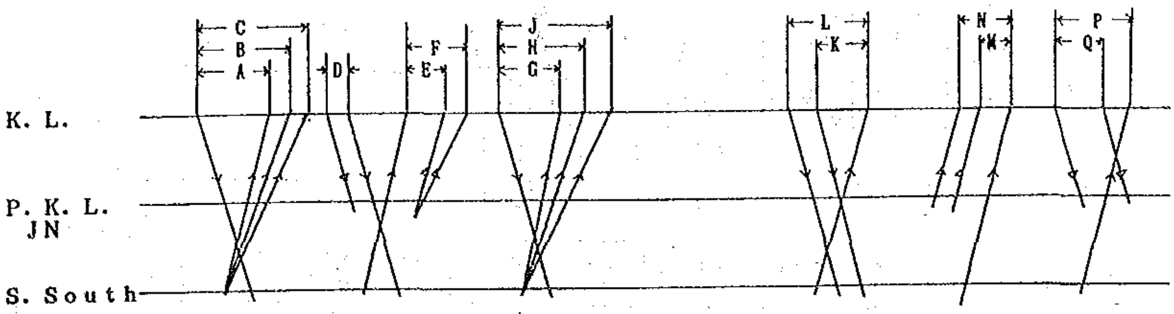
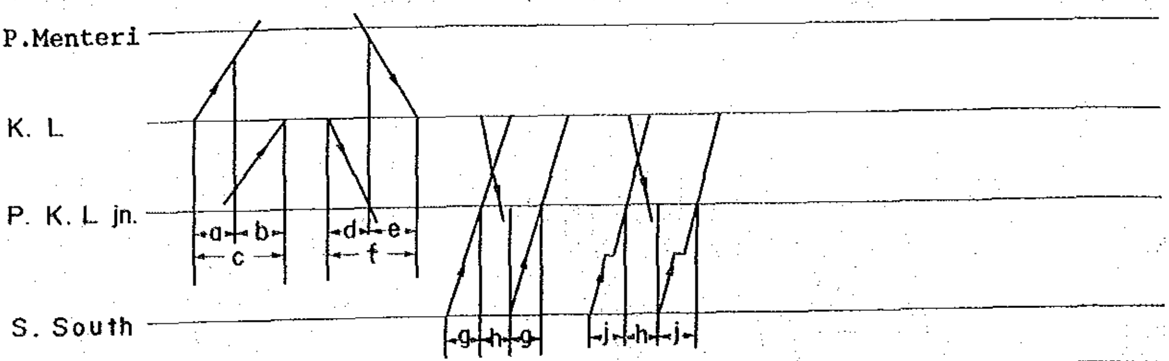
Appendix 5-6-1 Kuala Lumpur Station Minimum Train Headway Chart

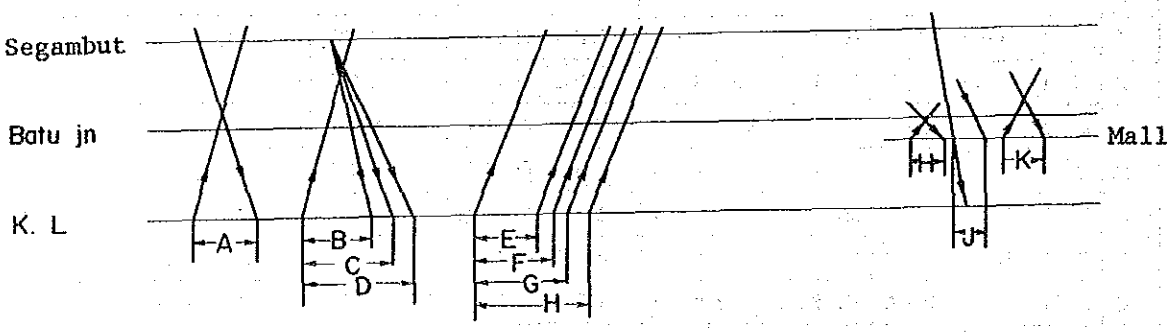


Tipe	Departur or Arrival		Time (Calculated) (min)	Time (Scheduled) (min-sec)	
A	M. L 2・A	M. L 1～4・D	130" (2'10")	2'15"	
B	M. L 3・4・A	do	145" (2'25")	2'30"	
C	M. L 1・A	do	165" (2'45")	3'00"	
D	P. K. L 4・D	M. L 1～4・D	178" (2'58")	3'00"	
E	M. L 1・A	P. K. L 2・A	156" (2'36")	2'45"	
F	do	P. K. L 3・4・A	171" (2'51")	3'00"	
G	M. L 1・2・D	M. L 2・A	226" (3'46")	4'00"	
H	do	M. L 3・4・A	241" (4'01")	4'15"	
J	do	M. L 1・A	260" (4'20")	4'30"	
K	M. L 3・D	M. L 3・4・A	204" (3'24")	3'30"	
L	M. L 4・D	do	211" (3'31")	3'45"	
M	P. K. L 2・A	M. L 1・A	154" (2'34")	2'45"	
N	P. K. L 1・A	M. L 2・A	188" (3'08")	3'15"	
P	P. K. L 3・4・D	M. L 1・A	460" (7'40")	8'00"	8'00" or more
Q	M. L 2・A	P. K. L 3・4・D	122" (2'02")	2'00"	2'00" or less

(Note)
1. DMUs are assumed to have performance curves drawn up by the JICA team.
2. Each DMU train is assumed to consist of 10 cars (220m long).
3. Existing signal facilities will be used between Kuala Lumpur and P.Klang Line Junction.
4. Tracks at P.Klang Line Junction are assumed to cross on the ground level.
5. M.L: Rawang - Seremban Line
6. P.K.L: P.Klang Line
7. D : Departure (figure denotes departure track number)
8. A : Arrival(figure denotes arrival track number)

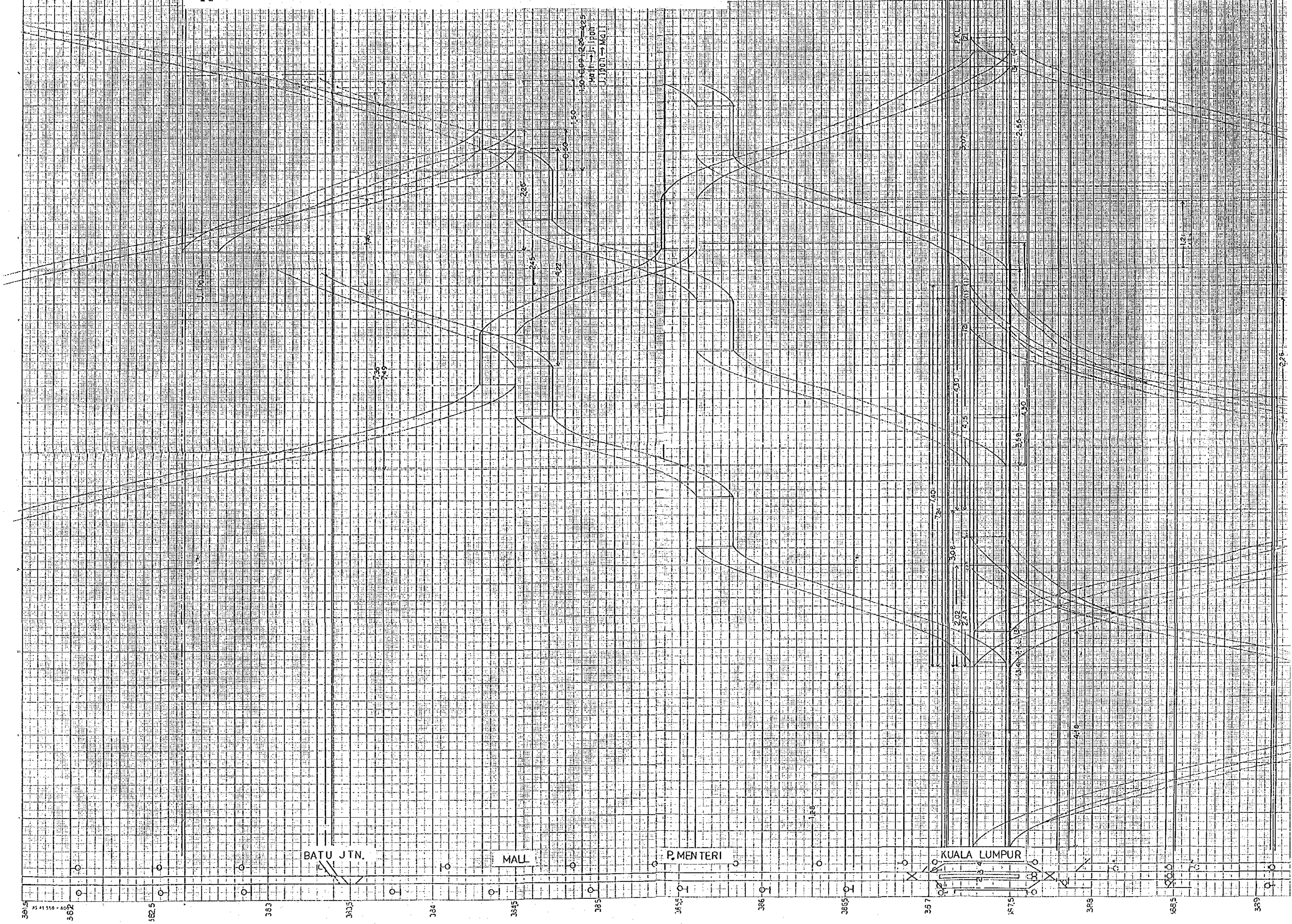


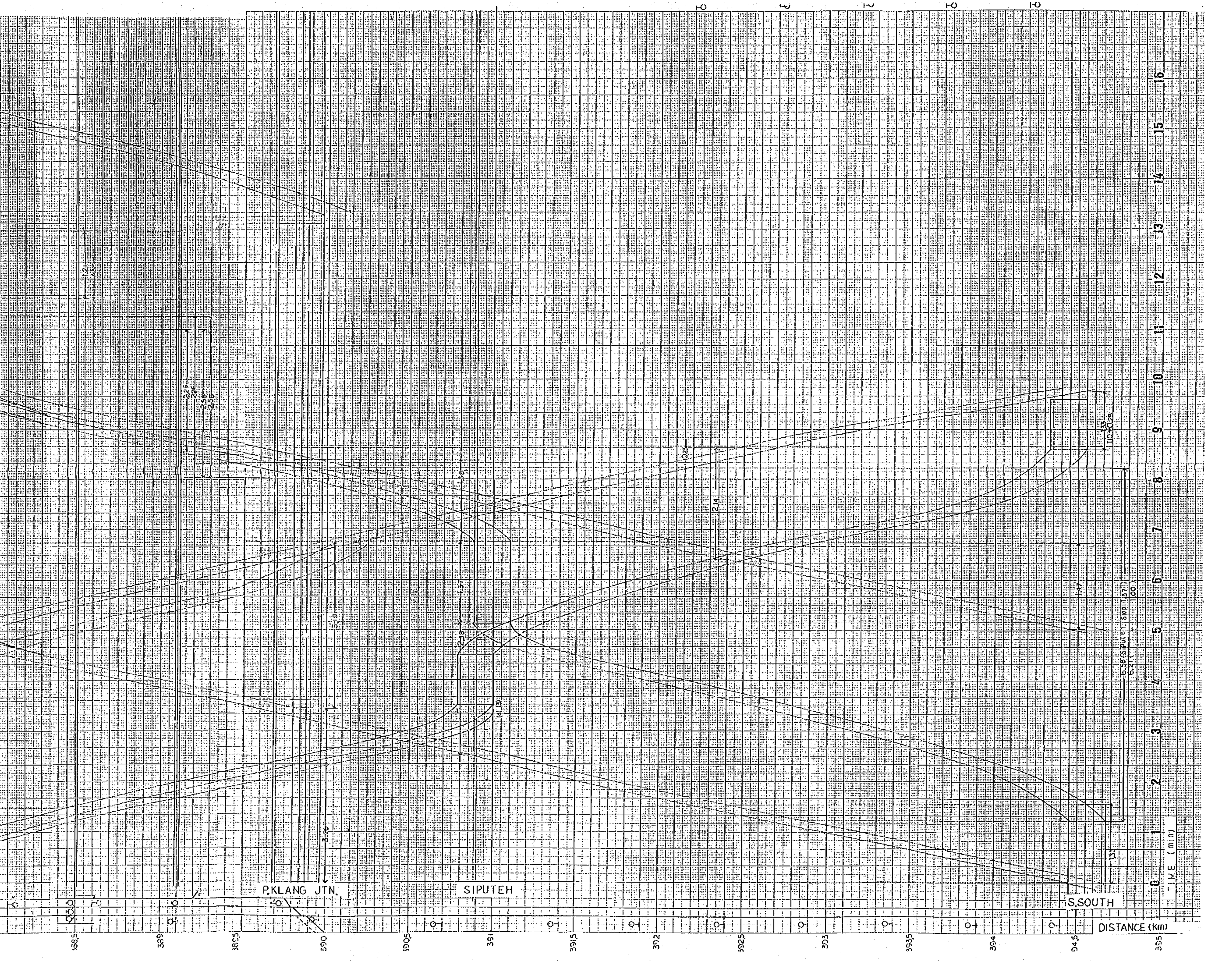
Tipe	Departur or Arrival		Time (Calculate) (min)	Time (Scheduled) (min-sec)	
a	1・2・D		81" (1'21")	1'30"	
b	1・A		146" (2'26")	2'30"	
c	1・2・D	1・A	227" (3'47")	4'00"	
d	4・D		88" (1'28")	1'30"	
e	4・A		176" (2'56")	3'00"	
f	4・D	4・A	264" (4'24")	4'30"	
g	Rabbit・S.South (P)	Rabbit・P.K.L Jn (P)	206" (3'26")	3'30"	
h	Rabbit・P.K.L Jn (P)	P.K.L Train Jn (P)	199" (3'19")	3'30"	
j	Local・S.South・D	Local・P.K.L Jn (P)	381" (6'21")	6'30"	



Tipe	Departur or Arrival		Time (Calculate) (min)	Time (Scheduled) (min-sec)	
A	1・2・D	1・2・A	280" (4'40")	4'45"	
B	3・4・D	3・A	280" (4'40")	4'45"	
C	do	4・A	297" (4'57")	5'00"	
D	do	1・2・A	334" (5'34")	5'45"	
E	1・2・D	1・2・D	238" (3'58")	4'00"	
F	do	3・4・D	238" (3'58")	4'00"	
G	3・4・D	1・2・D	318" (5'18")	5'30"	
H	Mall・D (To Sentul)	Mall・A (To Sentul)	50"	0'30"	K or H Batu Jn Single Track
J	M. L Mall・D	Sentul L・A	238" (3'58")	4'00"	Batu Jn Double Track
K	Mall・D (To Sentul)	Sentul L・D	(4'25")	4'30"	H or K Batu Jn Single Track

Appendix 5-6-2 Time-Distance Chart to Determine Minimum Headway




P.KLANG JTN.
SIPUTEH
S.SOUTH
DISTANCE (km)
TIME (min)

Appendix 5-7-1 Present Status and Problems of Level-Crossing of Tracks

Upon completion of the DTP, there will be two junctions between Rawaing, Kuala Lumpur and Seremban, where railway tracks cross on the ground level, hampering train scheduling when the number of trains is increased, and severely affecting overall train operation when a train delay occurs. (Refer to Fig. 1.)

Schedule for each type of train to pass level-crossing points (S, P, and Q) is determined from the train diagram and signal positions, as shown in the Table 1.

The use rate of a level crossing point is generally limited to 60%, and even at the levels of 40% to 50%, it often becomes difficult to operate trains.

In case the number of trains per peak hour in 2005 is shown in Table 1, the rate of using level crossing points (S and P) will be 40% to 57%.

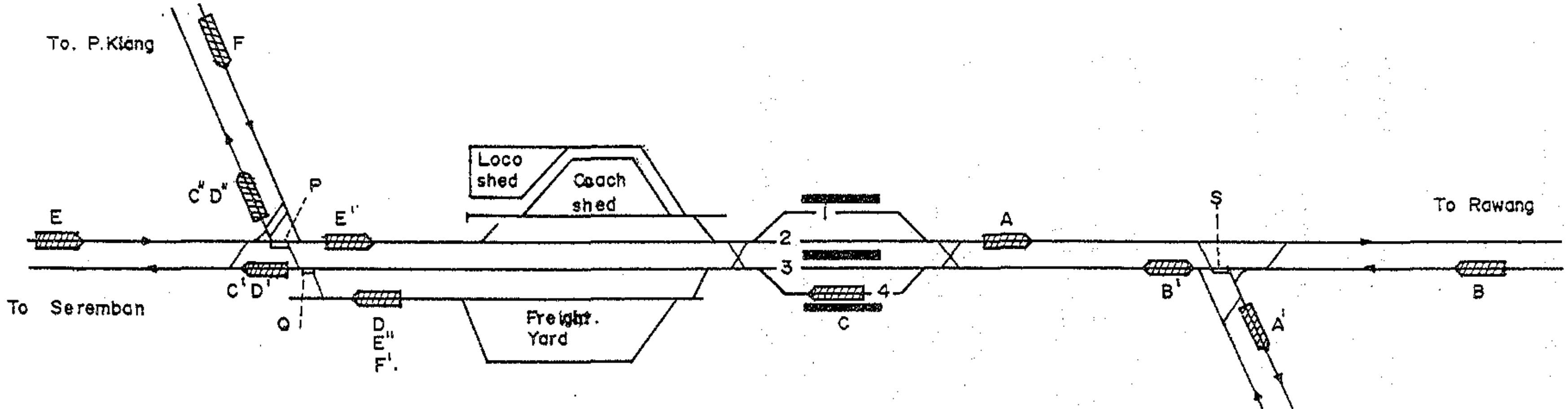
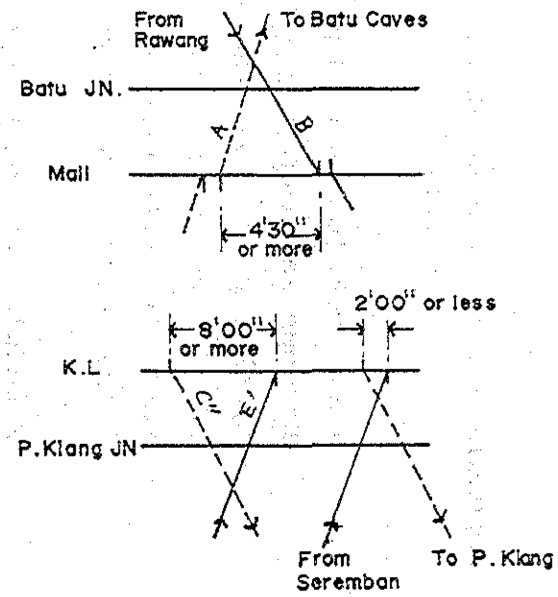


Fig. 1 Level Crossing Points at Kuala Lumpur Station

Table 1 Duration of Use of Level Crossing Points by Train Type and Utilization Rate During Peak Hours

Level crossing point	S					P					Q				
	Route	Train type	No. of trains	Duration of use	Total	Route	Train type	No. of trains	Duration of use	Total	Route	Train type	No. of trains	Duration of use	Total
Duration of use by route (minute/second)	A→A'	DMU	6	2'00"	12	C→C'	DMU	6	3'30"	21	C→C'	DMU		3'30"	
		Freight	-	4'30"	-	D→D'	Freight	-	3'30"	-		P.C		4'00"	
	B→B'	DMU	6	2'00"	12	E→E'	DMU	2	* 2'30"	5		Freight		4'30"	
		P.C	-	3'30"	-			4	** 2'00"	8	D→D'	Freight		3'30"	
		Freight	-	4'00"	-		P.C	-	2'30"	-	D→D"	Freight	-	3'30"	
							Freight	-	4'00"	-	F→F'	Freight		5'00"	
						E→E"	Freight	-	5'00"	-					
						F→F'	Freight	-	5'00"	-					
Total					24 (40%)					34 (57%)					-

Note: 1: P.C ...... Passenger Train
2: * ...... Siputeh · Pass
3: ** ...... Siputeh · Stop



Appendix 5-8-1 Traffic Assignment to Peak and Off-peak Hours

Traffic assignment to peak and off-peak hours was carried out on the basis of MRA Passenger Department's data as well as results of the bus transport survey, including the number of passing buses and the number of passengers carried.

(1) MRA Passenger Department's data (passenger demand forecast for commuter and subarban services)

MRA's data is shown in Table 1.

Table 1 Passenger Demand Forecast of Commuter and Suburban Services (MRA)

Sector	DMU	No. of Trios/ Day	Peak Load-ing trip	%	No. of Trips	No. of Pass. Trips/ Day	Off Peak Load-ing Trip	%	No. of Trips	No. of Pass./ Trips/ Day	Total No. of Pass. Trips/ Day
K.L.- Rawang	3x4 car	68	450	102	34	15,300	300	68	34	10,200	25,500
K.L.- Seremban	6x4 car	68	600	136	34	20,400	350	80	34	11,900	32,300
K.L.- P.Klang	4x4 car	50	400	91	25	10,000	300	75	25	7,500	17,500
K.L.- Subang	2x3 car	50									4,000
	15 sets										79,300

From the table, the number of passenger trips is assigned to peak and off-peak hours as shown in Table 2.

Table 2 Comparison of Passenger Trips during Peak and Off-peak Hours

Section	No. of Passenger trips/day					
	Peak		Off-peak		Total	
K.L.-Rawang	15,300	60	10,200	40	25,500	100
K.L.-Seremban	20,400	63	11,900	37	32,300	100
K.L.-P.Klang	10,000	57	7,500	43	17,500	100
K.L.-Subang	-		-		-	

As shown in the above table, the number of passenger trips during peak hours accounted for 60% of the total for K.L. and Rawang, and 40% during off-peak hours. On the other hand, the number of passenger trips between K.L. and Serémban was 63% for peak hours and 37% for off-peak hours.

The number of passenger trips per hour during morning peak hours, the rate of concentration, was calculated as follows:

$$60\ (\%) \div 2 \div 2.5\ (H) = 12\ \%$$
$$63\ (\%) \div 2 \div 2.5\ (H) = 13\ \%$$

(2) Estimate from bus traffic volume

The number of buses counted at points 10km from K.L. and the rate of concentration are shown in Table 3.

Table 3 Number of Buses Counted and Average Rate of Concentration

	Number of busses				Average rate of concentration per hour	No. of buses passing in 24 hours
	6:00-	7:00-	8:00-	Sub total		
Sungai Buloh						
Number of outbound buses	9	10	10	29		141
Concentration rate per hour	6.4	7.1	7.1	20.6	6.9	
Number of inbound buses	11	13	12	36		175
Concentration rate per hour	6.3	7.5	6.9	20.6	6.9	
Total Number of buses	20	23	22	65		316
Total Concentration rate	6.3	7.3	7.0	20.6	6.9	
Petaling						
Number of outbound buses	87	107	81	275		1281
Concentration rate per hour	6.8	8.4	6.3	21.5	7.2	
Number of inbound buses	67	75	79	221		1104
Concentration rate per hour	6.1	6.8	7.2	20.0	6.8	
Total Number of buses	154	182	160	496		2385
Total Concentration rate	6.5	7.6	6.7	20.8	6.9	
Sangai Besi						
Number of outbound buses	16	9	12	37		229
Concentration rate per hour	7.0	4.0	5.3	16.2	5.4	
Number of inbound buses	21	13	15	49		206
Concentration rate per hour	10.2	6.3	7.3	23.8	7.9	
Total Number of buses	37	22	27	86		435
Total Concentration rate	8.5	5.1	6.2	19.8	6.6	

Average for inbound 7.2 %
Average for outbound 6.5 %

Between 6:00 a.m. and 9:00 a.m., the average concentration rate of the number buses per hour is approximately 7%. On the other hand, in the road traffic survey conducted in the process of drawing up the master plan, the percentage of the number of bus passengers per hour (outbound and inbound) during peak hours was estimated at 15%. (Refer to

Klang Valley Transportation Study Technical Report E-12 Railway Study December 1986.)

From the concentration rate and the percentage of bus passengers during peak hours, the number of bus passengers during peak hours appears to be around twice the daily average bus number.

15% ÷ 7% = 2.14

(3) Traffic assignment to daytime and nighttime off-peak hours

The following shows results of a periodical traffic survey conducted by former FNR in 1985.

Table 4 Traffic Concentration Rate during Daytime and Nighttime Off-peak Hours

Hour / Traffic volume	8	9	10	11	12	13	14	15	Sub-total	19	20	21	22	23	24	Sub-total	Total
(thousand passengers) Outbound	39	74	56	59	60	65	63	94	510	261	192	165	103	64	32	817	1327
Inbound	204	209	98	74	66	63	59	65	838	57	42	34	20	12	4	169	1007
Total	243	283	154	133	126	128	122	159	1348	318	234	199	123	76	36	986	2334
Composition(%)	11	12	7	6	5	5	5	7	58	14	10	8	5	3	2	42	100

(Note) 1. Total traffic volume on Tokaido, Sobu, Chuou, Tohoku, Takasaki, Joban lines

2. For 8:00 a.m. zone, one third of the total traffic volume is assumed to be carried between 8:30 and 9:00.
In former JNR, the ratio of traffic between 8:30 a.m. and 4:00 p.m. to that between 7:00 p.m. and 12:30 a.m. was about 60:40.

Appendix 5-9-1 Traffic Volume Between Stations

Table 1 Predicted Traffic Volume between Stations by Type of DMU Trains, Peak and Off-peak Hours, and Outbound and Inbound Traffic (Weekdays) (in 2005)

Year 2005 (with the project) Station	L-1 Sectional Traffic Volume (person/day)	L-1 Peak (Morning) UP/DN	L-1 Off-peak Daytime UP/DN	L-1 Off-peak Nighttime UP/DN	L-3 Sectional Traffic Volume (person/day)	L-3 Peak (Morning) UP/DN	L-3 Off-peak Daytime UP/DN	L-3 Off-peak Nighttime UP/DN
RAWANG								
	24,899	2,614	2,988	1,992	1,488	154	176	117
KUANG		4,356	2,988	1,992		286	176	117
	16,576	1,741	1,989	1,326	4,128	433	495	330
H 1		3,232	1,989	1,326		805	495	330
	16,576	1,741	1,989	1,326	4,128	433	495	330
S. BULOH		3,232	1,989	1,326		805	495	330
	27,958	2,895	3,355	2,236	4,521	475	542	362
KEPONG		5,451	3,355	2,236		882	542	362
	25,556	2,683	3,067	2,044	7,522	790	902	602
H 2		4,983	3,067	2,044		1,467	902	602
	25,556	2,683	3,067	2,044	7,522	790	902	602
SEGAMBUT		4,983	3,067	2,044		1,467	902	602
	48,162	5,057	5,780	3,853	7,937	833	952	635
MALL		9,331	5,780	3,853		1,548	952	635
	20,238	2,125	2,429	1,619	8,208	862	985	657
P. MENTERI		3,946	2,429	1,619		1,601	985	657
	21,787	2,288	2,614	1,743	2,295	241	276	184
K.L.		4,248	2,614	1,743		448	276	184
	57,772	11,829	6,413	4,275	2,295	470	254	170
SIPUTEH		6,369	6,413	4,275		253	254	170
	64,254	13,156	7,132	4,755	4,582	938	509	339
S. SOUTH		7,084	7,132	4,755		505	509	339
	62,879	12,834	6,958	4,638	10,695	2,189	1,187	792
S. BESI		6,910	6,958	4,638		1,179	1,187	792
	11,905	2,438	1,321	881	23,297	4,770	2,586	1,724
SERDANG		1,313	1,321	881		2,568	2,586	1,724
	5,010	1,026	556	371	18,525	3,793	2,056	1,371
H 3		552	556	371		2,043	2,056	1,371
	2,360	483	262	175	18,544	3,797	2,058	1,372
KAJANG		260	262	175		2,045	2,058	1,372
	2,360	483	262	175	10,875	2,227	207	804
BANGI		260	262	175		1,199	207	804
					303	62	34	22
B. BENAR						33	34	22
					250	51	28	19
NILAI						27	28	19
					249	51	28	19
LABU						27	28	19
					249	51	28	19
TIROI						27	28	19
					249	51	28	19
SEREMBAN						27	28	19
TOTAL								

Year 2005 (with the project) Station	Total (L-1 + L-3) Sectional Traffic Volume (person/day)	Total (L-1 + L-3) Peak (Morning) UP/DN	Total (L-1 + L-3) Off-peak Daytime UP/DN	Total (L-1 + L-3) Off-peak Nighttime UP/DN	L-2 Sectional Traffic Volume (person/day)	L-2 Peak (Morning) UP/DN	L-2 Off-peak Daytime UP/DN	L-2 Off-peak Nighttime UP/DN	Total (L-1 + L-3 + L-2) Sectional Traffic Volume (person/day)	Total (L-1 + L-3 + L-2) Peak (Morning) UP/DN	Total (L-1 + L-3 + L-2) Off-peak Daytime UP/DN	Total (L-1 + L-3 + L-2) Off-peak Nighttime UP/DN
RAWANG												
	26,367	2,768	3,164	2,109	5,188	545	623	415	31,555	3,313	3,787	2,524
KUANG		5,142	3,164	2,109		1,011	623	415		6,153	3,787	2,524
	20,704	2,174	2,484	1,656	5,941	624	713	476	26,645	2,798	3,197	2,132
H 1		4,037	2,484	1,656		1,159	713	476		5,196	3,197	2,132
	20,704	2,174	2,484	1,656	5,941	624	713	476	26,645	2,798	3,197	2,132
S. BULOH		4,037	2,484	1,658		1,159	713	476		5,196	3,197	2,132
	32,477	3,410	3,897	2,598	12,941	1,359	1,553	1,035	45,418	4,769	5,450	3,633
KEPONG		6,333	3,897	2,598		2,524	1,553	1,035		8,857	5,450	3,633
	33,078	3,473	3,969	2,646	18,500	1,943	2,220	1,480	51,578	5,416	6,189	4,126
H 2		6,450	3,969	2,646		3,608	2,220	1,480		10,058	6,189	4,126
	33,078	3,473	3,969	2,646	18,500	1,943	2,220	1,480	51,578	5,416	6,189	4,126
SEGAMBUT		6,450	3,969	2,646		3,608	2,220	1,480		10,058	6,189	4,126
	56,099	5,890	6,732	4,488	37,615	3,950	4,514	3,009	93,714	9,840	11,246	7,497
MALL		10,939	6,732	4,488		7,335	4,514	3,009		18,274	11,246	7,497
	28,446	2,987	3,414	2,276	8,747	918	1,049	699	37,193	3,905	4,463	2,975
P. MENTERI		5,547	3,414	2,276		1,706	1,049	699		7,253	4,463	2,975
	24,082	2,529	2,890	1,927	13,059	1,371	1,567	1,044	37,141	3,900	4,457	2,971
K.L.		4,696	2,890	1,927		2,547	1,567	1,044		7,243	4,457	2,971
	60,067	12,299	6,667	4,445	35,631	7,295	3,955	2,637	95,698	19,594	10,622	7,082
SIPUTEH		6,622	6,667	4,445		3,928	3,955	2,637		10,550	10,622	7,082
	68,836	14,094	7,641	5,094	35,631	7,295	3,955	2,637	104,467	21,389	11,596	7,731
S. SOUTH		7,589	7,641	5,094		3,928	3,955	2,637		11,517	11,596	7,731
	73,374	15,073	8,145	5,430	35,631	7,295	3,955	2,637	109,005	22,318	12,100	8,067
S. BESI		8,089	8,145	5,430		3,928	3,955	2,637		12,017	12,100	8,067
	35,202	7,208	3,907	2,605	35,631	7,295	3,955	2,637	70,833	14,503	7,862	5,242
SERDANG		3,881	3,907	2,605		3,928	3,955	2,637		7,809	7,862	5,242
	23,535	4,819	2,612	1,742	35,631	7,295	3,955	2,637	59,166	12,114	6,567	4,379
H 3		2,595	2,612	1,742		3,928	3,955	2,637		6,523	6,567	4,379
	20,904	4,280	2,320	1,547	35,631	7,295	3,955	2,637	56,535	11,575	6,275	4,184
KAJANG		2,305	2,320	1,547		3,928	3,955	2,637		6,233	6,275	4,184
	13,235	2,710	1,469	979	17,057	3,492	1,893	1,262	30,292	6,202	3,362	2,241
BANGI		1,459	1,469	979		1,881	1,893	1,262		3,340	3,362	2,241
	303	62	34	22	17,057	3,492	1,893	1,262	17,360	3,554	1,927	1,284
B. BENAR		33	34	22		1,881	1,893	1,262		1,914	1,927	1,284
	250	51	28	19	17,057	3,492	1,893	1,262	17,307	3,543	1,921	1,281
NILAI		27	28	19		1,881	1,893	1,262		1,908	1,921	1,281
	249	51	28	19	17,057	3,492	1,893	1,262	17,306	3,543	1,921	1,281
LABU		27	28	19		1,881	1,893	1,262		1,908	1,921	1,281
	249	51	28	19	17,057	3,492	1,893	1,262	17,306	3,543	1,921	1,281
TIROI		27	28	19		1,881	1,893	1,262		1,908	1,921	1,281
	249	51	28	19	17,057	3,492	1,893	1,262	17,306	3,543	1,921	1,281
SEREMBAN		27	28	19		1,881	1,893	1,262		1,908	1,921	1,281
TOTAL												

Section	Peak (Morning) UP	Peak (Morning) Down	Off-peak (Daytime) UP	Off-peak (Daytime) Down	Off-peak (Nighttime) UP	Off-peak (Nighttime) Down
Rawang -- K.L.	0.3 x 0.35	0.3 x 0.65	0.4 x 0.6 x 0.5	0.4 x 0.6 x 0.5	0.4 x 0.4 x 0.5	0.4 x 0.4 x 0.5
K.L. -- Seremban	0.315x 0.65	0.315x 0.35	0.37x 0.6 x 0.5	0.37x 0.6 x 0.5	0.37x 0.4 x 0.5	0.37x 0.4 x 0.5

Note:
1. L-1 and L-3 denote local trains, and L-2 denotes rapid trains (K.L. and Seremban only).
2. The traffic volume between stations is a sum of daily average traffic volume, both outbound and inbound, in 2005 (with project) on the basis of the demand forecast.
3. "Morning peak" shows traffic volume between stations (passengers/day) multiplied by 30% between Rawang and K.L. and 31.5% between K.L. and Seremban, and divided by the ratio of 65:35 for inbound (to K.L.) and outbound trains.
4. "Off-peak" shows traffic volume between stations (passengers/day) subtracted by traffic volume during peak hours (morning peak x 2), multiplied by 60% for daytime and 40% for nighttime, and divided into half for outbound and inbound trains.

Table 2 Predicted Traffic Volume between Stations by Type of DMU Trains, Peak and Off-peak Hours, and Outbound and Inbound Traffic (Weekdays) (in 1997)

Year 1997 (with the project)	L-1				L-3				Total (L-1 + L-3)				L-2				Total (L-1 + L-3 + L-2)			
Station	Sectional Traffic Volume (person/day)	Peak Morning UP / DN	Off-peak Daytime UP / DN	Off-peak Nighttime UP / DN	Sectional Traffic Volume (person/day)	Peak Morning UP / DN	Off-peak Daytime UP / DN	Off-peak Nighttime UP / DN	Sectional Traffic Volume (person/day)	Peak Morning UP / DN	Off-peak Daytime UP / DN	Off-peak Nighttime UP / DN	Sectional Traffic Volume (person/day)	Peak Morning UP / DN	Off-peak Daytime UP / DN	Off-peak Nighttime UP / DN	Sectional Traffic Volume (person/day)	Peak Morning UP / DN	Off-peak Daytime UP / DN	Off-peak Nighttime UP / DN
RAWANG																				
	11,045	1,160	1,325	884	637	67	77	51	11,682	1,227	1,402	935	2,702	283	324	216	14,384	1,510	1,726	1,151
KUANG		2,154	1,325	884		124	77	51		2,278	1,402	935		527	324	216		2,805	1,726	1,151
	7,532	791	904	603	1,777	186	213	142	9,309	977	1,117	745	3,254	342	391	260	12,563	1,319	1,508	1,005
N 1		1,469	904	603		346	213	142		1,815	1,117	745		635	391	260		2,450	1,508	1,005
	7,532	791	904	603	1,777	186	213	142	9,309	977	1,117	745	3,254	342	391	260	12,563	1,319	1,508	1,005
S. BULOH		1,469	904	603		346	213	142		1,815	1,117	745		635	391	260		2,450	1,508	1,005
	14,532	1,526	1,744	1,163	2,013	211	241	161	16,545	1,737	1,985	1,324	6,061	636	728	484	22,606	2,373	2,713	1,808
KEPONG		2,834	1,744	1,163		392	241	161		3,226	1,985	1,324		1,182	728	484		4,408	2,713	1,808
	18,445	1,937	2,213	1,475	4,073	427	489	326	22,518	2,364	2,702	1,801	11,425	1,200	1,371	914	33,943	3,564	4,073	2,715
N 2		3,597	2,213	1,475		794	489	326		4,391	2,702	1,801		2,228	1,371	914		6,619	4,073	2,715
	18,445	1,937	2,213	1,475	4,073	427	489	326	22,518	2,364	2,702	1,801	11,425	1,200	1,371	914	33,943	3,564	4,073	2,715
SEGAMBUT		3,597	2,213	1,475		794	489	326		4,391	2,702	1,801		2,228	1,371	914		6,619	4,073	2,715
	33,729	3,541	4,047	2,698	4,732	497	568	379	38,461	4,038	4,615	3,077	17,196	1,806	2,064	1,376	55,657	5,844	6,679	4,453
MALL		6,577	4,047	2,698		923	568	379		7,500	4,615	3,077		3,353	2,064	1,376		10,853	6,679	4,453
	15,499	1,627	1,860	1,240	4,957	521	595	397	20,456	2,148	2,455	1,637	8,114	852	973	649	28,570	3,000	3,428	2,286
P. MENTERI		3,022	1,860	1,240		967	595	397		3,989	2,455	1,637		1,582	973	649		5,571	3,428	2,286
	18,864	1,981	2,264	1,509	2,166	227	260	173	21,030	2,208	2,524	1,682	9,590	1,007	1,151	768	30,620	3,215	3,675	2,450
K.L.		3,679	2,264	1,509		422	260	173		4,101	2,524	1,682		1,870	1,151	768		5,971	3,675	2,450
	46,811	9,985	5,196	3,464	2,166	443	240	160	48,977	10,028	5,436	3,624	24,519	5,020	2,722	1,815	73,496	15,048	8,158	5,439
SIPUTEH		5,161	5,196	3,464		239	240	160		5,400	5,436	3,624		2,703	2,722	1,815		8,103	8,158	5,439
	51,398	10,524	5,705	3,803	3,946	808	438	292	55,344	11,332	6,143	4,095	24,519	5,020	2,722	1,815	79,863	16,352	8,865	5,910
S. SOUTH		5,667	5,705	3,803		435	438	292		6,102	6,143	4,095		2,703	2,722	1,815		8,805	8,865	5,910
	47,575	9,741	5,281	3,521	8,112	1,661	900	600	55,687	11,402	6,181	4,121	24,519	5,020	2,722	1,815	80,206	16,422	8,903	5,936
S. BESI		5,245	5,281	3,521		895	900	600		6,140	6,181	4,121		2,703	2,722	1,815		8,843	8,903	5,936
	10,057	2,059	1,116	744	18,834	3,856	2,091	1,394	28,891	5,915	3,207	2,138	24,519	5,020	2,722	1,815	53,410	10,935	5,929	3,953
SERDANG		1,109	1,116	744		2,076	2,091	1,394		3,185	3,207	2,138		2,703	2,722	1,815		5,888	5,929	3,953
	4,363	893	484	323	13,960	2,859	1,550	1,033	18,323	3,752	2,034	1,356	24,519	5,020	2,722	1,815	42,842	8,772	4,756	3,171
N 3		481	484	323		1,539	1,550	1,033		2,020	2,034	1,356		2,703	2,722	1,815		4,723	4,756	3,171
	2,810	575	312	208	14,059	2,879	1,560	1,040	16,869	3,454	1,872	1,248	24,519	5,020	2,722	1,815	41,388	8,474	4,594	3,063
KAJANG		310	312	208		1,550	1,560	1,040		1,860	1,872	1,248		2,703	2,722	1,815		4,563	4,594	3,063
	2,810	575	312	208	7,912	1,620	878	585	10,722	2,195	1,190	793	11,402	2,335	1,266	844	22,124	4,530	2,456	1,637
BANGI		310	312	208		872	878	585		1,182	1,190	793		1,257	1,266	844		2,439	2,456	1,637
					301	62	33	22	301	62	33	22	11,402	2,335	1,266	844	11,703	2,397	1,299	866
B. BENAR						33	33	22		33	33	22		1,257	1,266	844		1,290	1,299	866
					150	31	17	11	150	31	17	11	11,402	2,335	1,266	844	11,552	2,366	1,283	855
NILAI						17	17	11		17	17	11		1,257	1,266	844		1,274	1,283	855
					150	31	17	11	150	31	17	11	11,402	2,335	1,266	844	11,552	2,366	1,283	855
LABU						17	17	11		17	17	11		1,257	1,266	844		1,274	1,283	855
					150	31	17	11	150	31	17	11	11,402	2,335	1,266	844	11,552	2,366	1,283	855
TIROI						17	17	11		17	17	11		1,257	1,266	844		1,276	1,283	855
					150	31	17	11	150	31	17	11	11,402	2,335	1,266	844	11,552	2,366	1,283	855
SEREMBAN						17	17	11		17	17	11		1,257	1,266	844		1,274	1,283	855
TOTAL																				

Section	Peak (Morning)		Off-peak (Daytime)		Off-peak (Nighttime)	
	UP	Down	UP	Down	UP	Down
Rawang -- K.L.	0.3 x 0.35	0.3 x 0.65	0.4 x 0.6 x 0.5	0.4 x 0.6 x 0.5	0.4 x 0.4 x 0.5	0.4 x 0.4 x 0.5
K.L. -- Seremban	0.315x 0.65	0.315x 0.35	0.37x 0.6 x 0.5	0.37x 0.6 x 0.5	0.37x 0.4 x 0.5	0.37x 0.4 x 0.5

Note:
1. L-1 and L-3 denote local trains, and L-2 denotes rapid trains (K.L. and Seremban only).
2. The traffic volume between stations is a sum of daily average traffic volume, both outbound and inbound, in 1997 (with project) on the basis of the demand forecast.
3. "Morning peak" shows traffic volume between stations (passengers/day) multiplied by 30% between Rawang and K.L. and 31.5% between K.L. and Seremban, and divided by the ratio of 65:35 for inbound (to K.L.) and outbound trains.
4. "Off-peak" shows traffic volume between stations (passengers/day) subtracted by traffic volume during peak hours (morning peak x 2), multiplied by 60% for daytime and 40% for nighttime, and divided into half for outbound and inbound trains.

Appendix 5-10-1 Number of Long-distance Passenger Trains and Freight Trains to be Operated

(1) Long-distance passenger trains

MRA does not have a concrete plan for operation of long-distance passenger trains in the future.
According to the yearbook, passenger traffic declined gradually between 1982 and 1986, in terms of number of passengers and passenger-kilometers. However, for the purpose of determining the number of trains, increase in passenger traffic at an annual 3% is assumed. As a result, the number of long-distance passenger trains to be operated in 1990 and 2005 is shown as follows.

Table 1 Number of Long-distance Passenger Trains by Time Zone

			5:30 - 6:30	6:30 - 8:30	8:30 - 16:00	16:00 - 19:00	19:00 - 24:00	Total
Rawang - K.L.	1990	UP	0	0	5	0	3	8
		DN	2	0	3	0	3	8
	2005	UP	0	0	7	0	4	11
		DN	3	0	4	0	4	11
K.L. - Seremban	1990	UP	2	0	2	0	1	5
		DN	0	0	3	0	2	5
	2005	UP	3	0	3	0	1	7
		DN	0	0	4	0	3	7

Note: 1. The time zone for operating trains is based on the situation at K.L. Station.
2. The time zone is modified for 1990.
3. Among trains to be operated in 1990, two trains between Rawang and K.L. (one for each direction) will be operated three times per week.
4. The number of trains in 1990 does not include rail buses operated between P.Klang and Sentul.

(2) Freight trains

Again, MRA does not have a concrete plan for oeration of goods trains in the future. According to the yearbook, freight traffic levelled off between 1982 and 1986 in terms of tonnage and ton-kilometers.

Nevertheless, increase in freight traffic at 3% annually was assumed again, for the purpose of estimating the number of freight trains, as shown below.

Table 2 Number of Freight Trains by Time Zone

Section	Year		3:00 - 6:00	6:00 - 8:30	8:30 - 16:00	16:00 - 19:00	19:00 - 24:00	Total
Rawang - Batu JN	1990	UP	3	0	3	0	6	12
		DN	5	0	5	0	2	12
	2005	UP	8	0	3	0	6	17
		DN	7	0	6	0	4	17
Batu JN - K.L.	1990	UP	3	0	4	0	5	12
		DN	4	0	6	0	3	13
	2005	UP	8	0	4	0	5	17
		DN	6	0	7	0	6	19
K.L. - K.L. Yard	1990	UP	3	0	4	0	5	12
		DN	4	0	6	0	3	13
	2005	UP	8	0	4	0	5	17
		DN	6	0	7	0	6	19
K.L. Yard - P.Klarg JN	1990	UP	6	0	4	0	6	16
		DN	5	0	7	0	4	16
	2005	UP	9	0	6	0	8	23
		DN	7	0	9	0	7	23
P.Klarg JN - Salak South	1990	UP	4	0	3	0	6	13
		DN	4	0	7	0	2	13
	2005	UP	7	0	4	0	8	19
		DN	6	0	8	0	5	19
Salak South - Seremban	1990	UP	4	0	2	0	4	10
		DN	3	0	5	0	2	10
	2005	UP	7	0	3	0	5	15
		DN	5	0	6	0	4	15

Note: 1. The time zone for operating trains is based on the situation at K.L. Station.
2. The time zone is modified for 1990.
3. The number of freight trains in 1990 is modified under the assumption that a bypass line for Batu Junction, P.Klang Junction, and Salak South Junction has been completed.

Appendix 5-11-1 Estimation of DMU Train Consist

Year 2005 T=10 Min. (Down)	(On peak)	107 person / coach x177% = 189 RAPID	LOCAL	107 person / coach x200% = 214 RAPID	LOCAL	140 person / coach x 175% = 245 RAPID	LOCAL	140 person / coach x200% = 280 RAPID	LOCAL
1.	RAWANG								
			2.7		2.4		2.1		1.8
2.	KUANG								
			2.3		2.0		1.8		1.6
3.	H 1								
			2.3		2.0		1.8		1.6
4.	S. BULOH								
			3.9		3.5		3.0		2.6
5.	KEPONG								
			4.4		3.9		3.4		3.0
6.	H 2								
			4.4		3.9		3.4		3.0
7.	SEGAMBUT								
			[8.1]		[7.1]		[6.2]		[5.5]
8.	MALL								
			3.2		2.8		2.5		2.2
9.	P. MENTERI								
			3.2		2.8		2.5		2.2
10.	K. L.								
(Up)		[7.7]	7.2	[6.8]	6.4	[6.0]	5.6	[5.2]	4.9
11.	SIPUTEH								
		[7.7]	8.3	[6.8]	7.3	[6.0]	6.4	[5.2]	5.6
12	S. SOUTH								
		[7.7]	[8.8]	[6.8]	[7.8]	[6.0]	[6.8]	[5.2]	[6.0]
13.	S. BESI								
		[7.7]	4.2	[6.8]	3.7	[6.0]	3.3	[5.2]	2.9
14.	SERDANG								
		[7.7]	2.8	[6.8]	2.5	[6.0]	2.2	[5.2]	1.9
15.	H 3								
		[7.7]	2.5	[6.8]	2.2	[6.0]	1.9	[5.2]	1.7
16.	KAJANG								
		3.7	1.6	3.3	1.4	2.9	1.2	2.5	1.1
17.	BANGI								
		2.6	0.1	2.3	0.1	2.0	0.1	1.8	0.1
18.	B. BENAR								
		2.6	0.1	2.3	0.1	2.0	0.1	1.8	0.1
19.	NILAI								
		2.6	0.1	2.3	0.1	2.0	0.1	1.8	0.1
20.	LABU								
		2.6	0.1	2.3	0.1	2.0	0.1	1.8	0.1
21.	TIROI								
		2.6	0.1	2.3	0.1	2.0	0.1	1.8	0.1
22.	SEREMBAN								

	Station	RAPID	LOCAL
Number of Train	RAWANG	*	*
		0	12
	K. L.	*	*
		5	9
	KAJANG	*	*
		7	9
	BANGI	*	*
		7	(3)
	SEREMBAN	*	*

(Note) [ ] denotes the number of coaches per train consist for the section having the highest traffic volume.

Appendix 5-12-1 Current Transport Volume at Each Station (Seremban - Rawang)

(per day)

Station	Passenger transport				Freight transport							
	No. of boarding passengers				Tonnage Inward				Tonnage Outward			
Fiscal year	-86	-87	-88	-89	-86	-87	-88	-89	-86	-87	-88	-89
SEREMBAN	337	465	407	444	48	53	58	75	57	38	23	21
LABU	-	-	-	-	-	-	-	-	-	-	-	-
BTG.BENAR	-	-	-	-	-	-	-	-	38	89	54	74
KAJANG	56	61	70	73	17	12	17	14	0	0	0	0
* SERADANG	-	0.20	0.63	1.33	-	-	-	-	-	-	-	-
KUALA LUMPUR	3,219	3,193	4,060	3,633	291	298	381	442	50	50	137	57
* SEGAMBUT	-	0.44	0.66	0.72	5	-	6	5	-	-	-	-
SG.BULOU	21	24	32	45	-	-	-	-	0	0	0	0
RAWANG	35	31	28	40	133	85	98	103	957	1,432	1,562	1,288

(Note) 1. Source: MRA
2. * denotes satellite stations.

Appendix 5-13-1 Recent Trends in Train Delays

Number of Express Train								
			delay time (min)					
Year	Total		0	1～10	11～20	21～30	31～60	60 or more
1982	No. of train	2190	198	347	422	349	414	460
	rate (%)	100	9.04	15.84	19.27	15.94	18.90	21.01
1983	No. of train	2190	499	457	326	216	344	348
	rate (%)	100	22.79	20.87	14.88	9.86	15.71	15.89
1984	No. of train	3225	1601	271	243	203	243	664
	rate (%)	100	49.64	8.40	7.54	6.29	7.54	20.59
1985	No. of train	3635	2422	187	209	232	145	440
	rate (%)	100	66.63	5.15	5.75	6.38	3.99	12.10
1986	No. of train	3647	2773	162	160	155	107	290
	rate (%)	100	76.04	4.44	4.39	4.25	2.93	7.95
1987	No. of train	3650	2198	138	197	191	191	735
	rate (%)	100	60.22	3.78	5.40	5.23	5.23	20.14
1988	No. of train	2812	1536	145	148	187	148	648
	rate (%)	100	54.62	5.16	5.26	6.65	5.26	23.05
1989	No. of train	2535	886	138	180	221	198	912
	rate (%)	100	34.95	5.44	7.10	8.72	7.81	35.98

(Note) Sections between Butterworth, Kuala lumpur and Singapore
(Source: MRA)

Number of Normal, Mail Train								
Year	Total		delay time (min)					
			0	1～10	11～20	21～30	31～60	60 or more
1982	No. of train	4375	1282	800	692	510	688	403
	rate (%)	100	29.30	18.28	15.82	11.66	15.73	9.21
1983	No. of train	4376	1482	860	644	407	555	428
	rate (%)	100	33.87	19.65	14.72	9.30	12.68	9.78
1984	No. of train	4385	2294	490	477	286	404	434
	rate (%)	100	52.32	11.17	10.88	6.52	9.21	9.90
1985	No. of train	4368	3102	188	197	164	148	569
	rate (%)	100	71.01	4.30	4.51	3.76	3.39	13.03
1986	No. of train	4380	3449	137	133	139	105	417
	rate (%)	100	78.74	3.13	3.04	3.17	2.40	9.52
1987	No. of train	4380	2962	123	151	174	171	799
	rate (%)	100	67.63	2.81	3.45	3.97	3.90	18.24
1988	No. of train	4392	2818	120	202	229	194	829
	rate (%)	100	64.16	2.73	4.60	5.21	4.42	18.88
1989	No. of train	4380	2351	161	219	287	242	1120
	rate (%)	100	53.68	3.67	5.00	6.55	5.53	25.57

Chapter 6

DIESEL MULTIPLE UNIT (DMU)

Appendix 6-2-1 Maximum Load Factor of DMUs for DTP

To determine the load factor; i.e. the ratio of overcrowdness to passenger capacity, standing capacity is calculated.

The car width is assumed to be 2,550mm from the maximum load gauges width of 2,819mm. Assuming that each chair is 975mm long, the width of aisle will be 600mm (= 2,550 - 2 x 975).

On the basis of this, the aisle area (including door ways and an area occupied by each passenger (m^2) are estimated.

(Head car) $0.6 \times 17.025 + 2.55 \times 1.2 \times 2 = 16.335\ m^2$

$16.335 / 36 = 0.453\ m^2/\text{passenger}$

(Mid car) $0.6 \times 17.940 + 2.55 \times 1.2 \times 2 = 16.884\ m^2$

$16.884 / 36 = 0.469\ m^2/\text{passenger}$

In Japan, the congestion rate at the maximum load factor of commuter train is assumed to to be 0.14 m^2/passenger. By using this rate, the number of standing passengers is estimated to be 116 (= 16.335/0.14) for the head car and 120 (16.884/0.14) for the mid car.

When the number of seating passengers is added, 187 passengers are accommodated in the head car and 191 in the mid car. Thus, if a DMU train consists of three cars, the planned maximum transport capacity becomes 565 passengers/train.
(= 188 passengers/car)

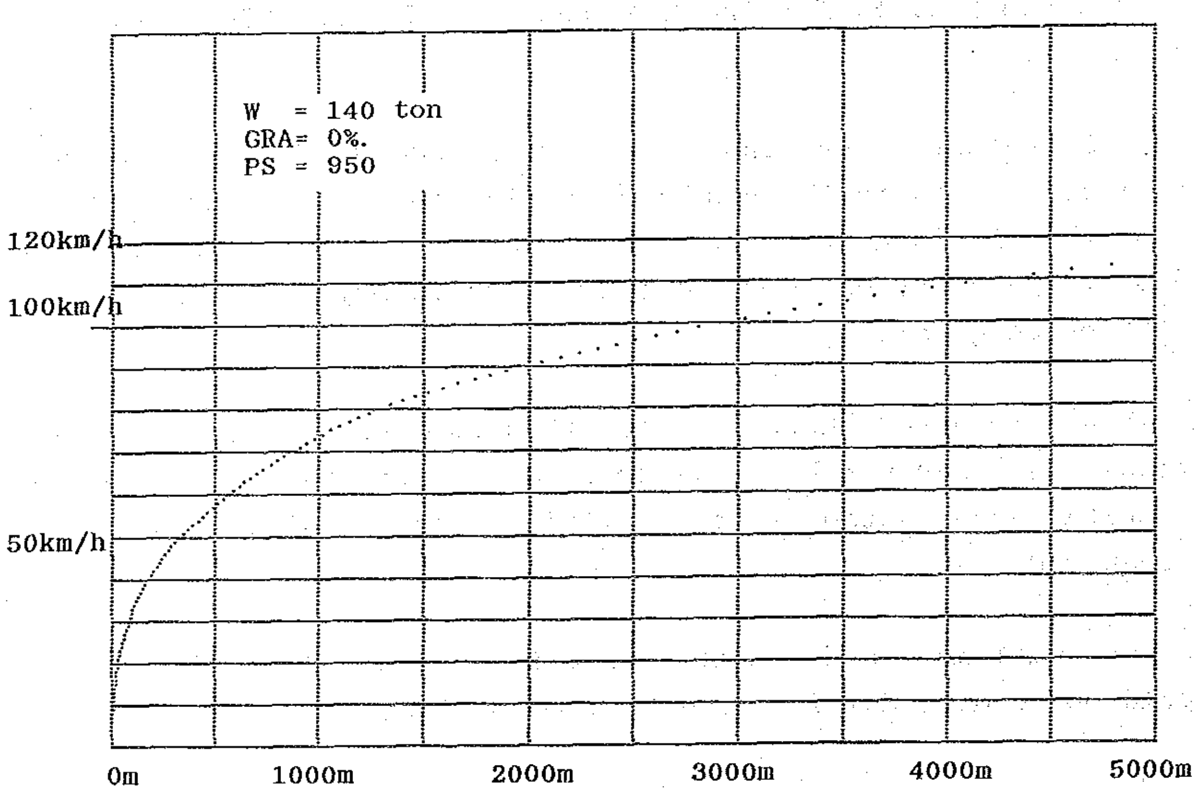
It should be noted, however, that this congestion degree (0.14 m^2/passenger) may not be applicable to Malaysia due to difference in culture and custom, thus detailed survey and discussion will be required.

The maximum load factor in this case is determined at 177%, and should be permitted for a short period of time.

Appendix 6-2-2 Running Performance of DMU Train for DTP

Running Performance Curve,
Speed-Distance, Tractive Force, Running Resistance,
Travel Time Tables

V km/h	F kg	Z kg	R kg	S m	T sec.	Akm/h/s
0	10055	10405	350	0.0	0.00	2.3940
5	9136	9500	364	1.5	2.17	2.1752
10	8124	8505	380	6.6	4.58	1.9344
15	7292	7690	399	16.0	7.27	1.7361
20	6457	6876	419	30.7	10.30	1.5374
25	5665	6107	442	52.2	13.72	1.3489
30	4962	5429	467	82.1	17.63	1.1814
35	4302	4795	493	122.6	22.10	1.0242
40	3820	4343	522	176.0	27.22	0.9096
45	3382	3936	554	244.3	32.99	0.8053
50	2942	3529	587	331.0	39.55	0.7004
55	2770	3393	622	437.7	46.86	0.6596
60	2642	3302	660	561.2	54.58	0.6291
65	2467	3167	700	703.2	62.75	0.5874
70	2244	2986	742	869.1	71.58	0.5343
75	2110	2895	785	1062.4	81.17	0.5023
80	1792	2624	832	1291.3	91.79	0.4267
85	1382	2262	880	1588.9	104.75	0.3291
90	1241	2171	930	1974.7	120.60	0.2955
95	1189	2171	983	2417.4	137.81	0.2830
100	1044	2081	1037	2921.7	156.41	0.2485
105	942	2036	1094	3519.1	177.36	0.2242
110	747	1900	1153	4249.2	201.77	0.1778
115	595	1810	1214	5210.4	232.49	0.1418
120	442	1719	1277	6504.7	272.07	0.1052



Appendix 6-3-1 Car Particulars by Seat Arrangement Type

Semi-cross seat type	Front Wall	Driver's Room	Middle Wall	1.55 Door-1	Door-2	0.44 Long seat	1.6 Box seat	Rear Wall	Total Length	Impossible Space	Seating Capacity (persons)	Standing Areas (Sq.m)	Standing Capacity (persons)	Carrying Capacity (persons)	0.14 Max. Capacity (persons)	Maximum Ratio
Head Car	0.15	1.6	0.1	3 4.65		14 6.16	5 8.00	0.40	21.06	1	67	23.71	66	133	236	177 %
Mid Car	0.1			3 4.65		14 6.16	6 9.60	0.4	20.91	1	75	24.91	70	145	253	174 %

Train Consist	No. of Passengers	Max. no. of Passengers	Loadability
2 D + 5 M	991	1,737	175.31 %
4 D + 3 M	967	1,704	176.23 %
(Difference)	24	33	
Average	979	1,721	175.77 %
per 1 DMU Car (/ 7)	139.86	245.82	

Train Consist	No. of Seat	Standing	Total
2 D + 5 M	509	482	991
4 D + 3 M	493	474	967
Average	71.57	68.29	139.86

Appendix 6-3-2 Number of Cars Per Train in 2005 (During Peak Hours)

Year 2005 T=10 Min.		107 person / car (DTP) x177% = 189		107 person / car (DTP) x200% = 214		140 person / car (RBCS) x176% = 245		140 person / car (RBCS) x200% = 280	
(Down)	(On peak)	RAPID	LOCAL	RAPID	LOCAL	RAPID	LOCAL	RAPID	LOCAL
1.	RAWANG								
			2.7		2.4		2.1		1.8
2.	KUANG								
			2.3		2.0		1.8		1.5
3.	H 1								
			2.3		2.0		1.8		1.5
4.	S.BULOH								
			3.9		3.4		3.0		2.6
5.	KEPONG								
			4.4		3.9		3.4		3.0
6.	H 2								
			4.4		3.9		3.4		3.0
7.	SEGAMBUT								
			8.1		7.1		6.2		5.4
8.	MALL								
			3.2		2.8		2.5		2.2
9.	P.MENTERI								
			3.2		2.8		2.5		2.2
10.	K.L.								
(Up)		7.7	7.2	6.8	6.4	6.0	5.6	5.2	4.9
11.	SEPUTEH								
		7.7	8.3	6.8	7.3	6.0	6.4	5.2	5.6
12	S.SOUTH								
		7.7	8.8	6.8	7.8	6.0	6.8	5.2	6.0
13.	S.BESI								
		7.7	4.2	6.8	3.7	6.0	3.3	5.2	2.9
14.	SERDANG								
		7.7	2.8	6.8	2.5	6.0	2.2	5.2	1.9
15.	H 3								
		7.7	2.5	6.8	2.2	6.0	1.9	5.2	1.7
16.	KAJANG								
		3.7	1.6	3.3	1.4	2.9	1.2	2.5	1.1
17.	BANGI								
		2.6		2.3		2.0		1.8	
18.	B.BENAR								
		2.6	↑	2.3	↑	2.0	↑	1.8	↑
19.	NILAI		1-car		1-car		1-car		1-car
		2.6	Shuttle	2.3	Shuttle	2.0	Shuttle	1.8	Shuttle
20.	LABU		Train		Train		Train		Train
		2.6	↓	2.3	↓	2.0	↓	1.8	↓
21.	TIROI								
		2.6		2.3		2.0		1.8	
22.	SEREMBAN								

	Station	RAPID	LOCAL
Number of Train	RAWANG	*	*
		0	12
	K.L.	*	*
		5	9
	KAJANG	*	*
		5	9
	BANGI	*	*
		7	3
	SEREMBAN	*	*

Appendix 6-3-3 Load Factor by Section (6-car train and 7-car train)

Year 2005 T=10 Min. (On peak)	140 persons / car (Semi-cross Seat Type)							
	6 cars				7 cars			
	U P		DOWN		U P		DOWN	
	RAPID	LOCAL	RAPID	LOCAL	RAPID	LOCAL	RAPID	LOCAL
1. RAWANG								
		0.3		0.6		0.3		0.5
2. KUANG								
		0.3		0.5		0.2		0.4
3. H 1								
		0.3		0.5		0.2		0.4
4. S.BULOH								
		0.5		0.9		0.4		0.8
5. KEPONG								
		0.5		1.0		0.5		0.9
6. H 2								
		0.5		1.0		0.5		0.9
7. SEGAMBUT								
		1.0		1.8		0.8		1.6
8. MALL								
		0.4		0.7		0.3		0.6
9. P.MENTERI								
		0.4		0.7		0.3		0.6
10. K.L.								
	1.7	1.6	0.9	0.9	1.5	1.4	0.8	0.8
11. SEPUTEH								
	1.7	1.9	0.9	1.0	1.5	1.6	0.8	0.9
12 S.SOUTH								
	1.7	2.0	0.9	1.1	1.5	1.7	0.8	0.9
13. S.BESI								
	1.7	1.0	0.9	0.5	1.5	0.8	0.8	0.4
14. SERDANG								
	1.7	0.6	0.9	0.3	1.5	0.5	0.8	0.3
15. H 3								
	1.7	0.6	0.9	0.3	1.5	0.5	0.8	0.3
16. KAJANG								
	0.8	0.4	0.4	0.2	0.7	0.3	0.4	0.2
17. BANGI								
	0.6		0.3		0.5		0.3	
18. B.BENAR								
	0.6	↑	0.3	↑	0.5	↑	0.3	↑
19. NILAI								
	0.6	1-car Shuttle Train	0.3	1-car Shuttle Train	0.5	1-car Shuttle Train	0.3	1-car Shuttle Train
20. LABU								
	0.6	↓	0.3	↓	0.5	↓	0.3	↓
21. TIROI								
	0.6		0.3		0.5		0.3	
22. SEREMBAN								

	Station	RAPID	LOCAL
Number of Train	RAWANG	*	*
		0	12
	K.L.	*	*
		5	9
	KAJANG	*	*
		5	9
	BANGI	*	*
		7	3
	SEREMBAN	*	*

Note:
1.73 means maximum passenger carrying capacity (245 passengers/car)
1.00 means passenger carrying capacity (140 passengers/car)

Appendix 6-3-4 Seat Occupancy Ratio by Section (6-car train and 7-car train)

Year 2005, T=10 Min. (On peak)

140 persons / car (Semi-cross Seat Type)

Section	6 cars (432 seats) UP RAPID	6 cars UP LOCAL	6 cars DOWN RAPID	6 cars DOWN LOCAL	7 cars (504 seats) UP RAPID	7 cars UP LOCAL	7 cars DOWN RAPID	7 cars DOWN LOCAL
1. RAWANG – 2. KUANG		0.6		1.2		0.5		1.0
2. KUANG – 3. H 1		0.5		1.0		0.5		0.9
3. H 1 – 4. S. BULOH		0.5		1.0		0.5		0.9
4. S. BULOH – 5. KEPONG		0.9		1.7		0.8		1.5
5. KEPONG – 6. H 2		1.0		1.9		0.9		1.7
6. H 2 – 7. SEGAMBUT		1.0		1.9		0.9		1.7
7. SEGAMBUT – 8. MALL		1.9		3.5		1.6		3.0
8. MALL – 9. P. MENTERI		0.8		1.4		0.6		1.2
9. P. MENTERI – 10. K. L.		0.8		1.4		0.6		1.2
10. K. L. – 11. SEPUTEH	3.4	3.2	1.8	1.7	2.9	2.7	1.6	1.5
11. SEPUTEH – 12 S. SOUTH	3.4	3.6	1.8	2.0	2.9	3.1	1.6	1.7
12 S. SOUTH – 13. S. BESI	3.4	3.9	1.8	2.1	2.9	3.3	1.6	1.8
13. S. BESI – 14. SERDANG	3.4	1.9	1.8	1.0	2.9	1.6	1.6	0.9
14. SERDANG – 15. H 3	3.4	1.2	1.8	0.7	2.9	1.1	1.6	0.6
15. H 3 – 16. KAJANG	3.4	1.1	1.8	0.6	2.9	0.9	1.6	0.5
16. KAJANG – 17. BANGI	1.6	0.7	0.9	0.4	1.4	0.6	0.7	0.3
17. BANGI – 18. B. BENAR	1.2		0.6		1.0		0.5	
18. B. BENAR – 19. NILAI	1.2		0.6		* 1.0		0.5	
19. NILAI – 20. LABU	1.2	↑ 1-car Shuttle Train ↓	0.6	↑ 1-car Shuttle Train ↓	1.0	↑ 1-car Shuttle Train ↓	0.5	↑ 1-car Shuttle Train ↓
20. LABU – 21. TIROI	1.2		0.6		1.0		0.5	
21. TIROI – 22. SEREMBAN	1.2		0.6		1.0		0.5	

Number of Train	Station	RAPID	LOCAL
	RAWANG	*	*
		0	12
	K. L.	*	*
		5	9
	KAJANG	*	*
		5	9
	BANGI	*	*
		7	3
	SEREMBAN	*	*

Note: *1.0 means all seats are just occupied by passengers, and everyone can get seat. (Rapid train from Seremban)

Appendix 6-3-5 Table 1 Number of Cars Per Train (During Daytime Off-Peak Hour)

Year 2005 T=10 Min. (Off peak) [Daytime]		140 persons / coach (Semi-cross Seat Type) 1 car (80 %) = 112 persons			
		U P		DOWN	
		RAPID	LOCAL	RAPID	LOCAL
1.	RAWANG				
			2.3		2.3
2.	KUANG				
			1.9		1.9
3.	H 1				
			1.9		1.9
4.	S.BULOH				
			3.2		3.2
5.	KEPONG				
			3.7		3.7
6.	H 2				
			3.7		3.7
7.	SEGAMBUT				
			6.7		6.7
8.	MALL				
			2.7		2.7
9.	P.MENTERI				
			2.7		2.7
10.	K.L.				
		7.1	5.4	7.1	5.4
11.	SEPUTEH				
		7.1	6.2	7.1	6.2
12.	S.SOUTH				
		7.1	6.6	7.1	6.6
13.	S.BESI				
		7.1	3.2	7.1	3.2
14.	SERDANG				
		7.1	2.1	7.1	2.1
15.	H 3				
		7.1	1.9	7.1	1.9
16.	KAJANG				
		4.2	1.2	4.2	1.2
17.	BANGI				
		4.2	0.1	4.2	0.1
18.	B.BENAR				
		4.2	0.1	4.2	0.1
19.	NILAI				
		4.2	0.1	4.2	0.1
20.	LABU				
		4.2	0.1	4.2	0.1
21.	TIROI				
		4.2	0.1	4.2	0.1
22.	SEREMBAN				

	Station	RAPID	LOCAL
Number of Trains	RAWANG	*	*
		0	15
	K.L.	*	*
		5	11
	KAJANG	*	*
		4	11
	BANGI	*	*
		4	3
	SEREMBAN	*	*

Appendix 6-3-5 Table 2 Number of Cars Per Train
(During Nighttime Off-Peak Hour)

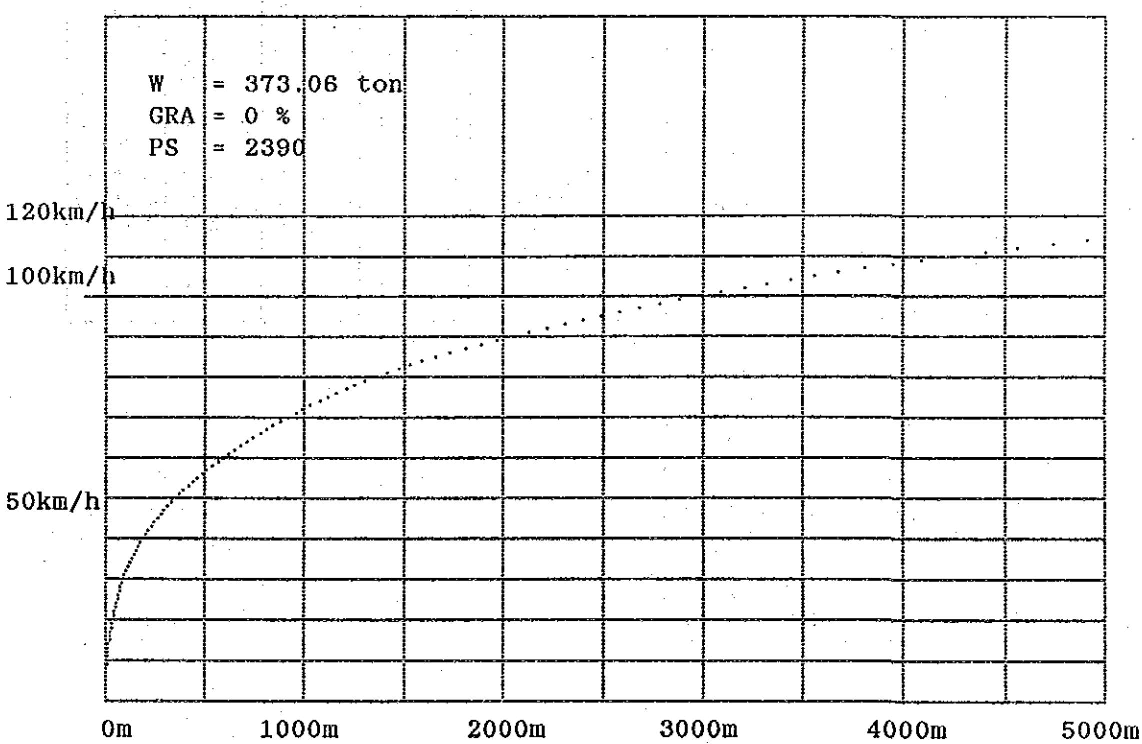
Year 2005 T=10 Min. (Off peak) [Night time]		140 persons / coach (Semi-cross Seat Type) 1 car (80 %) = 112 persons			
		U P		DOWN	
		RAPID	LOCAL	RAPID	LOCAL
1.	RAWANG				
			2.3		2.3
2.	KUANG				
			1.9		1.9
3.	H 1				
			1.9		1.9
4.	S.BULOH				
			3.2		3.2
5.	KEPONG				
			3.7		3.7
6.	H 2				
			3.7		3.7
7.	SEGAMBUT				
			6.7		6.7
8.	MALL				
			2.7		2.7
9.	P.MENTERI				
			2.7		2.7
10.	K.L.				
		5.9	5.7	5.9	5.7
11.	SEPUTEH				
		5.9	6.5	5.9	6.5
12.	S.SOUTH				
		5.9	6.9	5.9	6.9
13.	S.BESI				
		5.9	3.3	5.9	3.3
14.	SERDANG				
		5.9	2.2	5.9	2.2
15.	H 3				
		5.9	2.0	5.9	2.0
16.	KAJANG				
		3.8	1.2	3.8	1.2
17.	BANGI				
		3.8	0.1	3.8	0.1
18.	B.BENAR				
		3.8	0.1	3.8	0.1
19.	NILAI				
		3.8	0.1	3.8	0.1
20.	LABU				
		3.8	0.1	3.8	0.1
21.	TIROI				
		3.8	0.1	3.8	0.1
22.	SEREMBAN				

	Station	RAPID	LOCAL
Number of Trains	RAWANG	*	*
		0	10
	K.L.	*	*
		4	7
	KAJANG	*	*
		3	7
	BANGI	*	*
		3	2
	SEREMBAN	*	*

Appendix 6-3-6 Running Performance Required of DMUs for PBCS (7-car Train)

DMUs for RBCS: Running Performance Curve, Speed-Distance, Tractive Force, Running Resistance, Travel Time Tables

V km/h	F kg	Z kg	R kg	S m	T sec.	Akm/h/s
0	25244	26176	933	0.0	0.00	2.2555
5	22931	23900	969	1.6	2.30	2.0489
10	20387	21396	1009	7.0	4.86	1.8216
15	18294	19348	1053	17.0	7.72	1.6346
20	16198	17299	1101	32.6	10.93	1.4473
25	14212	15364	1153	55.4	14.57	1.2698
30	12450	13657	1208	87.2	18.72	1.1124
35	10797	12064	1267	130.2	23.47	0.9647
40	9597	10926	1329	186.9	28.90	0.8575
45	8506	9901	1395	259.3	35.02	0.7600
50	7412	8877	1465	351.1	41.96	0.6623
55	6997	8536	1539	463.9	49.69	0.6252
60	6692	8308	1616	594.0	57.83	0.5979
65	6269	7967	1698	743.2	66.41	0.5601
70	5729	7511	1782	916.9	75.66	0.5119
75	5413	7284	1871	1118.3	85.65	0.4836
80	4638	6601	1963	1355.2	96.64	0.4144
85	3631	5690	2059	1659.9	109.91	0.3245
90	3304	5463	2159	2049.2	125.91	0.2952
95	3200	5463	2262	2490.3	143.06	0.2860
100	2866	5235	2370	2985.6	161.32	0.2561
105	2641	5121	2480	3560.5	181.49	0.2360
110	2185	4780	2595	4242.9	204.31	0.1952
115	1839	4552	2713	5100.4	231.71	0.1643
120	1490	4325	2835	6180.3	264.75	0.1331



Appendix 6-3-7 Number of Cars Required Per Train in 1997

Year 1997 T=10 Min. (On peak) [Morning]		140 persons / car (Semi-cross seat Type)							
		245 persons / car (x175%)				280 persons / car (x200%)			
		U P		DOWN		U P		DOWN	
		RAPID	LOCAL	RAPID	LOCAL	RAPID	LOCAL	RAPID	LOCAL
1.	RAWANG								
			0.8		1.5		0.7		1.3
2.	KUANG								
			0.7		1.2		0.6		1.1
3.	H 1								
			0.7		1.2		0.6		1.1
4.	S.BULOH								
			0.9		1.7		0.8		1.5
5.	KEPONG								
			1.3		2.5		1.2		2.2
6.	H 2								
			1.3		2.5		1.2		2.2
7.	SEGAMBUT								
			2.3		4.3		2.0		3.8
8.	MALL								
			1.3		2.3		1.1		2.0
9.	P.MENTERI								
			1.4		2.5		1.2		2.2
10.	K.L.								
		4.1	4.8	2.2	2.6	3.6	4.2	1.9	2.3
11.	SEPUTEH								
		4.1	5.2	2.2	2.8	3.6	4.6	1.9	2.5
12.	S.SOUTH								
		4.1	4.2	2.2	2.2	3.6	3.6	1.9	2.0
13.	S.BESI								
		4.1	2.5	2.2	1.3	3.6	2.2	1.9	1.2
14.	SERDANG								
		4.1	1.6	2.2	0.9	3.6	1.4	1.9	0.8
15.	H 3								
		4.1	1.4	2.2	0.8	3.6	1.3	1.9	0.7
16.	KAJANG								
		1.9	0.8	1.0	0.4	1.7	0.7	0.9	0.4
17.	BANGI								
		1.4		0.7		1.2		0.6	
18.	B.BENAR								
		1.4		0.7		1.2		0.6	
19.	NILAI		↑		↑		↑		↑
		1.4	1-car	0.7	1-car	1.2	1-car	0.6	1-car
20.	LABU		Shuttle		Shuttle		Shuttle		Shuttle
		1.4	Tarin	0.7	Tarin	1.2	Tarin	0.6	Tarin
21.	TIROI		↓		↓		↓		↓
		1.4		0.7		1.2		0.6	
22.	SEREMBAN								

	Station	RAPID	LOCAL
Number of Train	RAWANG	*	*
		0	10
	K.L.	*	*
		5	9
	KAJANG	*	*
		5	9
	BANGI	*	*
		7	3
	SEREMBAN	*	*

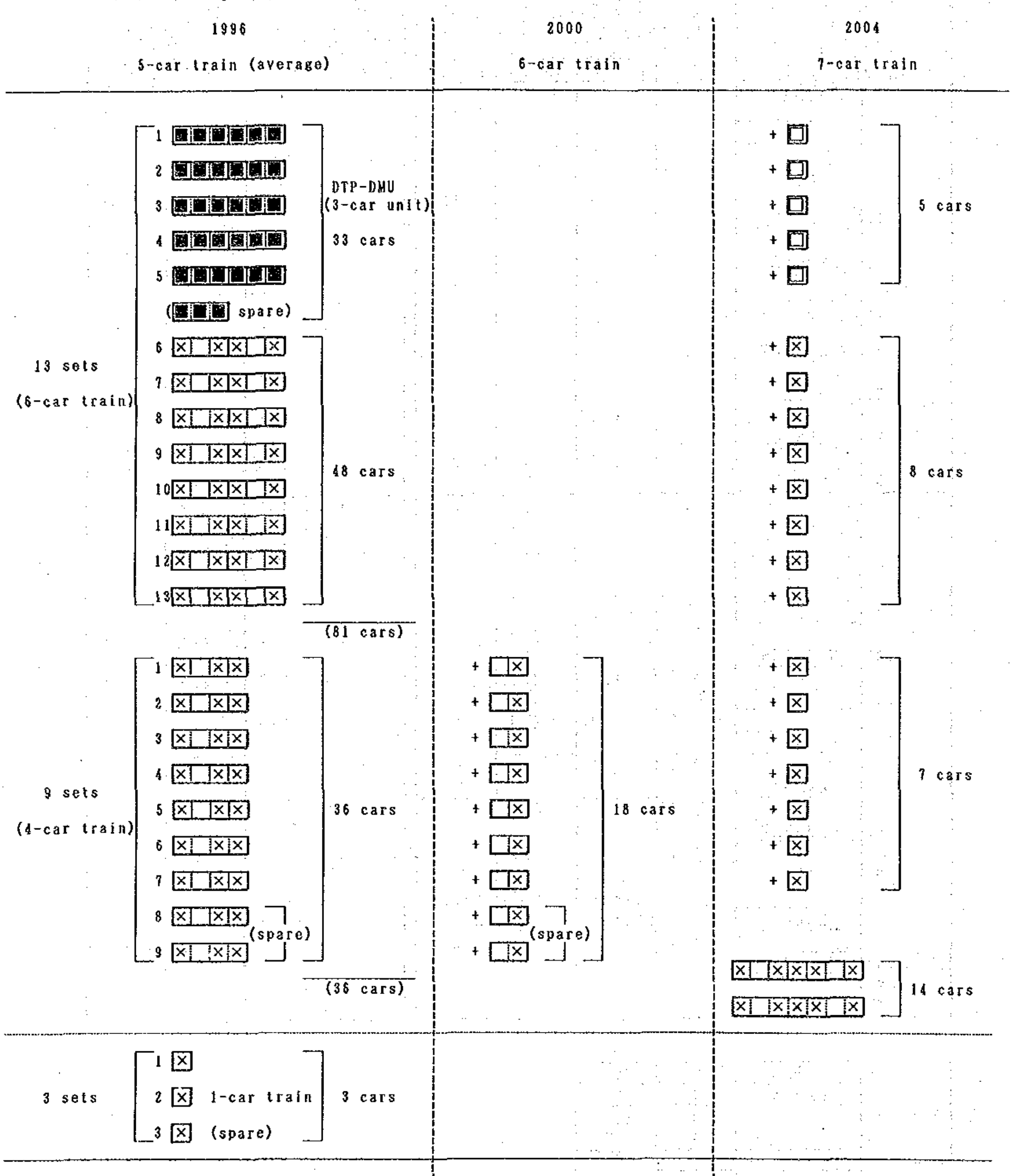
Appendix 6-3-8 Number of Cars Required Per Train in 2001

Year 2001 T=10 Min. (On peak) [Morning]		140 persons / car (Semi-cross seat Type) 245 persons/car (x175%) U P		DOWN		280 persons/car (x200%) U P		DOWN	
		RAPID	LOCAL	RAPID	LOCAL	RAPID	LOCAL	RAPID	LOCAL
1.	RAWANG								
			1.0		1.8		0.9		1.6
2.	KUANG								
			0.8		1.6		0.7		1.4
3.	H 1								
			0.8		1.6		0.7		1.4
4.	S.BULOH								
			1.5		2.7		1.3		2.4
5.	KEPONG								
			1.8		3.4		1.6		3.0
6.	H 2								
			1.8		3.4		1.6		3.0
7.	SEGAMBUT								
			3.2		5.9		2.8		5.2
8.	MALL								
			1.4		2.6		1.2		2.3
9.	P.MENTERI								
			1.5		2.7		1.3		2.4
10.	K.L.								
		5.0	5.1	2.7	2.7	4.4	4.4	2.4	2.4
11.	SEPUTEH								
		5.0	5.8	2.7	3.1	4.4	5.0	2.4	2.7
12.	S.SOUTH								
		5.0	6.0	2.7	3.2	4.4	5.2	2.4	2.8
13.	S.BESI								
		5.0	3.0	2.7	1.6	4.4	2.6	2.4	1.4
14.	SERDANG								
		5.0	1.9	2.7	1.0	4.4	1.7	2.4	0.9
15.	H 3								
		5.0	1.8	2.7	0.9	4.4	1.5	2.4	0.8
16.	KAJANG								
		2.4	1.1	1.3	0.6	2.1	1.0	1.1	0.5
17.	BANGI								
		1.7		0.9		1.5		0.8	
18.	B.BENAR								
		1.7		0.9		1.5		0.8	
19.	NILAI		↑		↑		↑		↑
		1.7	1-car	0.9	1-car	1.5	1-car	0.8	1-car
20.	LABU		Shuttle		Shuttle		Shuttle		Shuttle
		1.7	Train	0.9	Train	1.5	Train	0.8	Train
21.	TIROI		↓		↓		↓		↓
		1.7		0.9		1.5		0.8	
22.	SEREMBAN								

	Station	RAPID	LOCAL
Number of Train	RAWANG	*	*
		0	10
	K.L.	*	*
		5	9
	KAJANG	*	*
		5	9
	BANGI	*	*
		7	3
	SEREMBAN	*	*

Appendix 6-3-9 DMUs Introduction Schedule

DMU Perchasing Programme for RBCS



	1996	2000	2004
Total Number of cars to be operated :	120 cars	138 cars	172 cars
Total Number of cars to be purchased :	87 cars	18 cars	34 cars

Note: ■ shows DMUs introduced by DTP

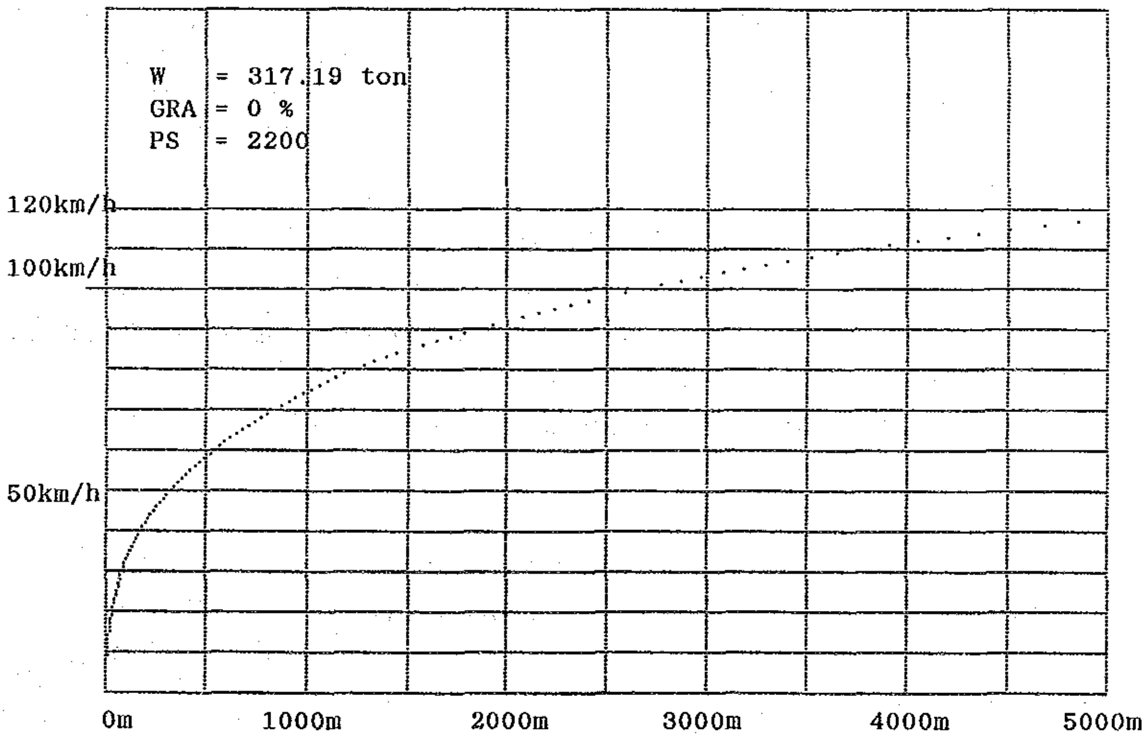
☒ shows DMUs with engine introduced by RBCS

Total number of DMU cars to be perchased :

172 - 33 = 139

Appendix 6-4-1 Running Performance of DMUs for RBCS (6-car train)

V km/h	F kg	Z kg	R kg	S m	T sec.	Akm/h/s
0	23302	24095	793	0.0	0.00	2.4488
5	21176	22000	824	1.5	2.12	2.2254
10	18837	19695	859	6.4	4.47	1.9795
15	16913	17810	896	15.6	7.11	1.7774
20	14986	15924	938	30.0	10.06	1.5749
25	13161	14143	982	51.0	13.40	1.3831
30	11542	12571	1030	80.1	17.21	1.2129
35	10024	11105	1081	119.6	21.57	1.0534
40	8922	10057	1135	171.4	26.54	0.9376
45	7921	9114	1193	237.6	32.13	0.8325
50	6917	8171	1254	321.3	38.46	0.7270
55	6539	7857	1318	424.0	45.50	0.6872
60	6262	7648	1386	542.4	52.90	0.6580
65	5876	7333	1457	677.8	60.69	0.6175
70	5383	6914	1531	835.2	69.07	0.5657
75	5096	6705	1609	1017.3	78.11	0.5355
80	4386	6076	1690	1230.9	88.01	0.4610
85	3464	5238	1774	1503.9	99.90	0.3640
90	3167	5029	1862	1850.3	114.14	0.3328
95	3076	5029	1953	2241.1	129.33	0.3232
100	2772	4819	2047	2678.2	145.45	0.2913
105	2570	4714	2145	3182.3	163.14	0.2701
110	2155	4400	2245	3775.5	182.98	0.2264
115	1841	4190	2350	4510.6	206.46	0.1935
120	1524	3981	2457	5420.2	234.29	0.1601



Running Performance Curve (6-car Consist)

Appendix 6-4-2 Major Running Performance Specification of RBCS Railcar

(1) Required performance

1) Acceleration

If five engines of 550 PS are selected for a 7-car train, output per Car will be 392 PS and the required time for 0 - 100 km/h will be less than 134 seconds.

2) Deceleration

Deceleration by ordinary brakes will be 2.6 km/h/s and that by emergency brakes 2.88 km/h/s, with stopping distance from the maximum speed being less than 700m.

Relatively short distance between stations requires high deceleration, and rail surface conditions may be deteriorated due to rain, so a device to prevent wheel slipping needs to be equipped. At the same time, to prevent early wearing of brake shoes, engine exhaust brakes will be used for braking at high to medium speeds.

(2) Major features

1) Car body

General dimensions are as follows:

- Length : 21.00 m
  (distance between couplers:21.50 m)
- Width : 2.75 m
- Floor surface level : 1.10 m

Layout:

- Entrances : 3 on one side
- Driver's cab : Pass-through type

Construction:

- Light weight stainless steel body

The stainless steel body will be used in consideration to rainy weather, together with reduction of painting cost and simplification of cleaning outer plate.

Stainless steel body is either of semi-stainless steel or all-stainless steel type. The former uses stainless steel in some part of shell plate or structural members, while the latter uses it for almost all part of body; in particular, high tension stainless steel is effectively used to reduce the body weight by around 70% compared to ordinary steel body.

As commuter trains repeat rapid acceleration and deceleration, light weight stainless body is expected to improve fuel economy.

2) External appearance

DMUs will be designed by taking advantage of stainless body so as establish a public image as a modern commuter service.

3) Engine/transmission

To maximize cohesion of wheels, a 1-engine and 2-axle drive system will be used.

Use of 550 PS engines will reduce the number of cooling, hydraulic and fuel-related parts, in addition to engine and transmission, by 71% (for 7-car train) compared to 350 PS engines, leading to significant saving in maintenance cost.

4) Accommodation

Semi-cross type seats will be used. Spacing for facing seats will be 1,600mm, and long seat width for one person will be 440mm, compared 1,500mm and 430mm for Japanese ordinary commuter trains.

5) Bogie

Air spring will be used to improve riding comfort, and light weight bolsterless bogie will be used for improving of efficiency in maintenance work as well as manpower saving.

6) Safety device

As the minimum headway will be 5 minutes around Kuala Lumpur, the automatic train protection (ATP) device (continuous control) and the dead-man device will be installed.

Also, for effective communication at the time of train delay or accident, train radio will be installed.

7) Airconditioning system

A centralized airconditioning system will be installed at the center of rooftop. No heating system will be provided.

Ventilation will be of centralized duct type embedded in ceiling, with line fans for air circulation.

A diesel engine generator will be installed in each intermediate car to supply electricity for airconditioning to all cars.

8) Door

3 double sliding doors will be provided on one car side, with width of 1,300mm to allow smooth passenger flow during peak hours.

A semi-automatic door opening system will be designed to allow passengers to open doors from the inside or outside by pressing a button installed near doors, if lock is released by a conductor.

This system will prevent conditioned air from flowing out by unnecessary opening of doors. Also it will prevent rain from entering the compartment when the train stops at a platform without roof.

9) Step

RBCS will provide commuter service between Rawang and Seremban, and doors will be designed to fit 1,054mm-high platforms, so that no step for boarding will be provided.

10) Toilet

A toilet will not be provided in this DMU car.

11) Window

Windows will be of double construction for high soundproof effect, with tint to reflect ultraviolet rays for better cooling effect.

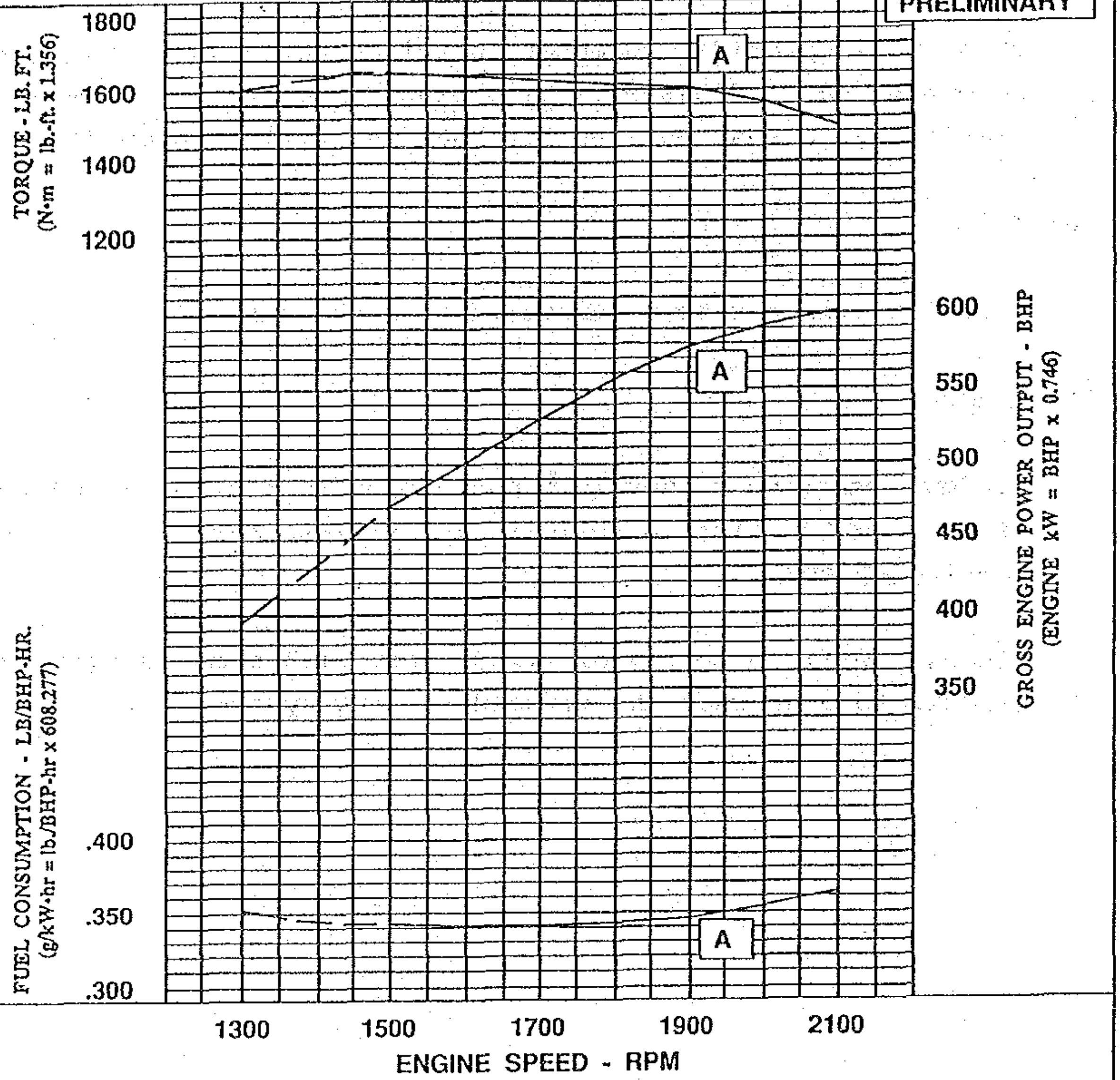
Windows will be mostly of fixed type, with some single-hung windows to open when the airconditioning system fails.

Appendix 6-6-1 Revolution Number and Fuel Consumption of Engine

Displacement: 1150 in.3 (18.9 litre) No. of Cylinders: 6 Rating:
Bore: 6.25 in. (159 mm) Stroke: 6.25 in. (159 mm) BHP (kW) @ RPM
CPL: 1190 600 (448) @ 2100

All data is based on the engine operating with fuel system, water pump, lubricating oil pump, air cleaner, and muffler; not included are alternator, compressor, fan, optional equipment and driven components.

PRELIMINARY



Curves shown above represent gross engine performance capabilities obtained and corrected in accordance with SAE J1349 conditions of 29.61 in Hg (100 kPa) barometric pressure [300 ft (90 m) altitude], 77°F (25°C) inlet air temperature, and 0.30 in Hg (1 kPa) water vapor pressure with No. 2 diesel fuel. The engine may be operated without changing the fuel setting up to 8,500 ft (2 600 m) altitude. For sustained operation at high load factors at higher altitudes, the fuel rate of the engine should be adjusted to limit performance by 4% per 1,000 ft (300 m) above 8,500 ft (2 600 m) altitude. The engine altitude capability is based upon an inlet temperature representative of the ambient temperature for that altitude. See reverse side for application rating guidelines.

TECHNICAL DATA DEPT.

Appendix 6-6-2 Fuel Consumption Per Engine by Service Section

Area	Route Section	Sheduled Operation Time (Sec.)	Acceleration Period (Sec.) Local	Acceleration Period (Sec.) Rappid	Acceleration Ratio (%)	Cruising, Coastering and Braking Ratio (%)	Stopping Time at Station (1 min)	K.L. Station (2.5min)	Fuel Consumption (liter): Acceleration 1.445 (ltr/min)	Fuel Consumption (liter): Coastering etc. 0.232 (ltr/min)	Fuel Consumption (liter): Idling 0.058 (ltr/min)	Fuel Consumption (liter): Total Estimation (Allowance include 5%)
Northern Part	Rawang -->> K.L. (Local)	2,160	1,102		50.00	50.00	9.0	2.5	26.010	4.176	0.667	Liter 32.396
	Rawang <<-- K.L. (Local) (KL 1/2)		1,046									
	(KL 3/4)		1,070									
	Average	2,160	1,058									
	Round Trip Time	4,320	2,160						(one way/one engine) Total 30.853 Liter			
Southern Part	K.L. -->> Bangi (Local) (KL 1/2)		1,178		47.35	52.65	7.0	2.5	27.371	4.886	0.551	Liter 34.448
	(KL 3)		1,112									
	(KL 4)		1,128									
	Average	2,400	1,149									
	K.L. <<-- Bangi (Local)	2,400	1,124									
	Round Trip Time	4,800	2,273						(one way/one engine) Total 32.807 Liter			
	K.L. -->> Seremban (Rapid) (KL 1/2)			1,682	46.43	53.57	2.0	2.5	38.244	7.084	0.261	Liter 47.869
	(KL 3)			1,782								
	(KL 4)			1,798								
	Average	3,420		1,736								
	K.L. <<-- Seremban (Rapid)	3,420		1,440								
	Round Trip Time	6,840		3,176					(one way/one engine) Total 45.589 Liter			
	Bangi -->> Seremban (Shuttle)	1,950	1,124		87.74	12.26	6.0	0.0	22.087	0.495	0.187	Liter 23.907
	Bangi <<-- Seremban (Shuttle)	1,950	2,298									
	Round Trip Time	3,900	3,422						(one way/one engine) Total 22.769 Liter			

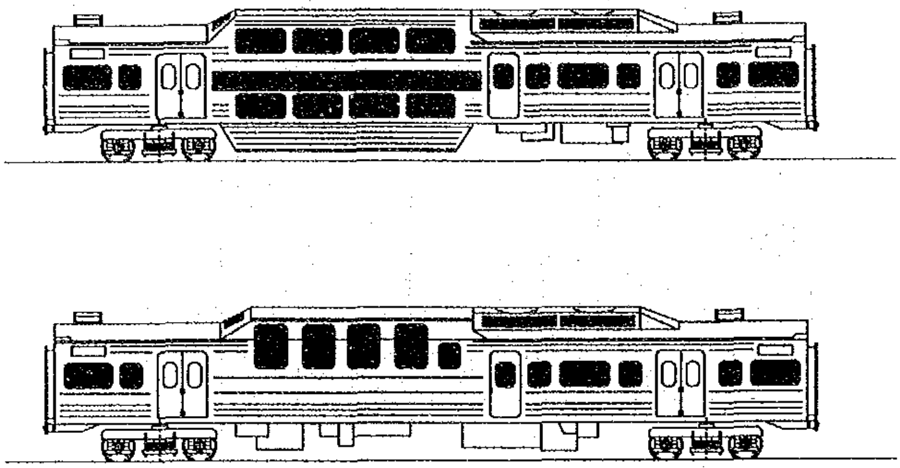
Appendix 6-6-3 Calculation Process for Annual Fuel Consumption

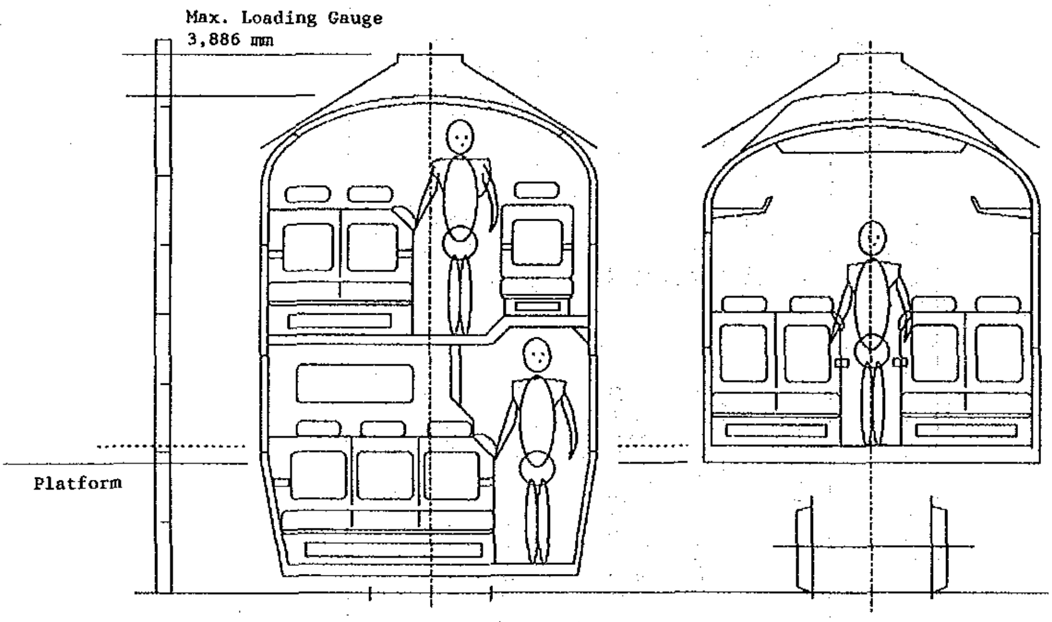
Area	Route Section	Fuel Consumption (Liter/ one way and one engine)	Year 1997 - Number of Trains / Day	Year 1997 - Number of Engines / Train	Year 1997 - Sectional Fuel Consumption per Day	Year 2001 - Number of Trains / Day	Year 2001 - Number of Engines / Train	Year 2001 - Sectional Fuel Consumption per Day	Year 2005 - Number of Trains / Day	Year 2005 - Number of Engines / Train	Year 2005 - Sectional Fuel Consumption per Day
Northern Part	Rawang -->> K.L. (Local) Rawang <<-- K.L. (Local)	Liter /min. 32.396	38	Ave. 3.6842	10,503	88	4	11,403	102	5	16,522
Southern Part	K.L. -->> Bangi (Local) K.L. <<-- Bangi (Local)	34.448	69	3.6842	8,757	69	4	9,508	72	5	12,401
	K.L. -->> Seremban (Rapid) K.L. <<-- Seremban (Rapid)	47.869	34	3.6842	5,996	34	4	6,510	34	5	8,138
	Bangi -->> Seremban (Shuttle) Bangi <<-- Seremban (Shuttle)	23.907	22	1	526	22	1	526	22	1	526
Grand Total				Liter/Year	9,410,429		Liter/Year	10,200,611		Liter/Year	13,719,080

Appendix 6-6-4 Train Kilometerage and DMU Car Kilometerage (1993 in DTP, 1997 and 2005 in RBCS)

Year	Route Section	Distance (km)	Number of train Total(up/down)	Train consist	Train kilometerage (km/day)	DMU Car kilometerage (km/day)
1993 (DTP)	Rawang~K.L.	32.0	80	3	2,560	7,680
		73.25	68	3	4,981	14,943
		Total	148	–	7,541	22,623
1997	Rawang~K.L.	32.0	(8)88	5	2,816	14,080
	K.L.~Kajang	26.75	103	5	2,756	13,780
	Kajang~Bangi	10.75	102	5	1,097	5,485
	Bangi~Seremban	35.75	36	5	1,287	6,435
	ditto	35.75	22	1	787	787
		Total			8,743	40,567
2005	Rawang~K.L.	32.0	(4)102	7	3,264	22,848
	K.L.~Kajang	26.75	(2)110	7	2,943	20,601
	Kajang~Bangi	10.75	(2)106	7	1,140	7,980
	Bangi~Seremban	35.75	36	7	1,287	9,009
	ditto	35.75	22	1	787	787
		Total			9,421	61,225

Appendix 6-7-1 Example of Double-Decker and High-Deck Railcar Appearance





Chapter 7

RAILWAY GROUND FACILITIES

Appendix 7-1-1 Measures for Speed Improvement on Narrow Gauge Track

(1) Recent trend

In the last half decade Japanese National Railways (JNR), and its successor, Japan Railway Group (JR), have been making efforts to increase train speeds in order to develop competitive power against road transport modes. After privatization profitability of speed-up investment has been put higher emphasis than before.

Hence, instead of such speed-up measures taken by JNR as re-routing with construction of new bridges and tunnels, or double tracking, more cost-effective speed-up measures are taken by JR.

(2) Improvement of speed restriction on curves

1) Basic theory

Basically restricted speed on curves is imposed to prevent outword overturning of the train running on the track without cant (Refer to Fig. 1).

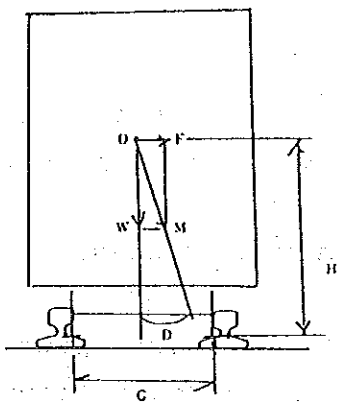


Fig. 1 Forces Functioning to Car on Track without Cant

The safety condition of running train is described below. The compound force (M) of gravity (W) and centrifugal force (M) from the centroid (O) of the car should cross the gauge line which connecting two rail heads, within the certain distance (D) from the centerline of the track.

Then,

$$D = \frac{GV^2}{127R} \times \frac{H}{G} = \frac{1}{a} \times \frac{G}{2}$$

Where,

V: Restricted velocity (km/h)

R: Radius (m)

G: Gauge (mm)

a: Safety factor (non-dimentional, $a = \frac{G}{2D}$)

H: The height of the centroid of the car from the rail head (mm).

Hence,

$$V=\sqrt{\frac{127GR}{2aH}} \quad \text{--- (a)}$$

In practice restricted speed grades on curves are set at every 5 km/h. (Refer to Table 7-1)

In MRA the following values are used for DMUs of RBCS,

a = 3

H = 1,650 mm (the Team estimate),

G = 1,000 mm

Then,

$V = 3.58\sqrt{R}$

The results of the calculation are also shown in Table 1. And refer to Main Report Fig. 5-3-2.

(3) Raising the restricted speed

On curves, with cant, the speed restriction is determined also taking into account other factors, such as riding comfort, track structure strength, etc.

The passengers of the train running on curves at the speed (V) and the eqilbrium cant (E), receive the over-centrifugal force which gives them discomfort. This is positively car-related with cant deficienty (Cd), if $E \geq C$ (the cant laid in practice).

From Fig. 2,

$$\tan \Theta = \frac{F}{W} = \frac{E}{G} = \frac{C+Cd}{G} \quad \text{(G: Gauge)}$$

where,

$F = m \frac{V^2}{R}$ (F: Centrifugal force)
(m: Mass)

$W = mg$ (R: Radius of the curve)
(W: Weight)

$E = C + Cd$ (g : Gravity constant)

Then,

$$V = \sqrt{\frac{127(C+Cd)R}{G}} \quad \text{--- (b)}$$

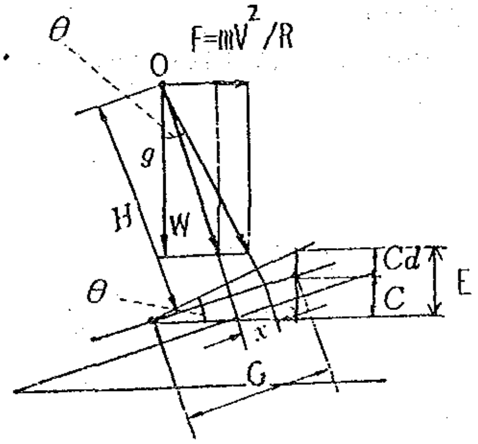


Fig. 2 Forces Functioning to Car on Track and Cant

The newly inaugurated super performance car; Super express "Hitachi" of JR has realized high permissible cant deficiency of 70 mm by maintaining the riding comfort in terms of lateral acceleration less than 0.08 g by adoption of high quality spring without pendlum car composition.

From the equation (b),

$$V = \sqrt{\frac{127(C+Cd)R}{G}} = 4.56\sqrt{R}$$

where, C = 105 mm (the maximum in JR),

Cd = 70 mm,

G = 1,067 mm

The relationship between R and V are also shown in Table 1. If MRA adopts the same super performance car which will realize in the future, the theoretical restricted speed on curves is calculated as follows.

In consideration of the difference of the gauge;

$$Cd = 70 \text{ mm} \times \frac{1{,}000 \text{ mm}}{1{,}067 \text{ mm}} = 65.6 \text{ mm}$$

From the equation (b),

$$V = 4.45\sqrt{R}$$

where, C = 90 mm (the maximum in MRA),

Cd = 65.6 mm,

G = 1,000 mm

The results of the calculation is listed in Table 1.

Table 1 Speed Restriction on Curves

(Gauge)	JR, JNR (1,067 mm)		MRA (1,000 mm)	
Curve Radius	DMUs EMUs	Super Performance car #1 #2	DMUs in RBCS	Super Performance car in future #1 #3
m	km/h	km/h	km/h	km/h
300	65	80	60	75
400	75	90	70	85
500	85	100	80	95
600	90	110	85	105
700	95	115	90	115
800	100	125	95	125
1000	105	130	100	130
1200	110	130	100	130
1400	115	130	100	130
Straight	120	130	120	130

#1 Super Express 'Hitachi' (series 651 AC/DC EMU)
#2 Equilbrium Cant = Maximum Cant + Maximum Cant Deficiency
= 105 mm + 70 mm = 175 mm
#3 Equilbrium Cant = Maximum Cant + Maximum Cant Deficiency
= 90 mm + 65.6 mm = 155.6 mm

(4) Ground facilities

The ground facilities are improved considering the train operation curve (the distance-speed curve). The countermeasures taken by JR are as follows:

1) Track Structure

a. Strengthen the track structure;
50 or 60 kg/m, PC-sleeper with 64 mm spacing at the minimum, 250 mm ballast depth.
b. Upgrading controll method of track condition.
C. Efficient scheduling of track maintenance works.

2) On Curves

a. Reinforcing the fastenings
The fastenings installed on the curve (R ≤ 600 m) receive the lateral force of equivalent to 80 % of the wheel load, while those of straight track get 40 %. Therefore PC-sleeper with reinforced fastenings which resist the above forces are adopted.
b. Realignment of sharp curves.
c. Elevating the cant, and increasing the transition curve length.

3) Turnout

- Mitigating the track maintenance works at the turnout. -

a. Using heavier rail. (70, 80, & 90 kg/m)
b. Welding lead rail and tongue rail into one piece.
c. Strengthen the slip plate.
d. Strengthen the H guard to resist the innerside wheel thrust, when passing the crossing.

4) Introduction of light weight cars

Reducing axel load and unsprung weight.

Appendix 7-1-2 Alternative Track Layout Plan of the Bangi Station

This alternative plan, where stabling tracks are located in the Seremban and east side, minimizes track modification of the DTP plan. This plan has, however, two disadvantages; i.e. level crossing to main tracks and swampy ground condition.

By comparison of the original plan mentioned in <u>Main Report 7-1-3(6)</u> and the alternative plan, the original plan is adopted as shown in the table below.

Table 1 Comparison and Conclusion

	Original Improvement Plan Fig. 7-1-9 (Main Report)	Alternative Plan Fig. 1
Traffic Disturbance due to Level Crossing ----- (Delay Recover), etc.	None	Exist
Minimum Radius of Stabling Tracks -----	800 m	Less than 200 m
Ground Condition -----	Better	Swampy
Future Development (Application to Train ----- Number Increase)	Excellent	Poor
Modification Cost (From Existing DTP Plan)-----	More	Less
(From Revised DTP Plan) -----	Less	Less
Conclusion -----	Adopted	Non-adopted

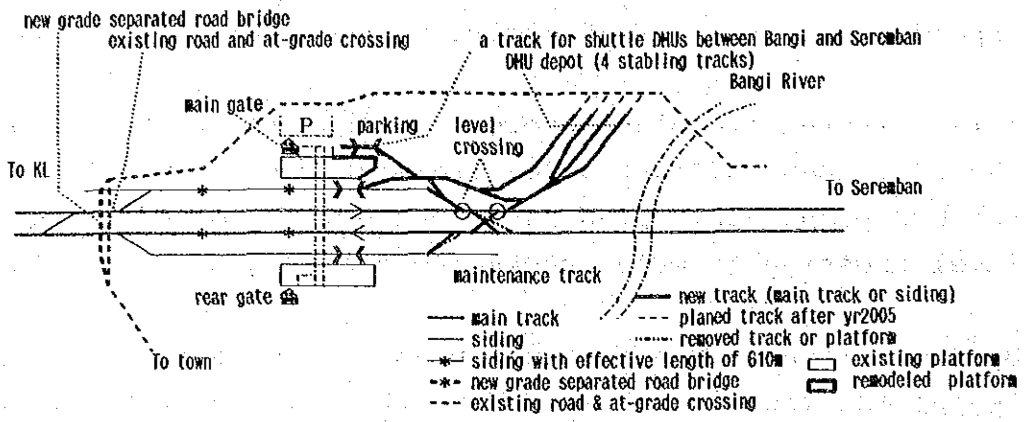


Fig. 1 Alternative Track Layout Plan of Bangi Station in RBCS

In case the shifting of a new road bridge in the original plan is not approved, another track layout plan (Plan-II) will be as shown in Fig. 2.

In this plan, however, the following problems are considered;

1) Inner two sidings have sharp curves of 200 m radius.
2) Tracks 2 and 5 have effective length of 610 m including cross-over, while Track 3 has 504 m.
3) Additional installation of signals

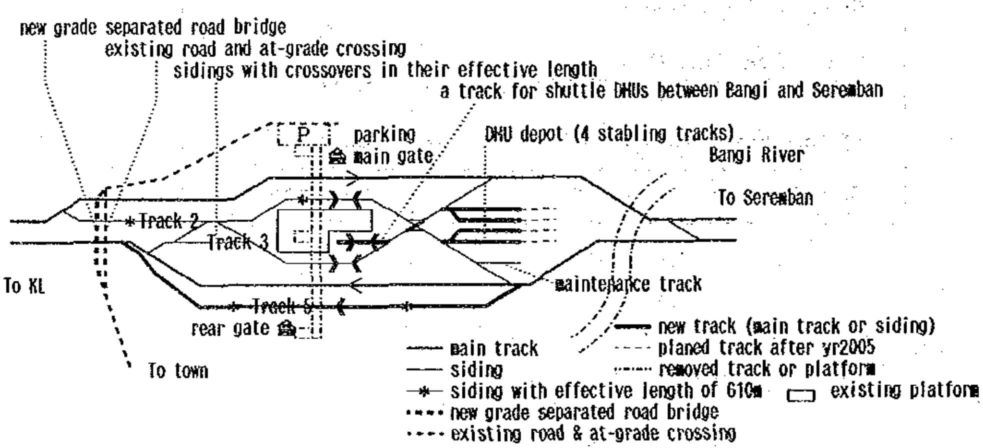


Fig. 2 Alternative Track Layout Plan (II) of Bangi Station in RBCS

Appendix 7-1-3 The Growth of Track Irregularity and its Theory

(1) Track subsiding

In Japan, since 1961 track conditions have been periodically measured by high speed track inspection cars. The behavior of subsiding of the track has been analyzed by the above data. The equation below was produced by using 2 train operation factors and 3 track ones. In parallel with this, it was found that the standard deviation, which represents the track irregularity, of the track subsiding is in proportion to the average value of track subsiding.

$$S = 2.09 \times 10^{-3} \cdot T^{0.31} \cdot V^{0.98} \cdot M^{1.10} \cdot L^{0.21} \cdot P^{0.26} \quad .... \text{(a)}$$

where
- S: Growth of track irregularity [mm/100 days]
- T: Passing tonnage [million ton/year]
- V: Average velocity (km/h)
- L: Explaining factor for rail gap
  (L=1 for a long welded rail, & L=10 for standard length rail)
  [NDF= non dimentional factor]
- P: Explaining factor for roadbed condition
  (L=1 for good roadbed & L=10 for bad one)
  [NDF]
- M: Track structure coefficient [NDF]

(2) Track structure coefficient

Track structure strength represents the pressure on the base ground caused by the wheel weight and impact through the track structure. For the convenience of the calculation, the coefficient (M) is set up, representing the relative strength to the standard structure strength (50kg/m rail with PS type, PC sleeper with 56.7cm spacing, ballast with 200mm depth). Therefore the more the track structure strength increases, the more the coeffi cient M decreases. M is calculated by use of the continuous elastic support model of track dynamics, consisting of mass of each track material (rail, sleeper, ballast & roadbed), unsprung parts of a car, and spring inter-connecting of each mass. The lowest spring is connected to the base ground. The spacing of springs is as same as that of fastening (sleeper) spacing. (Refer to Fig. 1)

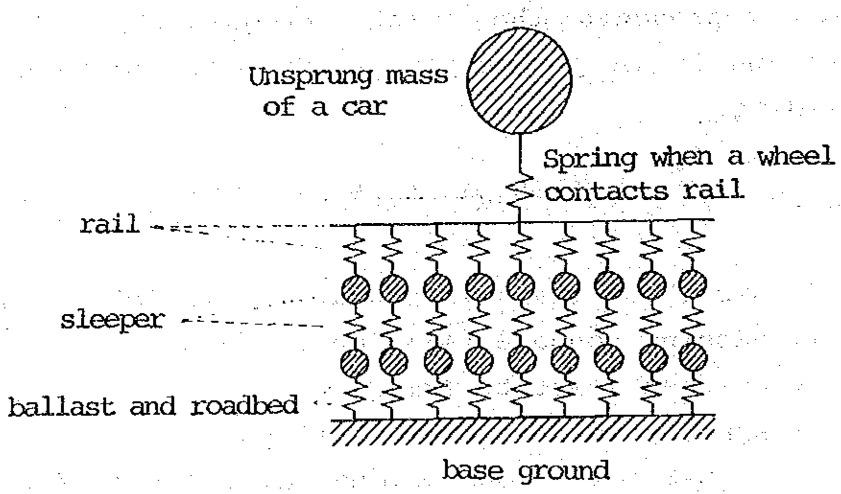


Fig. 1 Track Dynamics Model

(3) Calculation results of the growth of track irregularity of RBCS

Track irregularity of RBCS is caluculated by equation (a). According to the results shown in Table 1, the growth value of track irregularity per 100 days in 1990 is 0.71mm and for that "with-the-project" case in 2005 becomes 0.55mm, because the track structure will have been strengthened adopting PC sleeper and ballast with 250mm depth. Required track maintenance work is in proportion to that value, in principle. Considering double track in 2005, the track maintenance increase ratio from year 1990 to year 2005 becomes 55% as follows;

$$\frac{0.55mm \times 2}{0.71mm} = 1.55$$

The growth values of track irregularity per 100 days in 2005 are 0.55mm in "with-the-project" case and 0.47mm in "without-the-project" case. Therefore the track maintenance increase ratio between "with-" and "without-the-project" case becomes 17% as shown below;

$$\frac{0.55mm \times 2}{0.47mm \times 2} = 1.17$$

In "with-the-project" case, if 50kg/m rail (JR N-type) is adopted in 2005, the maintenance work can be reduced by 25%.

$$\frac{0.41mm \times 2}{0.55mm \times 2} = 0.75$$

Table 1 Growth of Track Irregularity

	Year		1990	2005		
	Items	Unit		'without'	'with'	'with' alter-native
Track	Rails: Mass per Meter	kg/m	40	40	40	50
	Stiffness (EI)	kgf-cm^3 (x 10^7)	2.89	2.89	2.89	4.12
	Sleeper: Width x Length Spacing	cm X cm cm	20 x 210 60	24 x 200 70	24 x 200 70	24 x 200 70
	Ballast: Depth	cm	20	25	25	25
	Track Structure Coefficient (M)	non-dimen-tional	1.43	1.37	1.37	1.06
	Factor for Rail Gap (L)	- " -	10 standard rail	1 welded rail	1 welded rail	1 welded rail
	Factor for road-bed (P)	- " -	10 bad	10 bad	10 bad	10 bad
Train Operation	Annual Passing Tonnage (T)	million ton	6.85	6.33	10.87	10.87
	Average Velocity (V)	km/h	46.8	53.0	53.0	53.0
	Growth of Track Irregularity (S)	mm/100 days	0.71	0.47	0.55	0.41

T and V come up from <u>Main Report Table 7-1-5</u>

Appendix 7-1-4 Measures to Improve Work Productivity

(1) Training

According to the JNR's experience, intensive training both on the job and in the academy have been executed for the maintenance crew with emphasis on the items below.

1) Operating skill of MTT (multiple tie-tamper)
2) Control method of track irregularity

Eventually the total MTT-tamping length increased by 5 times within 5 years, without increasing the number of maintenance crew. (Refer to Fig. 1)

(2) Maintenance Train

Maintenance trains should be operated with fixed and periodical schedule, carrying track maintenance materials such as rail, sleeper, ballast, etc.

(3) Maintenance Block

Setting appropriate non-operation time zone to facilitate large-scale track maintenance work. (Refer to Fig. 2)

(4) Set-off Mechanism

In order to maximize the net-working ratio in the maintenance block hours, installation of set-off mechanism for branching off the MTT is required.
(Refer to Fig. 2 and Pictures)

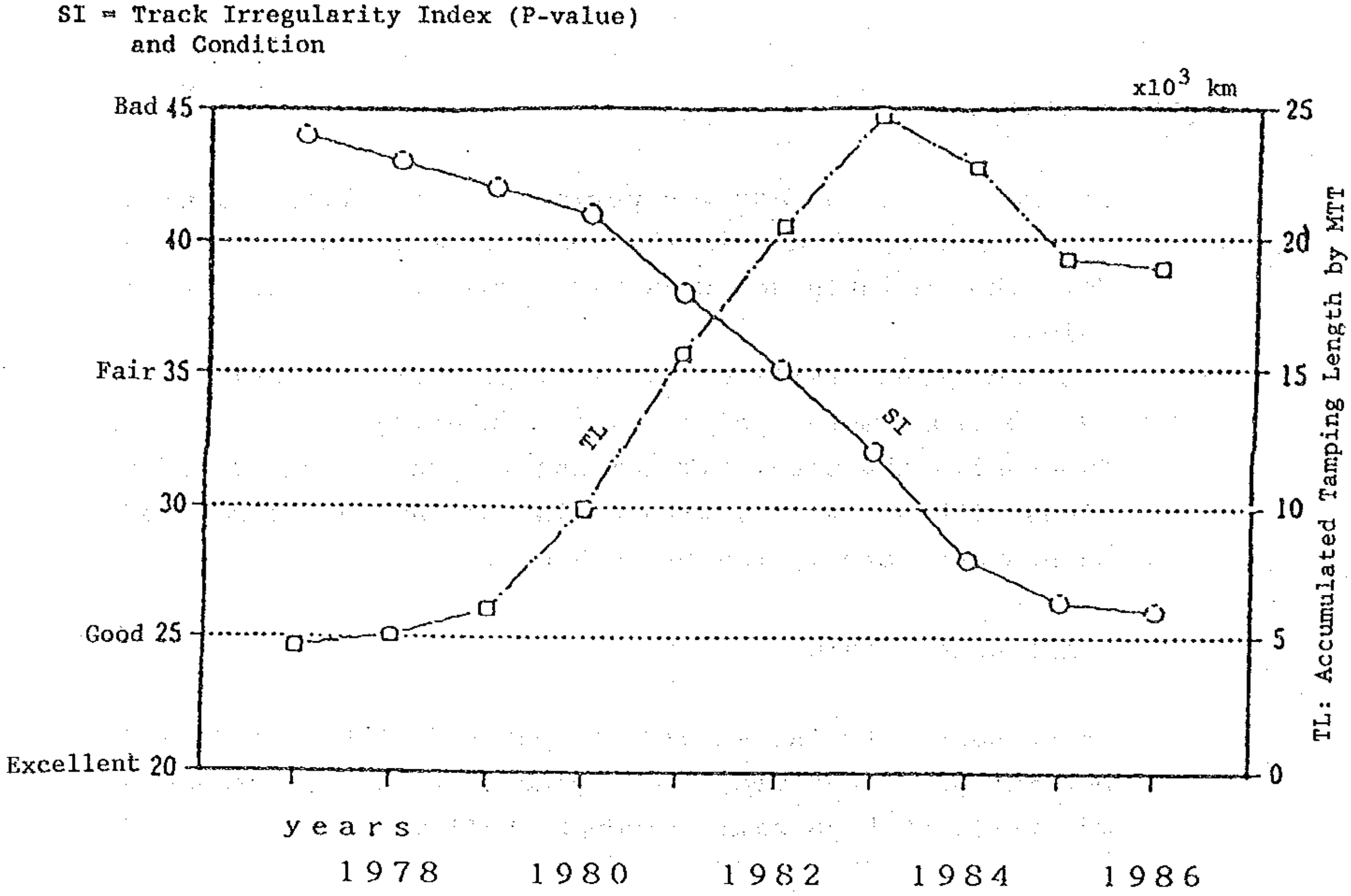
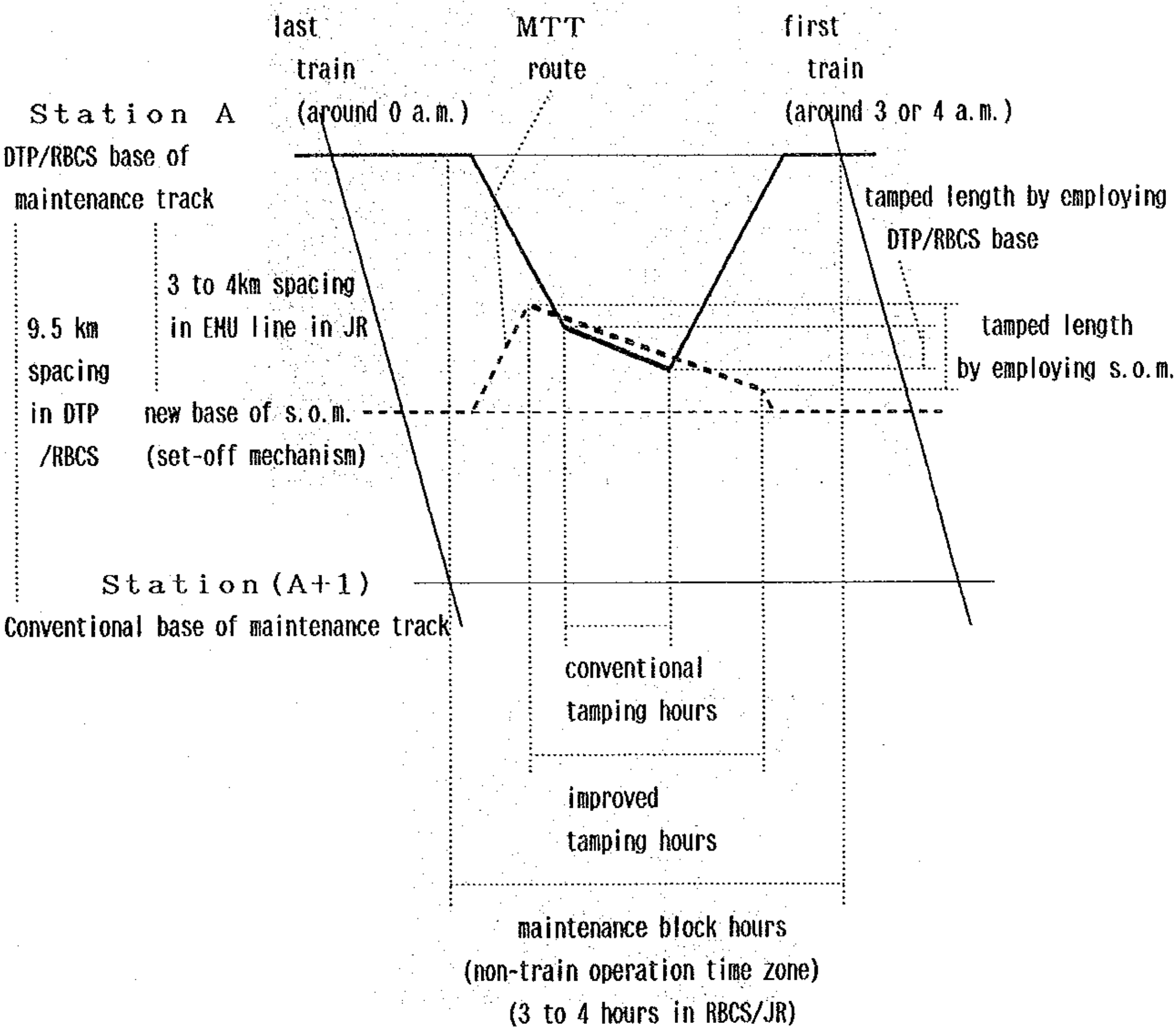
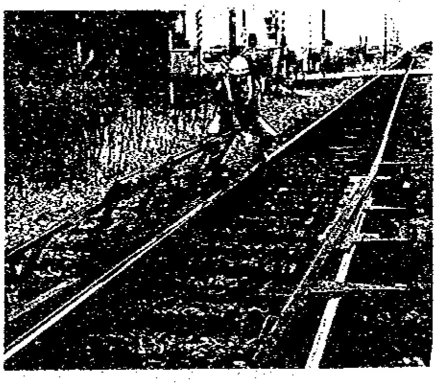


Fig. 1 The Improvement of Track Irregularity (SI) by Increasing of Tamping Length (TL) by MTT in JNR (Japanese National Railways)



EMU = Electric Multiple Unit

Fig. 2 Effective Use of Maintenance Block
- Example of MTT Tamping by Employing Set-off Mechanism-



Pictures : Set-off Mechanism at JR halt.

- No signalling equipments are required -

Appendix 7-1-5 Criteria for Establishing New Station, Rear Station Gate and Over-the-track Station

1) New Station

   a) Where there is a sharp increase in the number of passengers in the suburbs of large cities.
      (in this project, H2)
   b) Where a large project is planned.
      (in this project, H1, H3)
   c) Where a considerable effects are expected in developing tourism.

2) Conditions for Establishing a New Station

   a) To be viable from MRA's financial viewpoint and serve to promote public welfare
   b) To have more than 6,000 passengers per day
   c) The station's revenue exceed its expenditure.
   d) Flat place (the gradient shall be less than 3.5/1000)
   e) Select track alignment as straight as possible.
   f) Place which requires earthwork volume as little as possible.
   g) Easy improvement or expansion in future.

3) Conditions for Establishing a Rear Station Gate

   a) More than 6,000 persons per day who use the rear gate
   b) Local inhabitants have a request to prepare the rear gate
   c) Easy to acquire required land

4) Merits and Demerits of Over-the-track Station

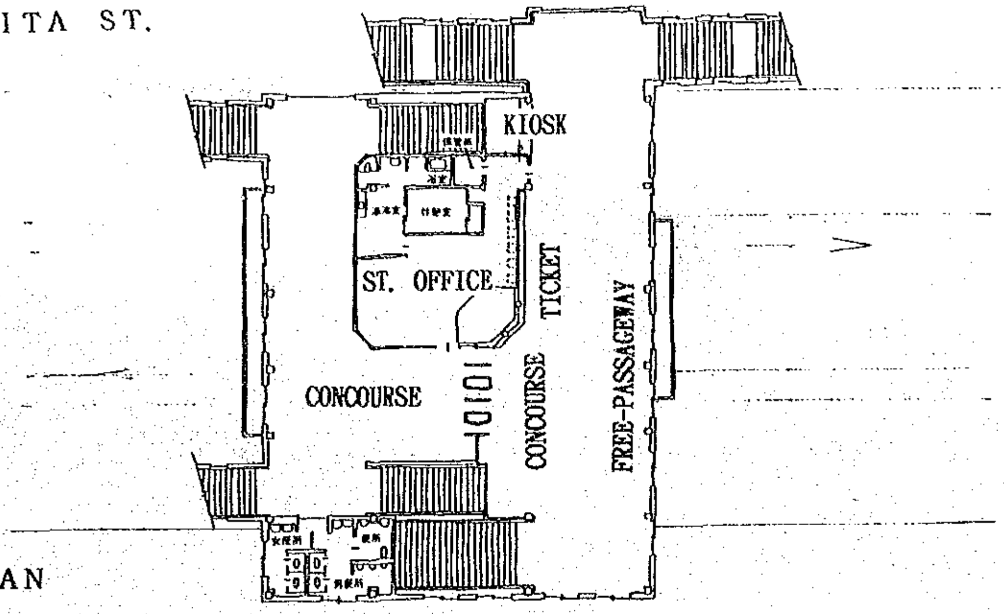
	Merits	Demerits
Relative to inhabitants	-The free through-passage saves the city from getting separated into two. -When the station front plaza is also double-decked by constructing pedestrian deck, the flows of cars and pedestrians can be separated	-Staircases trouble the free flow of the passengers, especially handicapped -As to the management of the free passage and pedestrian decks, special agreements with local government will be required
Land space	-Land space for station building can be economized (Concourse etc. can be built upstairs) -The existing station building can be utilized for other purposes	
Management	-Station man-power can be economized (less wickets, offices, etc.)	-For platform operation, special staffing is necessary
Plans and Structure	-The over-track passage leads directly to all platforms (convenient) -The Plan can be simple (rectangular), convenient for passengers	-The entire building becomes higher than an ordinary two storied building (overhead clearance) -The locations of the pillar holes are subject to the track layout. -The floor designs is not free -Staircases make the effective space of the floor smaller
Construction Cost		-Higher
Maintenance Work		-More complicated and expensive
Future improvement		-Free hands in future improvement are lost, more or less

5) Bearing the Cost

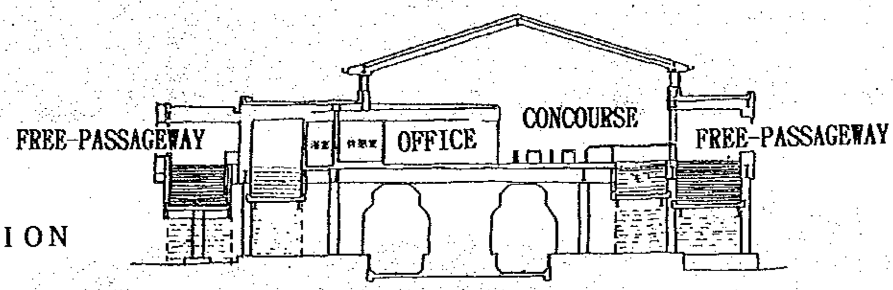
a) The cost for establishing a new station, a rear station building or an over-track station is borne by a petitioner (city) in principle.

b) In case when expenses are shared, the cost born by MRA is limited to the facilities required to operate trains, to handle passengers and to conduct station business.

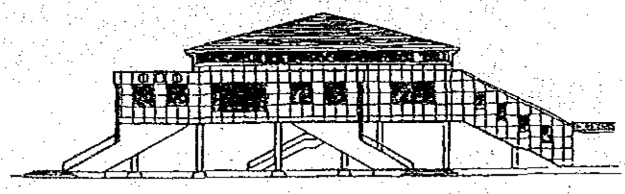
MITA ST.



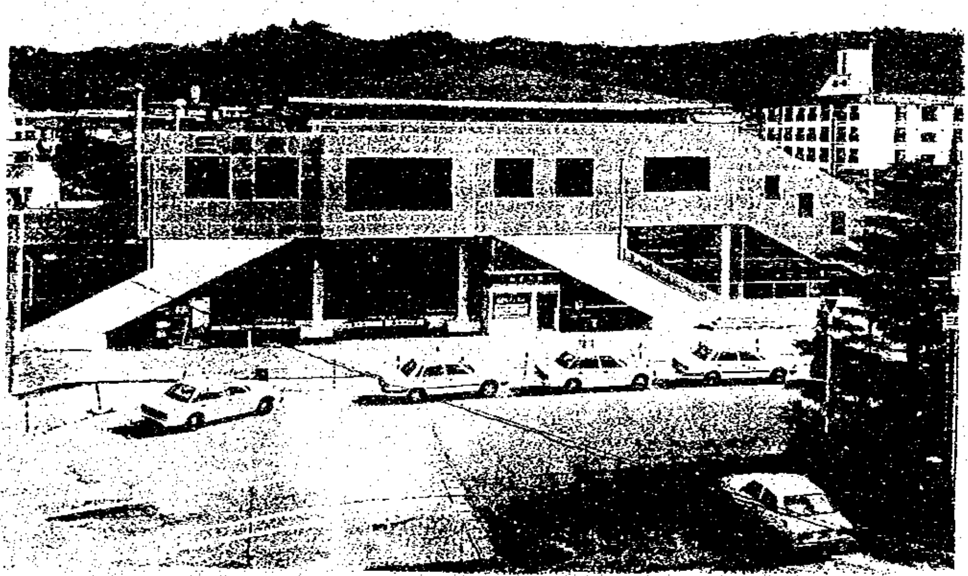
PLAN



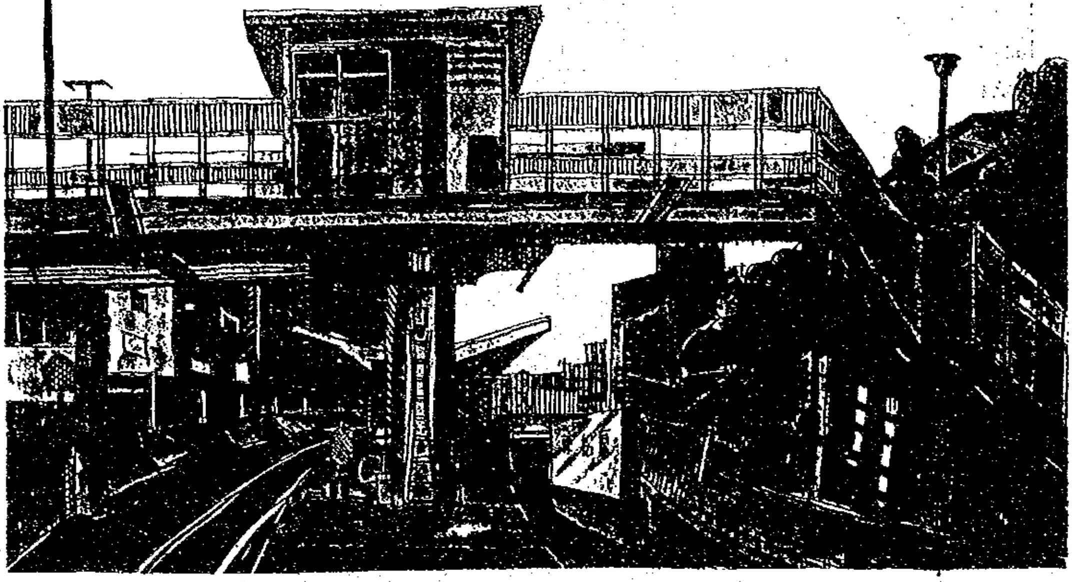
SECTION



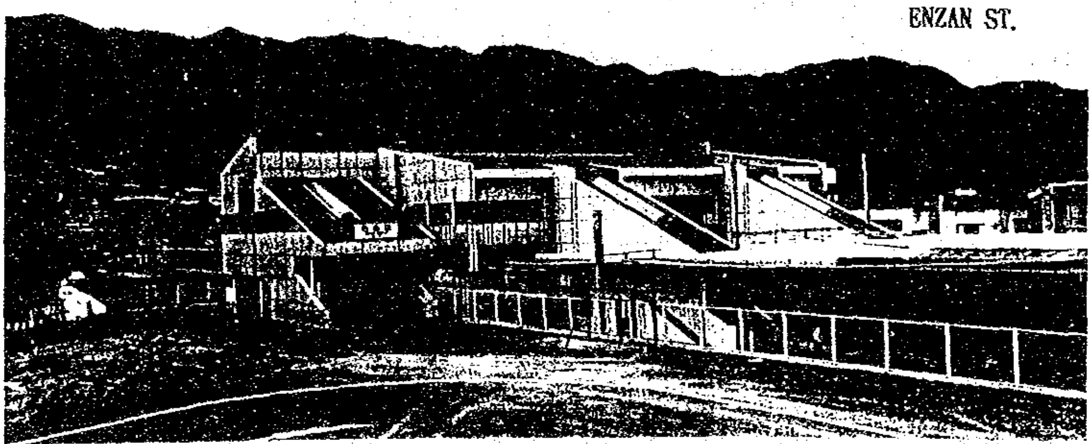
ELEVATION



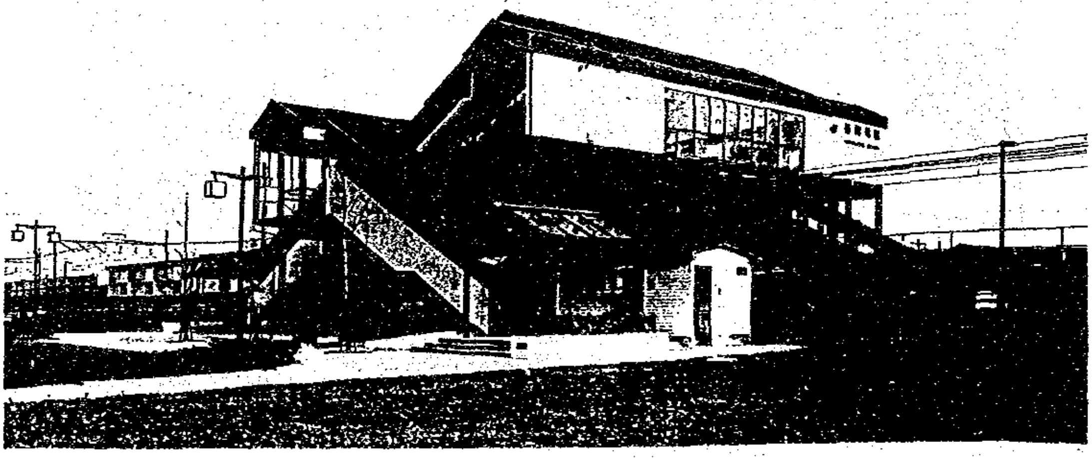
HIGASHI-MATSUBARA ST.



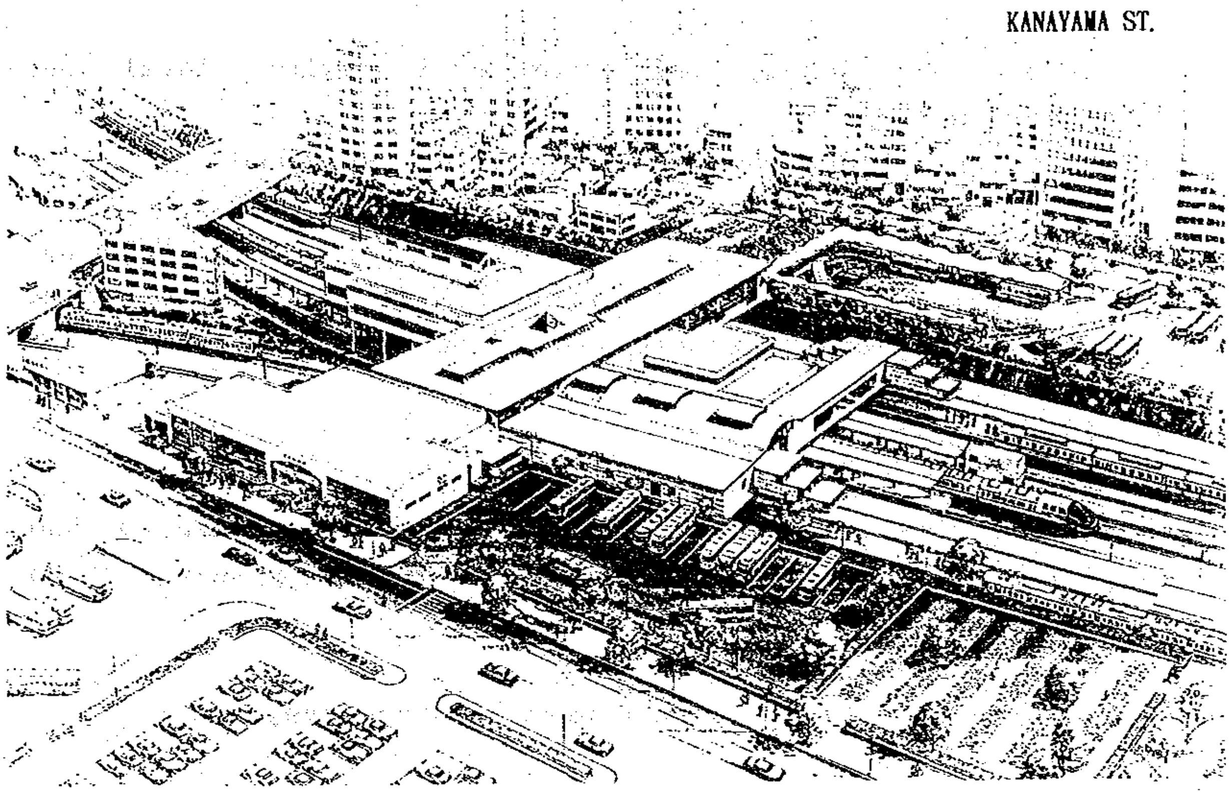
ENZAN ST.



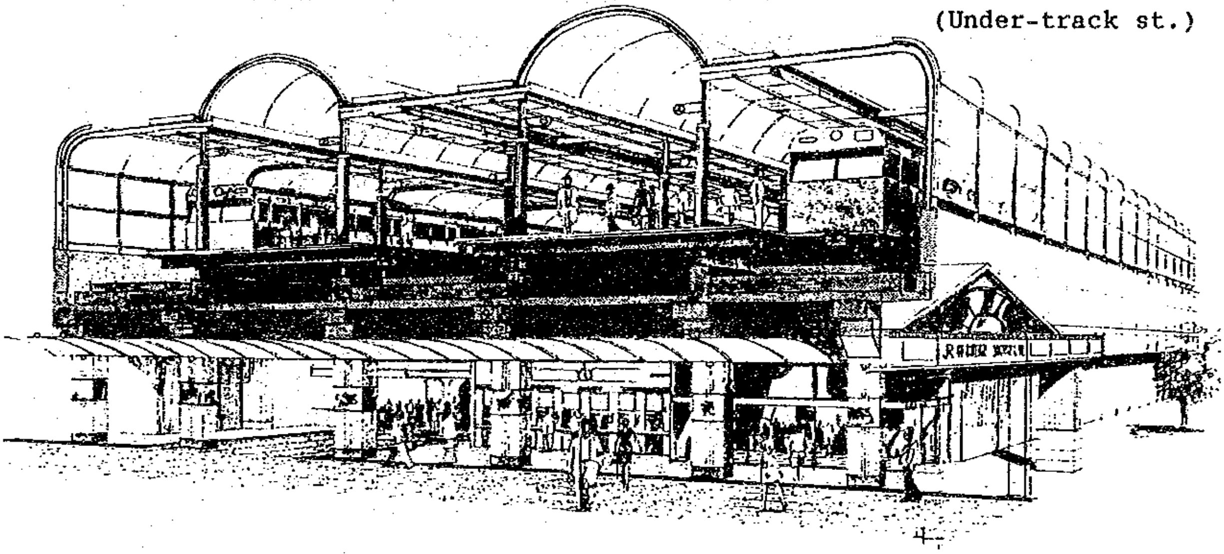
NISHI-OKAZAKI ST.



KANAYAMA ST.



SAKURAGICHO ST.
(section)
(Under-track st.)



Appendix 7-1-6 Station Facilities

1) Platform:

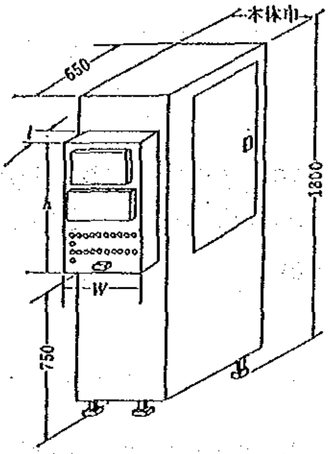
There are 3 types, i.e., lower level, medium level and higher level.
Sheds, over-track passageways, etc. are attached.

In this project, higher level platforms are planned (H=1,050mm). Sheds cover about 50% to 80% of platform length and over-track passageways connect platforms.

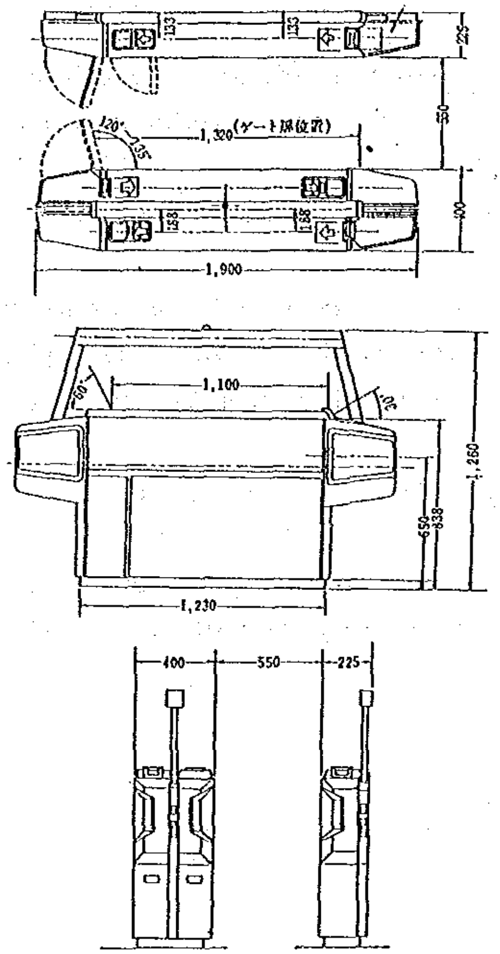
2) Station Building:

It has flow-functions to connect the station plaza to the platform and stay-function for facilitating passengers to wait for trains.

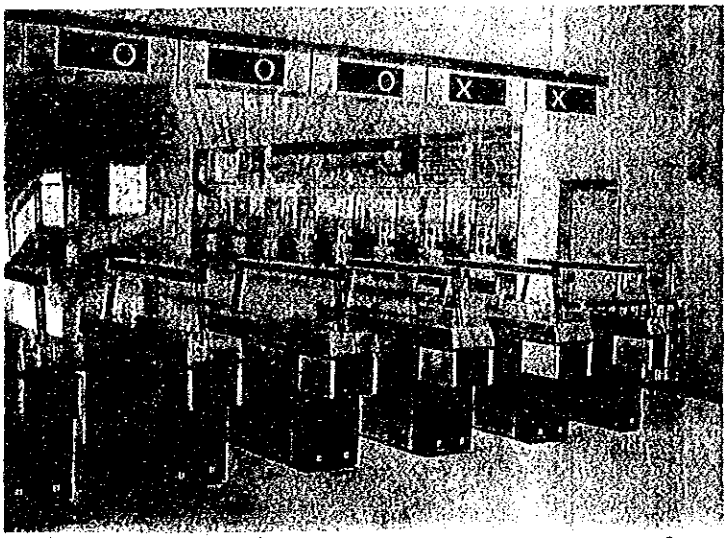
a) Flow-Facilities	:	hall, concourse, passageways, etc.
b) Passenger Treating Facilities	:	ticket office, wickets, fare adjustment office, tourist information office, baggage office, etc.
c) Service Facilities	:	waiting room, kiosk, coin lockers, telephone corner, toilet, etc.
d) Work Facilities	:	station master's room, station office, lecture room, rest room, etc.



TICKET
SELLING MACHINE



AUTOMATIC
TICKET BARRIER



TICKET SELLING MACHINES & AUTOMATIC TICKET BARRIERS

3) Equipments:

To improve efficiency of passenger handling functions, the following equipments are installed in commuter stations.

a) Ticket vending machine

A commuter put in coins or bank notes, push a button for destination and in the dish a ticket will come out printed a sum of money and the change.

b) Automatic ticket barrier

Some couples of units are installed together with one ordinary wicket at least.

Appendix 7-1-7 Station Plaza

The station plaza has two functions, i.e. passenger collecting/distributing function and smoothening function of related traffic flow.

1) Sidewalk :From the station entrance to the bus stop, the taxi stand and the streets.

2) Roadway :One way traffic to avoid crossings among roadways.

3) Car Parking :The parking lot are divided into two, i.e. for private cars and taxis, with easy access to roadways.

4) Taxi Stand :To be located near to the ticket counter and wickets.

5) Bus Stop :Located at convenient place for accessing from the road and the station entrance.

6) Green Belt :Provided to alleviate congestion and to add beautiful sight of station plaza.

7) Others :Comply with needs for providing underpasses, pedestrian decks, facilities for rental cars, etc. Bicycle parking are provided at suburban stations.

Appendix 7-1-8 Off-rail Business Operated at Station

1) Passenger service business in the station building:

   a) mini-shop, kiosk
   b) buffet, restaurant
   c) stall (foods, drinks, cigarettes, newspapers, magazines, etc.)
   d) porter and shoe shiner
   e) baggage checking office, coin lockers
   f) telephone corner, post office
   g) pay toilets, barbershops, etc.
   h) hotel information counter, taxi guide, rental car office, etc.
   i) car parking, bicycle parking

2) Transportation business in the station plaza:

   buses, taxis

3) Off-rail business:

   Restaurant (large-scaled or high-graded), shopping complex, department store, hotel, rental office, etc.

4) Others:

   Advertising business, recreation business, amusement center, warehouse, etc.

Appendix 7-1-9 Calculation Methods for Scaling

1) Platform Width

a) The smallest platform width

3 m or determined by the following method:

* Side Platform:
  W = 1.5 m + width of staircase or the house built on it

* Island Platform:
  W = 1.5 m x 2 + width of staircase or the house built on it

b) Method A

$W = W_1 + W_2 + r$

W : width (m)

r : allowances (m)

W_1: width according to the number of entraining passengers (m)

* PC, DC

  $W_1 = 0.44\ (n_1/a)^{1/2}$

* EC

  $W_1 = 0.20\ (n_1/a)^{1/2}$

W_2: width according to the number of detraining passengers (m)

* PC, DC

  $W_2 = 2n_2/3al$: $n_2/a < 2al$

  $W_2 = 4a/3$: $n_2/a > 2al$

* EC

  $W_2 = 2n/3al$: $n_2/a < 6.4al$

  $W_2 = 13a/3$: $n_2/a > 6.4al$

  n_1 : number of passengers per train getting on during rush hours

  n_2 : number of passengers per train getting off during rush hours

a : number of carriages
l : length of one carriage (m)

b) Method B

* Island Platform

$A = 0.8N + 3(n + 20) + a$

* Side Platform

$A = 0.8N + 1.5 (n + 20) + a$

A : area of platform (m^2)

N : number of passengers using the platform during rush hours

n : length of train (m)

a : area of staircases and houses on it (m^2)

2) Over-track Passageway and Staircase Width

Over-track passageway width is obtained usually by means of dividing number of passengers at rush hours by 3,000 persons and adding some allowances. The smallest value is 1.5 m.
Staircase width is equal or wider a little to the passageway width.

3) Area of Station Building

The area of a station building varies according to the number of passengers, the types of the station, the arrangement of tracks, the situation and location of the station, etc. To get a rough estimate, the following formulas are used:

a) General Station:

$$A = (10.5/((n) + 0.24) + 4.5) \times 10(n) \pm a$$

b) Commuter Station:

$$A = (3.6/(0.1(n) + 1) + 0.9) \times 10(n) \pm a$$

A : area of station (m^2)
n : number of passengers (1,000 person per day)
a : extra or reduction (m^2)

4) Ticket window

There are three types of ticket windows;

a) common ticket window
b) ticket vending machine
c) open counter

The width of a common window is about 1.5 m to 2.0 m. The ticket vending machine is about 90 cm wide per unit.

The number of windows are determined as follows:

a) commuter tickets 2,500 to 3,000 per window
b) long distance tickets 1,000 to 1,500 per window
c) special tickets 250 per window

and some spare windows are added.

5) Wicket:

Number of wickets are calculated as follows:
(some allowances are included)

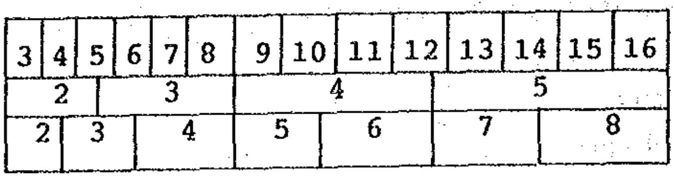
$$N = (n_1/p_1 + n_2/p_2)/T + a$$

N : number of wickets
n_1 : number of passengers getting on during rush period
n_2 : number of passengers getting off during rush period
p_1 : getting on speed of passengers 0.7/sec
p_2 : getting off speed of passengers 1.0/sec
T : 1 hour = 3600 sec
a : spare

6) Toilets

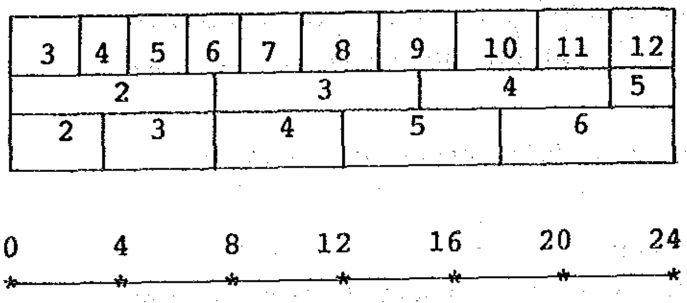
Toilets are usually set up in accordance with the following tables: (for commuters station)

(a = 10%)



*urinal : men
*bowl : men
*bowl : ladies

(a = 5%)



*urinal : men
*bowl : men
*bowl : ladies

*number of passengers getting on/off (10,000 per day)

$$a = \frac{\text{number of passengers during rush period(30min)}}{\text{number of passengers per day}} \%$$

7) Area of Station Plaza

The area of the station plaza varies according to the number of passengers, the types of the station, the layout and situation of the station, etc. The following formulas are given to make a rough estimate.

a) General Station (passengers less than 30,000):

maximum : $A = 11.22\sqrt{X} + 0.271X$
standard : $A = 9.846\sqrt{X} + 0.238X$
minimum : $A = 8.989\sqrt{X} + 0.217X$

b) General Station (passengers more than 30,000):

maximum : $A = 58.88\sqrt{X}$
standard : $A = 51.657\sqrt{X}$
minimum : $A = 47.162\sqrt{X}$

c) Commuter Station (passengers less than 73,000):

maximum : $A = 0.128\ X$
standard : $A = 0.119\ X$
minimum : $A = 0.0878X$

d) Commuter Station (passengers more than 73,000):

maximum : $A = 26.846\sqrt{X} + 0.0277X$
standard : $A = 25.088\sqrt{X} + 0.0259X$
minimum : $A = 18.316\sqrt{X} + 0.0189X$

A : area of station plaza (m^2)
X : Number of passengers expected after 20 years (person/day)