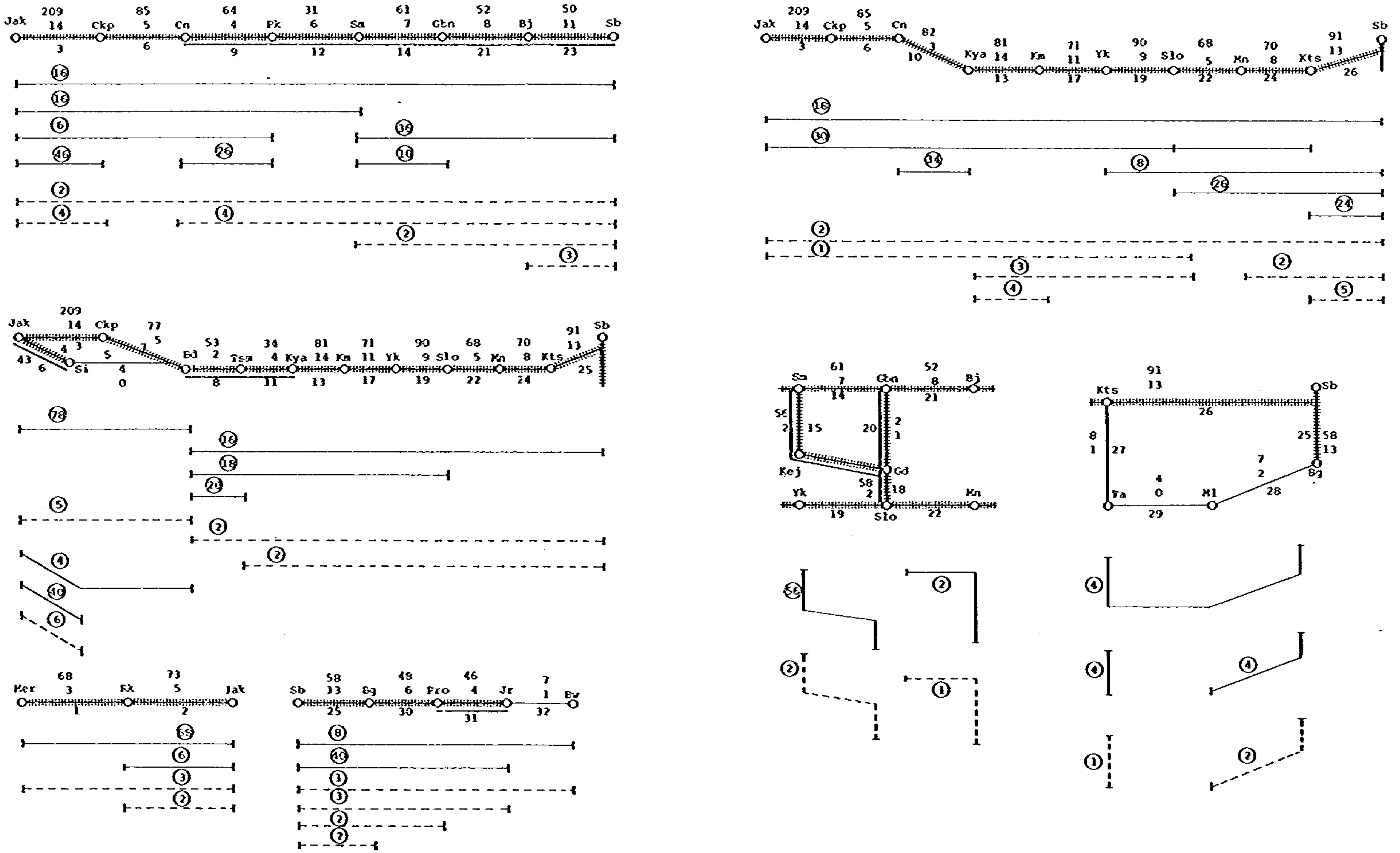


Fig. 3.2.2 (9)

(FY 2008)

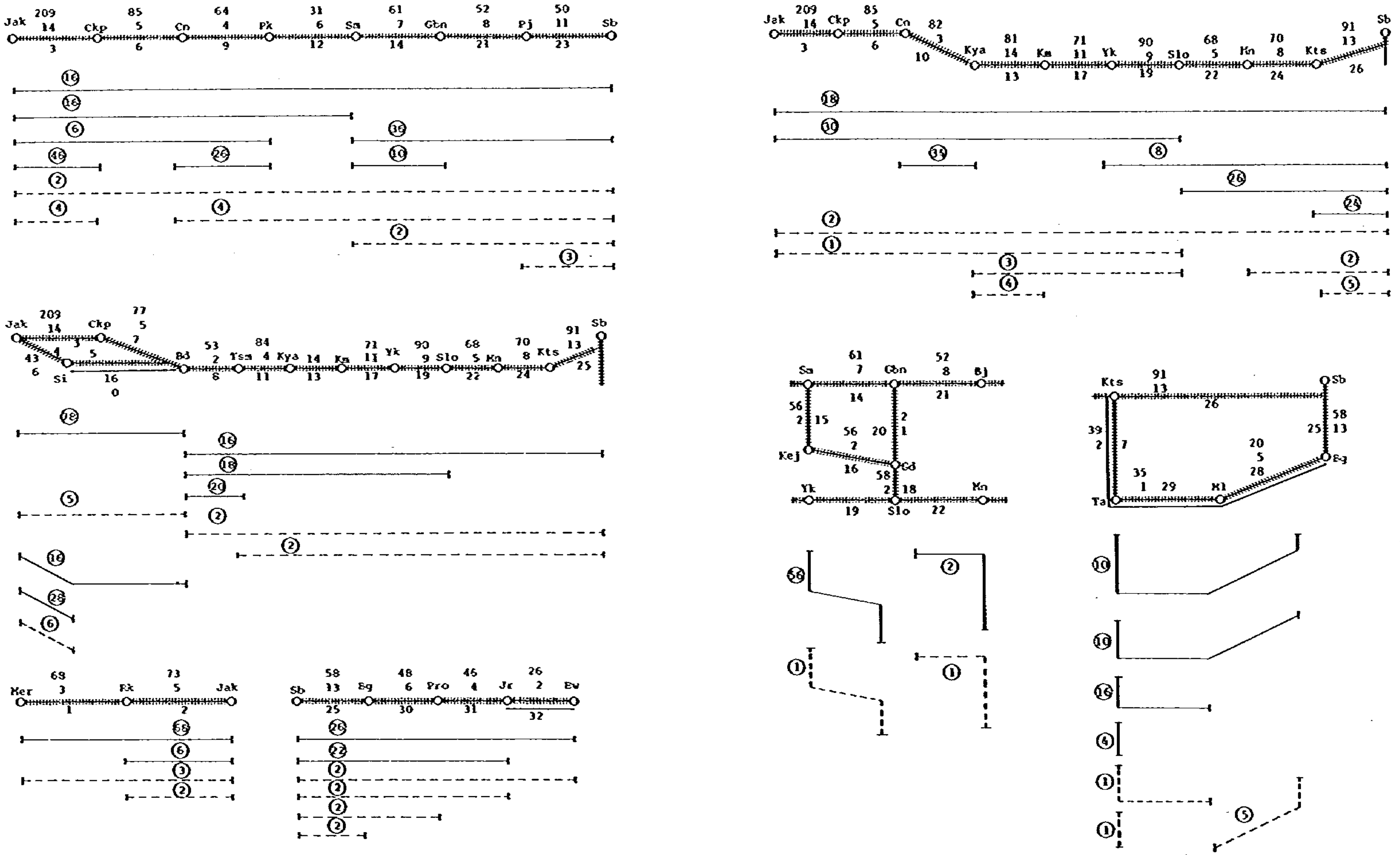


Fig.3.2.2.(10)

3) Train operation route and number of trains

Fig. 3.2.2 (1) through Fig. 3.2.2 (10) show the train operation route and the number of trains for each year when electrified sections are opened.

The number of trains between cities was determined based on the transport demand of each section (the number of trains required) and the OD table. In the forecast of transport demand, some sections have odd numbered trains, but in this program, all trains were set as an even number. However, since freight trains, may be operated every other day, some groups of freight trains were also set as an odd number.

Since trains were scheduled by strictly adhering to the forecast of transport demand, it is seen that some trains are to be operated for only one section, but it is expected that in actual operation such trains would be operated for longer sections in consideration of the passenger trends and the operation of cars, even if riding efficiency would fall.

The train operation route after electrification places an emphasis on those major cities of Jakarta, Surabaya, Bandung and Semarang, as does the current route.

4) Unit of train

It was decided to compose a passenger train with 9 cars in consideration of the effective length of railway track within a station yard. A freight train was decided to haul 1,000 tons by assuming the ratio between loaded cars and unloaded cars (actual record of 1981, PJKA) to be 0.633: 0.367. The number of cars of a freight train is 52 with 15-ton freight cars.

5) Train kilometer

Table 3.2.3 shows train kilometers by stage of electrification. The total train kilometers of passenger and freight trains in 2008 is about 178,000km, 3.5 times larger that of 1988. The train kilometers for freight is about 8% of the total.

The train kilometers for freight is about 8% of the total. The train kirometers of the electrified section were completely calculated by assuming that all trains would be hauled by electric locomotives. However, it is expected that some trains of electric rail-cars would be operated but some would be hauled by diesel locomotives.

(4) Arriving time after electrification

To accurately calculate the arriving time of a train, it is normally necessary to calculate the standard running time of the train by preparing a train operation curve and a train diagram which is prepared based on the standard running time thus calculated. Arriving times of trains between major stations obtained by approximate calculation are compared with those of the current trains as shown in Table 3.2.4.

The shrinkage arriving times after electrification can become as high as 36% to 48%. However, stopping times of the present trains are very long; for instance, the total stopping time at Bima is 65 min, Mutara Utara is 67 min and Mutiara Timur is 44 min. Stopping times of trains after electrification are set at 5 min for a major station and 3 min for a medium station. If the stopping time is made longer, the arrival time shrinkage falls slightly.

Since the Parahyangan train is operated nonstop between Gambir and Bandung (Bd-Jak train makes a stop at Jatinegara), its shortening rate is 26% which is considerably lower than that of other trains. The arriving time of a train after electrification includes some stopping time for passing by in single track sections, therefore such arriving time would be further shortened if the train is operated by nonstop system like Parahyangan train.

Table 3.2.3 Train Kilometer by Stage of Electrification

Year	Newly electrified section	Passenger train kilometer				Freight train kilometer				Total			
		DC EL	AC EL	DL	Sub-total	DC EL	AC EL	DL	Sub-total	DC EL	AC EL	DL	Sub-total
1988	Mri∿Ckp Ckp∿Cn	8,040.0	14,281.1	22,431.4	44,752.5	999.0	1,401.1	3,612.0	6,012.1	9,039.0	15,682.2	26,043.4	50,764.6
1989	Ckp∿Bd (Kac)	8,361.6	22,123.4	26,664.9	57,149.9	999.0	1,939.3	4,408.7	7,347.0	9,360.6	24,062.7	31,073.6	64,496.9
1991	Cn∿Yk	9,326.4	33,823.8	19,825.3	62,975.5	999.0	3,146.7	3,691.5	7,837.2	10,325.4	36,970.5	23,516.8	70,812.7
1992	Yk∿Slo	9,540.8	38,014.8	18,759.7	66,315.3	999.0	3,906.9	3,513.9	8,419.8	10,539.8	41,921.7	22,273.6	74,735.1
1994	Mri∿Kw AC dual tracks Sarpong∿Mar	9,622.0	54,028.8	23,641.9	87,292.7	575.7	5,531.2	3,550.6	9,657.5	10,197.7	59,560.0	27,192.5	96,950.2
1995	Slo∿Sb	9778.3	74,657.0	19,384.9	103,820.2	575.7	7,952.1	2,714.6	11,242.4	10,354.0	82,609.1	22,099.5	115,062.6
1996	Sb∿Pro	9,953.7	80,580.4	18,389.3	108,923.4	575.7	8,711.4	2,419.0	11,706.1	10,529.4	89,291.8	20,808.3	120,629.5
2003	Cn∿Sm∿Sb Bd∿Kya, Pro∿Jr Sm∿Kej∿Slo Cbn∿Cd	11,154.6	140,315.8	2,497.6	153,968.0	644.3	13,588.0	260.2	14,492.5	11,798.9	153,903.8	2,757.8	168,460.5
2008	Jr∿Bw Ktm∿Ml∿Bg	11,154.6	151,654.8	-	162,809.4	644.3	14,262.0	-	14,906.3	11,798.9	165,916.8	-	177,715.7

Table 3.2.4 Shortening of Arriving Time by Electrification

Operating section	After electrification	Present		Difference (B-A)	Shorten rate
	Arriving time (A)	Name of train	Arriving time (B)		$\frac{(B-A)}{B} \times 100\%$
Jakarta ∿ ∿ Surabaya Gubeng	10hr 34min	Bima	16hr 30min	5hr 56min	36.0
Jakarta ∿ Surabaya Pasar Turi	9hr 28min	Mutiara Utara	15hr 30min	6hr 02min	38.9
Semarangtawang ∿ Surabaya Pasar Turi	3hr 50min	Cepat Semarang-tawang	7hr 20min	3hr 30min	47.7
Bandung ∿ Surabaya Kota	9hr 28min	Mutiara Selatan	16hr 20min	3hr 52min	42.0
Banyuwangi ∿ Surabaya Kota	4hr 08min	Mutiara Timur	8hr 00min	3hr 52min	48.3
Jakarta ∿ Bandung	2hr 42min	Parahyangan	3hr 40min	58min	26.4

3.2.3 Line Capacity

Formula for calculating line capacity of single track section:

$$N = \frac{1,440}{(t+c)} \times f$$

Where N: Line capacity

t: Average running time between stations per train (min)

c: Blocking time (Tokenless block section) 1.5 min

f: Utilization rate of line 0.6

Tables 3.2.5 (1) through Table 3.2.5 (3) show the line capacities of sections after electrification.

The line capacities of sections when the maximum speed is set at 120 km/h and those of present sections are also listed, and the line capacity after electrification will be about 2 times larger at present. There is little difference in capacity between 100 km/h and 120 km/h of maximum speed.

This calculation formula is designed to obtain the number of trains when a net diagram is composed in a section, and consideration is not given to the connection with adjoining sections and passing by priority trains. If it is desired to set many passing priority trains, the number of trains will be lower than those calculated by this formula; therefore, the line capacity obtained by this formula should be considered only as a guideline.

Table 3.2.5 Line Capacity by Section (1)

Node No.	Section		Distance between stations whereby line capacity of section is determined				Line capacity (single track)			Remarks
	Name of station	Distance	Name of station	Distance	Maximum grade	Minimum radius of curvature	After electrification 100 km/h	After electrification 120 km/h	Present	
① - ②	Merak ~ Kangkasbitung	km 68,625	Karangantu ~ Cilegon	km 12,660	6 ‰	-	74	78	28	(1) Line capacity is indicated by the number of trains in both directions which can be operated per day on a single track (2) The utilization rate of the line is 0.6. (3) Assuming that tokenless block system is introduced at the time of electrification, line capacities are shown for both cases wherein maximum speed of 100 km/h and 120 km/h are used respectively.
② - ③	Kangkasbitung ~ Jakarta	83,097	Citeras ~ Kangkasbitung	9,859	15	300m	81	82	49	
③ - ④	Jakarta ~ Cikampek	84,746	Tambun ~ Cikarang	9,930	3	540	Dual track (240)	(240)	Dual track (111)	
③ - ⑤	Jakarta ~ Sukabumi	111,864	Batutulis ~ Maseng	9,718	17	150	69	69	40	
④ - ⑥	Cikampek ~ Bandung	89,727	Ciganea ~ Sukatani	7,235	16	200	94	96	40	
⑤ - ⑥	Sukabumi ~ Bandung	97,961	Cipatat ~ Tagogapu	10,825	40	150	61	61	42	
④ - ⑦	Cikampek ~ Cirebon	135,161	Teriat ~ Telagasari	10,185	5	500	90	96	44	
⑦ - ⑨	Cirebon ~ Kroya	157,954	Prupuk ~ Linggapura	10,772	14	300	81	82	36	
⑦ - ⑩	Cirebon ~ Pekalongan	135,993	Warudumur ~ Babakan	14,231	5	400	69	72	29	
⑥ - ⑧	Bandung ~ Tasikmalaya	115,059	Cipeundeuy ~ Ciawi	13,590	25	150	54	54	25	
⑧ - ⑨	Tasikmalaya ~ Kroya	132,583	Kawunganten ~ Jeruklegi	12,808	5	500	75	82	27	
⑩ - ⑫	Pekalongan ~ Semarang	87,980	Ujungnegoro ~ Kuripan	12,200	5	400	77	82	29	
⑨ - ⑪	Kroya ~ Kebumen	47,956	Gombong ~ Karanganyar	7,329	5	450	110	115	46	
⑪ - ⑭	Kebumen ~ Yogyakarta	91,762	Wates ~ Sentalo	10,145	5	300	86	86	32	
⑫ - ㉖	Semarang ~ Kedungjati	36,750	Brumbung ~ Tanggung	11,602	8	400	80	82	30	
⑫ - ⑬	Semarang ~ Gambringan	60,309	Gubug ~ Karangjati	13,080	5	300	72	75	26	

Table 3.2.5 Line Capacity by Section (2)

Node No.	Section		Distance between stations whereby line capacity of section is determined				Line capacity (single track)			Remarks
							After electrification			
	Name of station	Distance	Name of station	Distance	Maximum grade	Minimum radius of curvature	100 km/h	120 km/h	Present	
⑬ - ㉗	Cambringan ~ Gundih	9.915 km	Cambringan ~ Gundih	9.915 km	5 ‰	400m	90	90	38	
㉖ - ㉗	Kedungjati ~ Gundih	31.726	Jambean ~ Gundih	9.688	9	400	90	90	38	
⑮ - ㉗	Gundih ~ Solobalapan	41.957	Kalioso ~ Solobalapan	10.623	9	400	85	86	36	
⑭ - ⑮	Yogyakarta ~ Solobalapan	59.238	Gawok ~ Purwosari	6.639	7	-	116	123	52	
⑮ - ⑯	Solobalapan ~ Madiun	96.937	Kedungbanong ~ Walikukun	12.295	5	900	77	86	32	
⑬ - ⑰	Gambringan ~ Bojonegoro	114.856	Kalitidu ~ Bojonegoro	14.461	5	300	67	72	25	
⑰ - ⑱	Bojonegoro ~ Surabaya-pasarturi	104.802	Lamongan ~ Duduk	12.223	6	500	77	86	28	
⑯ - ⑲	Madiun ~ Kertosono	68.895	Sukomoro ~ Baron	10.635	3	700	87	96	36	
⑱ - ㉑	Surabayakota ~ Bangil	46.739	Gedangan ~ Sidoarjo	7.830	5	800	106	115	59	
⑲ - ⑱	Kertosono ~ Surabayakota	87.109	Curahmalang ~ Mojokerto	8.034	5	1,000	105	108	55	
⑲ - ⑳	Kertosono ~ Tulungaggung	58.659	Kediri ~ Ngadiluweh	9.535	5	500	92	101	36	
⑳ - ㉒	Tulungaggung ~ Malang	104.426	Rejotangan ~ Blitar	13.080	16	200	71	78	26	
㉑ - ㉒	Bangil ~ Malang	49.234	Lawang ~ Sengon	9.877	21	300	77	82	49	
㉑ - ㉓	Bangil ~ Probolinggo	54.413	Rejoso ~ Pasuruan	18.891	3	800	56	64	49	
㉓ - ㉔	Probolinggo ~ Jember	95.834	Randuagung ~ Klakah	11.506	15	300	77	78	49	
㉔ - ㉕	Jember ~ Banyuwangi	103.141	Mrawan ~ Garahan	9.609	18	300	81	82	40	