7-2 Signalling and Telecommunications

7-2-1 Current System

(1) Signalling

1) Block system

A tokenless block system, called "Relay Auto Block" (hereinafter referred to as RAB) is employed on the Rawang-Seremban section, and a key token block system is used between K.L. and Batu Jct., as shown in Fig. 7-2-1.

Major particulars of the RAB are as follows:

- Block operation is manipulated by the station masters of the ajoining stations.

- Train movement among block sections are detected by a short track circuit installed between an outer home signal and an advance starter signal.

- Last vehicle detectors are installed to make up for a possible detection error of the short track circuit due to train separation, short train length, etc.

- During the night time with low traffic, block section can be switched through.

Major problems of the current block system are the small line capacity caused by the following reasons.

- Long section length such as Kajang - Batang Benar (21 km), Rawang - SG. Buloh (14 km), and Labu - Seremban (14 km).

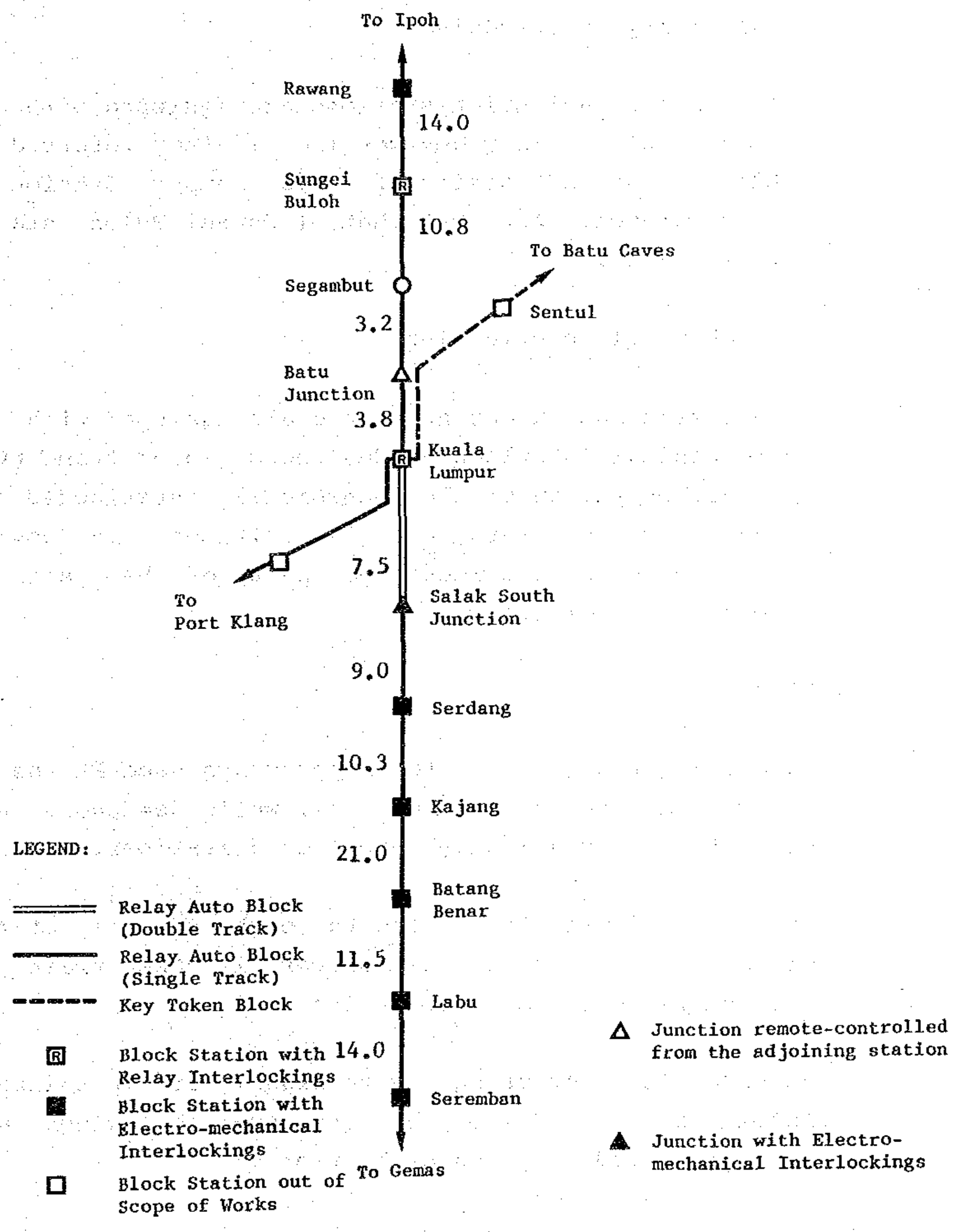


Fig. 7-2-1 Existing Signalling System

2) Interlocking device

a. All relay interlocking

K.L. and Sungei Buloh stations are equipped with all relay interlocking devices (hereinafter referred to ARI). The ARI device of Kuala Lumpur Station is comparatively new, but that of Sungei Buloh station is obsolete.

b. Mechanical interlocking

All stations except above two are equipped with the mechanical interlocking devices of lever frame type. Lever operation of the mechanically interlocked signals, switch points, etc. necessitates time consuming works and the mechanical parts of the system are prone to disorder.

3) Signal

Colour light signals of two aspects are used at the ARI stations and in the RAB sections, while semaphore signals at the mechanically interlocked stations.

The "E" signal is mounted to each advance starter signal to inform a train driver if the train has arrived without train separation.

At major level crossings, gate signals are installed to inform a train driver that the level crossings have been protected by gates or barriers.

4) Train detection device

Track circuits of DC type are adopted in the station yards and in RAB sections.

The last vehicle detectors, which control the E signal, are composed of a tail magnet receiving coil and a proving equipment.

5) Point machine

In the ARI stations and in the main tracks of some mechanically interlocked stations, electric point machines of trailable type are employed. In the most stations, however, mechanical point machines are used.

6) Level crossing protection system

There are 12 public level crossings. Based on the information through telephone provided by the adjoining stations, a gate man operates gate/barrier which is interlocked with a gate signal.

(2) Telecommunication

1) Transmission line

Transmission lines are mostly composed of open wires ranging from 4 to 10 wires. Underground cables, however, are installed in the station yards of Kuala Lumpur. (Refer to Fig. 7-2-2)

2) Communication equipment

In the RAB section, block telephones with local batteries are installed, while in the Key Token block section the magneto telephones with a handgenerator.

Train control telephones of a frequency selective type are provided at each station and related offices, facilitating them to make direct communication with the control center at Kuala Lumpur.

Magneto telephones are provided at some stations for direct communication with level crossings and depots. At the site, portable magneto telephone sets are used by train crew and maintenance gangs to communicate with the control center by connecting them to the open wires/terminal boxes.

Signal post telephones are mounted on some signal posts to facilitate communications between signal operators at signal cabins and train crew.

Telefacsimiles are provided at the control center for data exchange with the head office and district control offices.

Passenger information facilities by use of CCTV and displays are provided at the Kuala Lumpur station to inform the passengers of the train numbers, platform numbers, arriving/departing times, etc. Public address equipment for announcing train arriving/departing time are installed at the K.L. and the Seremban stations.

(3) Maintenance

4 maintenance depots at K.L. (main), K.L. (branch), Kajang, and Seremban are in charge of maintenance of the signalling and telecommunication facilities of the project section. The organization and staff number of the above are as shown in Appendix 7-2-1.

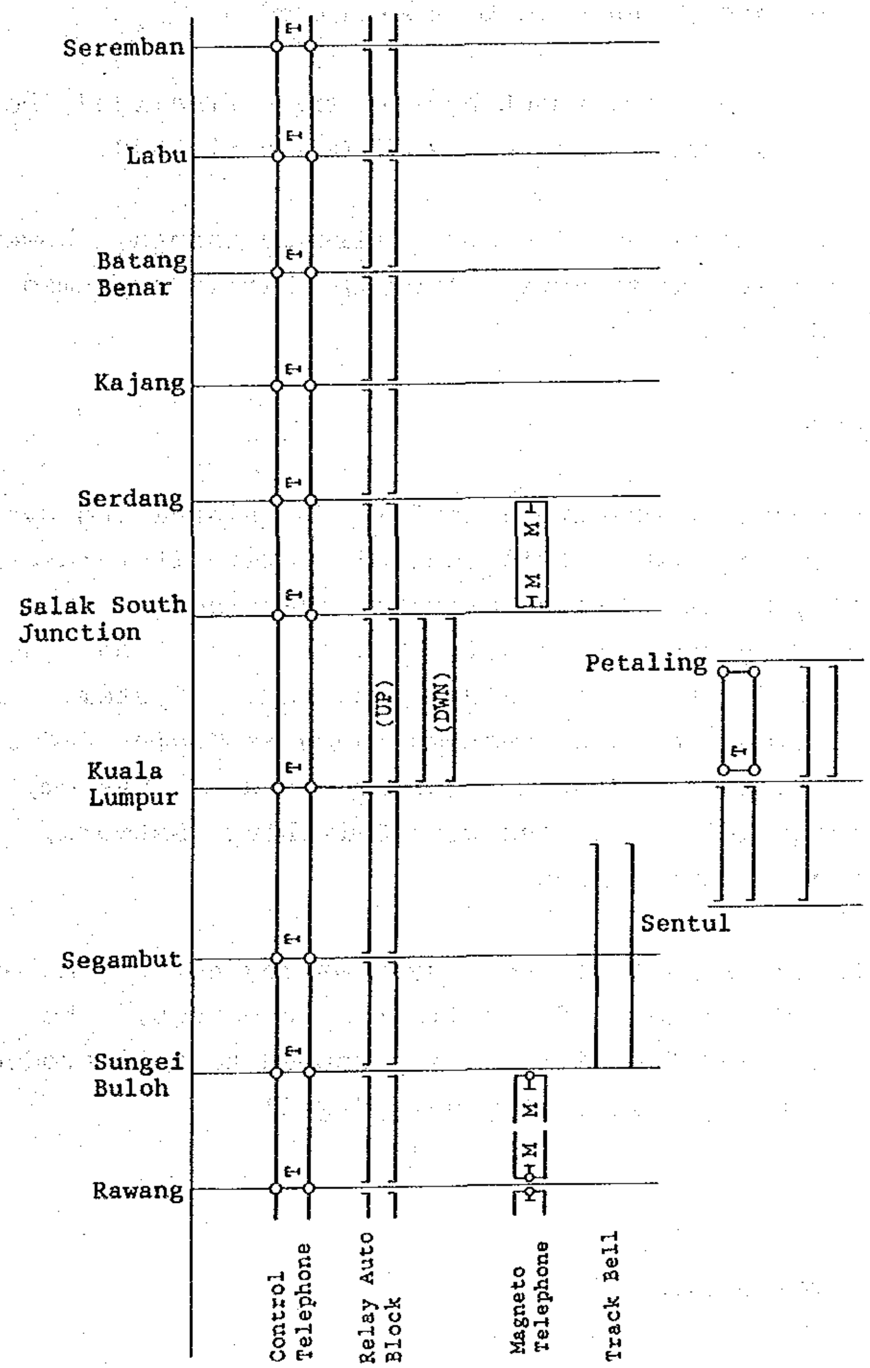


Fig. 7-2-2 Main Open Wire Circuits

7-2-2 Improvement Plan by DTP

In the DTP, the existing signalling and telecommunications facilities are planned to be modernised.

Details of the improvement has not been finalized, because the tendering is still going on as of October, 1990.

Based on the Tender Documents already issued, however, the modernised system expected after the DTP is presumed to be as described below.

(1) General

The Tender Documents stipulate the signalling systems such as Centralised Traffic Control (hereinafter referred to as "CTC") System, Train Describer (hereinafter referred to as "TD") System, Automatic Train Protection (hereinafter referred to as "ATP") and ARI System; and the telecommunications systems such as Train Radio System, Yard Radio System, Service Radio System, Digital Telecommunication and Data Switching Network, including optical fibre cables.

Although a part of these systems may not be implemented in the DTP becuase of the limited resources, the following systems and facilities are presumed to be introduced under the DTP. (Refer to Appendix 7-2-2)

(2) Signalling

1) CTC system

A computer-based CTC system will be established, with reserved capacity to allow its future extension up to Ipoh Station to the north, and up to Gemas Station to the south. The CTC Centre will be located in the station building of K.L..

Normally, Rawang, Sentul and Seremban Stations will not be controlled from the CTC centre, but their working status of signallings are indicated at the CTC centre.

Train Describer (TD) system will be employed, where data of four-digit train numbers are inputted by the train dispatchers at the CTC centre.

2) Interlocking system

a. Interlocking device

The existing interlocking device at Kuala Lumpur Station may be reused, however that of Sungei Buloh station will be replaced with a new one, because of its obsolescence.

In addition to new installations of 3 stations; i.e. Kuang, Kepong and Bangi, new ARI systems will replace the mechanical interlocking devices at 9 stations.

The mosaic-type local control panels will allow route setting by two push-buttons control method and switching CTC/Local control.

b. Signal

Existing semaphore signals will be replaced with colour light signals.

'E' signals and gate signals, however, will remain un-changed until introduction of automatic block system with continuous track circuits between stations and elimination of level crossings.

c. Point machine

In line with the introduction of ARI systems all the existing mechanical points on main tracks will be replaced with electric point machines.

3) Block instrument

a. Tokenless block

Tokenless block system will be employed in principle.

b. Automatic block system

The following sections will be equipped with the colour light automatic block signals:

- 3 aspect signal: Batu Junction to Salak South Junction
- 2 aspect signal: Kepong Station to Batu Junction, and Labu (partially) and Seremban Stations.

c. Reversible Blocking

Reversible block function will be introduced between each station.

4) Level crossing protection

All the level crossings within station yards will be interlocked with the ARI system.

Between stations gate-cum-block signals will be added.

(3) Telecommunications

1) Train radio system

Train radio system will be provided for two-way communication between a train driver and:

- Train dispatchers,
- Stationmasters at nearby stations, gatemen, and
- Guard.

12 frequencies of a 800 MHz band will be allocated for duplex operation and 2 frequencies for simplex one.

2) Telephone exchanges

Automatic digital telephone exchanges of 450 and 60 subscribers will be installed at Kuala Lumpur and Seremban stations respectively. These exchanges can accesses not only to the MRA's automatic telephone network but also to public automatic network.

3) Transmission lines

Optical fibre cables and metallic cables will be installed along the railway line. The former will be of a 34 Mbit/s and a 2 Mbit/s system. The latter will be used for short distance approach circuits.

7-2-3 Improvement Plan by RBCS

(1) Objectives

The improvement plan aims the followings:

- Shorter headway to increase railway traffic capacity,
- Effective operation of DMUs departing from and entering onto stabling tracks,
- Effective utilization of deaparture and arrival tracks at stations, and
- Prompt information service of train operation schedules and status.

(2) Preconditions

1) Train operation

Minimum headway : 10 minutes
Maximum train speed : 100 km/h
(120 km/h on the section between Labu and Seremban stations)
Maximum DMU train length : 160 m
Full-overlap block system : Preserved
3 aspect signal indication : Preserved ($G-Y-R_1-R_0$)

G : proceed with maximum speed,
Y : Proceed with caution,
R_1 : Permissible Stop (Reproceed available, but at low speed after completely stop), and
R_0 : Absolute Stop.

Reversible block system : Preserved

2) Major track layout modification

- Rawang : construction of stabling tracks,
- Brickfield Coach Shed : construction of parcel and

stabling tracks, and arrival/departure tracks for long-distance trains,

- Salak South Junction : construciton of over-track station building,
- Kajang : construction of island-type platforms and stabling tracks,
- Bangi : construction of island-type platforms and stabling tracks, and
- Seremban : construction of stabling tracks.

3) Ambient conditions

Meteorological conditions surrounding the project sections are as follows:

- Mean daily maximum temperature : 32.9°C
- Lowest minimum temperature : 19.9°C
- Mean daily maximum relative humidity : 95.6%
- Lowest minimum relative humidity : 26%
- Mean annual rain falls/raindays : 2,463 mm / 195 days
- Highest annual rain falls/raindays : 3,526 mm / 222 days
- Mean annual lightning days : 337 days

(3) Major improvement items

In consideration of limited resources, it is presumed that equipment stipulated as "optional" in the DTP specifications will not be implemented in the DTP.

Hence the following systems and euqipment are planned to be implemented under the RBCS as listed below.

1) Signalling system

- Automatic Block Signalling
- Automatic Train Protection (ATP)
- Reporting Equipment to print out actual train timings, delays and statistical data

- Improvement of TD System to allow local entry of train descriptions

2) Telecommunication system

- Yard Radio System
- Service Radio System
- Public Address System
- Improvement of Train Information System so as to display departure/arrival train schedules to be directly controlled by the TD system

(4) Signalling

1) Block system

To cope with the sharp increase in the railway traffic in the future, the tokenless block system which allows operating only one train in the inter-station railway section has to be upgraded into the automatic block system which permits operating plural number of trains between adjoining stations. To enable this, the inter-station sections are separated into several blocks by providing wayside block signals along the railway track.

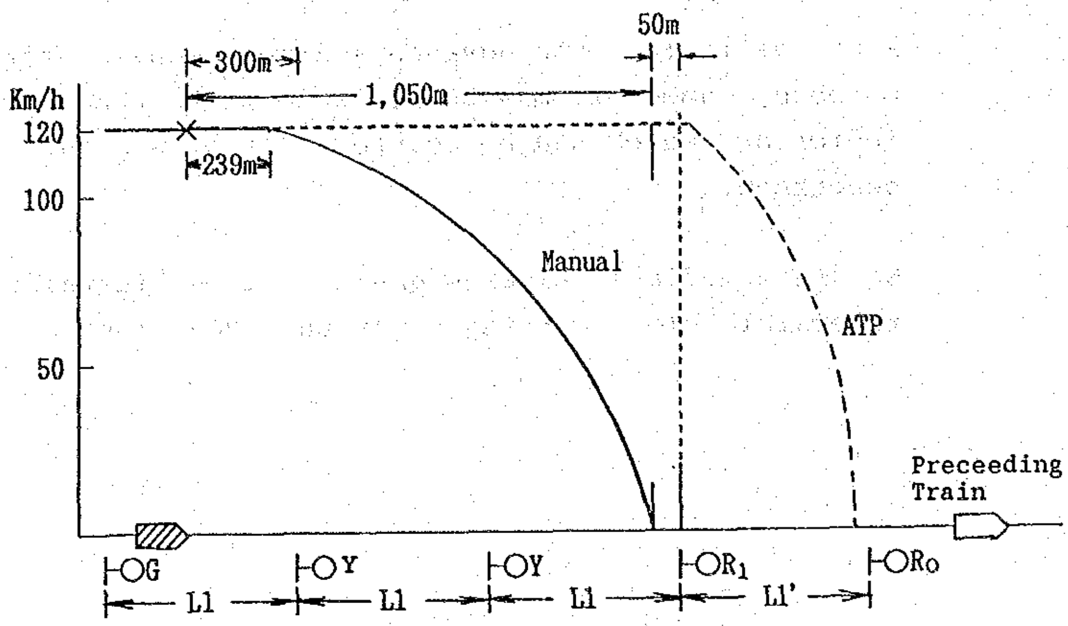
.he minimum spacing of block signals is set at 500 m in consideration of the presumed braking performance of DMU train, signal visibility (300 m), etc. (Refer to Fig. 7-2-3)

The actual spacing of block signals, however, are planned to be 600 m, taking into account that intermediate signals and outer home signals will be installed with a spacing of 1200 m under DTP.

The tokenless block system installed in the DTP to control the trains running in reverse-direction will be kept as it is. The advance starter signals for this purpose, however, may be replaced with the exclusive indicator which can be mounted to the starter signal concerned.

No intermediate block signals will be installed for reversible block working under the RBCS plan.

Case 1 : Maximum Train Speed at 120 km/h



Signal Visibility : 300 m

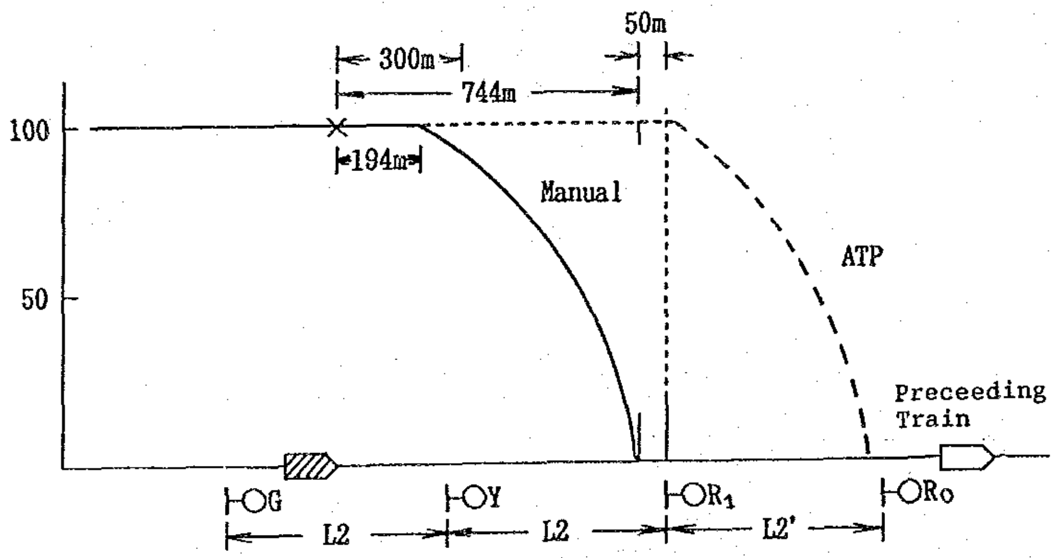
Normal Brake Distance (120 km/h to stop) : 1,050 m

L1' (Emergency Brake Distance) : 700 m

L1 $\geq$ (1100 - 300) x 1/2 = 400 m

∴ Minimum Signal Spacing : 700 m

Case 2 : Maximum Train Speed at 100 km/h



Normal Brake Distance (100 km/h to stop) : 744 m

L2' (Emergency Brake Distance) : 486 m

L2 $\geq$ (794 - 300) = 494 m ≒ 500 m

∴ Minimum Signal Spacing : 500 m

Fig. 7-2-3 Signal Indications and Block Section Length for RBCS

2) Signal

3-aspect system is adopted as follows, in consideration of the maximum running speed (100 km/h and 120 km/h), signal visibility (300 m), and braking distances (500 m from 100 km/h and 700 m from 120 km/h). (Refer to Fig. 7-2-3)

$G-Y-R_1-R_0$: In case of max. speed of 100 km/h
$G-Y-Y-R_1-R_0$: In csae of max. speed of 120 km/h

The adoption of the two stop signals R_1 and R_0 is required to constitute a full overlapping block section.

a. Inter-station section

Automatic block signals are installed along the railway track. The distance between each block signal is determined in consideration of the minimum DMU headway, track conditions (curve, grade, etc.), signal visibility, etc.

b. Station yard

Signals installed in the DTP will be reused, in principle. In some station yards where track layouts are changed, necessary modifications are made. (Refer to Appendix 7-2-3).

However, the E signals are not used any more, since train separation can be detected by continuous track circuits to be installed for the automatic block system.

3) Track circuit

The non-insulated AF track circuit system to be partially introduced in the DTP will be extensively employed for the entire DMU-train running tracks, taking advantage of its following characteristics:

- High reliability and maintenability, because they utilize rail itself, without necessitating installation of additional facilities/equipment,
- Superiority to the intermitent detection function, in view of safety and efficiency of train operation, and
- Availability for detection of rail breakages and data transmission.
  (Refer to Appendix 7-2-4)

4) Interlocking system

Track layouts of some stations are modified as listed in 7-2-3-(2)-2), to increase the train handling capacity, to enable shuttle operation of DMU, to add DMU stabling tracks, to facilitate passenger transfer etc.

In connection with the above modifications, the existing relay interlocking devices are to be modified or reinforced with additional installation of necessary field equipment and materials such as signals, indicators, point machines, and underground cables.
(Refer to Appendix 7-2-3)

5) Automatic train protection

In order to prevent train accidents, coping with the sharp increase in traffic density, automatic train protection (ATP) system is planned as follows:

- Mannual operation by a driver in normal conditions
- Full overlapping block system
- Three aspect wayside signal

- Minimum block length of 500 m
- AF track circuit
- Braking distance by emergency brake
  - 700 m ... from 120 km/h
  - 500 m ... from 100 km/h
- Air braking system
- Expanded applicability to other types of train

The ATP is to ensure a train to stop at the stop signal with the following way. When a train enters onto the block section protected by the signal indicating R_1 aspect the ATP will automatically start the emergency brake and make the train stop, so as to protect the train against overrunning the stop signal R_0.

In consideration of the above-mentioned conditions of the Rawang - Seremban section, the ATP which utilizes the AF track circuit is adopted.

The block length is to be set longer than the braking distance, which is required for the DMU trains to stop by emergency brake from its maximum operating speed. When a DMU passes over a signal R_1, the receiver in the cab detects it and the emergency brake is automatically applied and makes the train stop in front of the signal R_0.

This system is so simple that it does not require additional ground facilities, and only a few cab devices such as pick-up coil for signal R_1 and an interfacing device with an emergency brake will be required. The investment cost, therefore, is small and maintenance is easy.

This ATP can also be adopted to other types of train such as express and freight trains. However these trains are of longer braking distance so that emergency brake must be applied by signal Y.
(Refer to Fig. 7-2-4.)

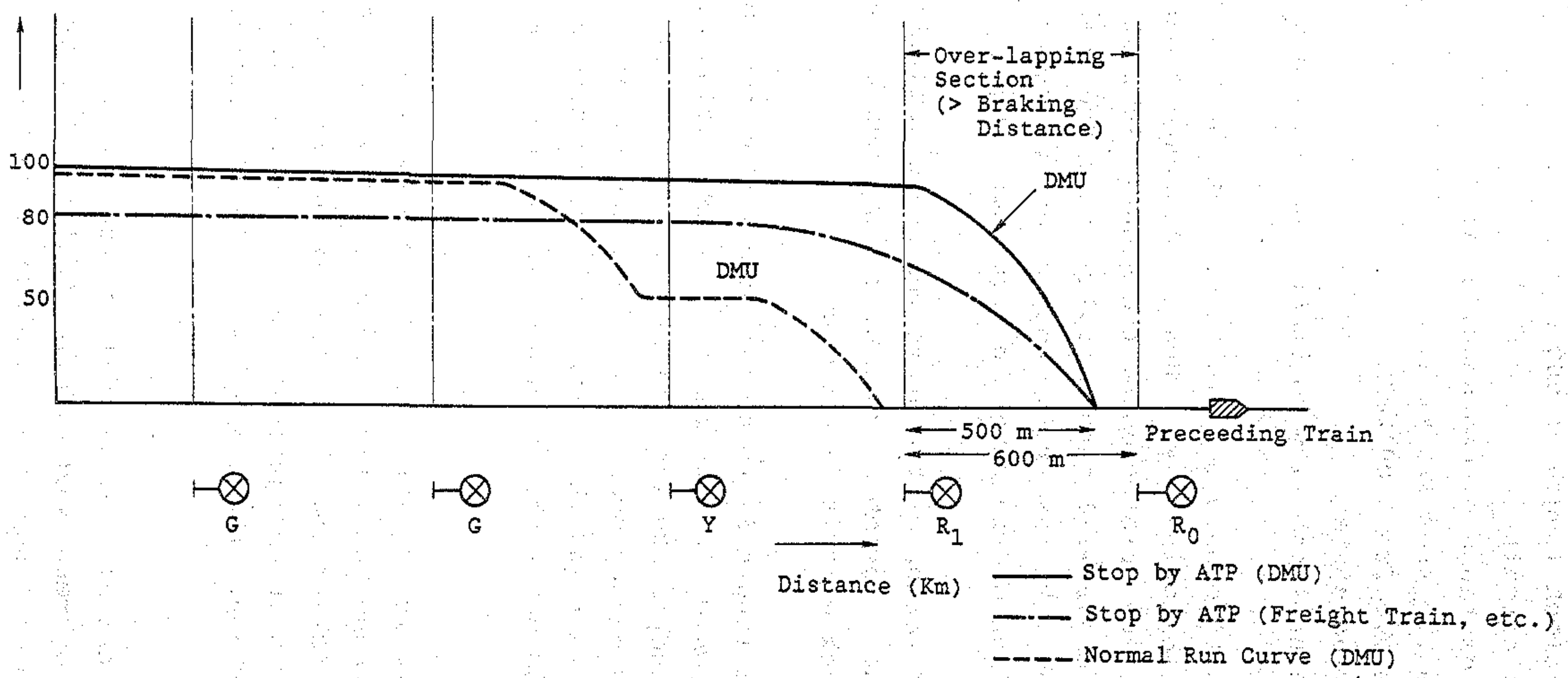


Fig. 7-2-4 Automatic Train Protection (ATP)

(5) Upgrading the Centralized Traffic Control (CTC)

1) Objectives

The need for prompt and optimal traffic control will grow in proportion to the DMU traffic increase. Hence the CTC introduced in the DTP will be upgraded in the following aspects:

- Local input function of train description (TD) data.
- Monitoring function of route-setting operation: to prevent a large scale traffic disorder caused by an wrong route setting which may happen at Batu Jct. and Port Klang Jct., the junction route setting for the trains which depart from Kuala Lumpur are automatically checked by collating the departing train number and the train route related to those junctions.
- Local monitoring function of traffic information.
- Automatic recording of train diagram and automatic processing of related statistics.

2) Center equipment

- Modify or add software related with the above-mentioned new functions.
- Modify CTC indication panel and VDU/key board.
- Modify TD system to allow data input from the Fringe Boxes located at boundary stations.
- Install data output terminals such as printer and plotter.
- Increase data transmission functions.

3) Local equipment

- Install the Fringe Boxes at Rawang, K.L., Kajang, and Seremban to input TD data and to monitor related traffic information

- Modify CTC local devices to cope with increase/modification in CTC data
- Modify software due to employment of the Fringe Boxes and the auxially VDU/Key boards at 12 offices.

(6) Telecommunications

1) Transmission line

a. Long distance transmission line

Spare channels of the fiber optics cable, installed in the DTP, will be used for transmitting the following data;

- Communication through yard radio systems between the CTC Centre and base stations,
- Communication through service radio systems between the CTC Centre and base stations,
- Data transmission between CTC centre and the fringe boxes,
- Transmitting data for train information system and public address system between CTC center and all stations (Refer to Fig. 7-2-5)

b. Local transmission line

In principle, spare conductors of the metallic cable, installed in the DTP, will be used. Within the station yards and equipment rooms, however, cables will be additionally installed for the following equipment/system.

- Base station equipment for yard and service radio systems,
- Train information systems,
- Public address systems,
- Synchronized clock systems,

- Synchronized clock systems,
- Signal telephones, etc.

2) Telecommunication equipment

a. Train radio system

Mobile radio sets and portable transceivers will be installed for the DMU train sets procured in the RBCS.

b. Yard radio system

Yard radio system will be introduced in major station yards such as K.L., Brickfield.

By the yard radio system a locomotive driver and a shunter can talk in the semi-duplex mode, moreover a yard master can monitor their communication and give his instructions if necessary.

To enable simultaneous shunting works in the same yard, a multi-channel radio system by use of 800 MHz band will be adopted.

c. Service radio system

The service radio system is introduced to serve maintenance gang in the field, allowing communication between a mobile radio and the railway exchange telephone network.

d. Signal telephone

For communication between the track side and station, signal telephones will be mounted to block signal posts.

e. Passenger information display system

To provide passengers with train operation information, passenger information displays are installed at every platform and some wickets.

The LED display system indicates time, platform, destination train type, etc. of departure/arrival trains.

The computer-based terminal equipment display information transmitted from the CTC Centre, and those can be manually inputted at each station.

f. Public address system

Public address systems will provide passengers in the station various information such as departure/arrival time and platform numbers and warning against approaching trains, including background music.

Those information are transmitted from the TD system at the CTC Centre, or manually inputted at each station.

g. Synchronized clock

To improve punctuality of DMU operation, synchronized clock systems are introduced, replacing the crystal clocks to be employed in the DTP.

The synchronized clock system are composed of a master clock and slave clocks which synchronize to the master clock.

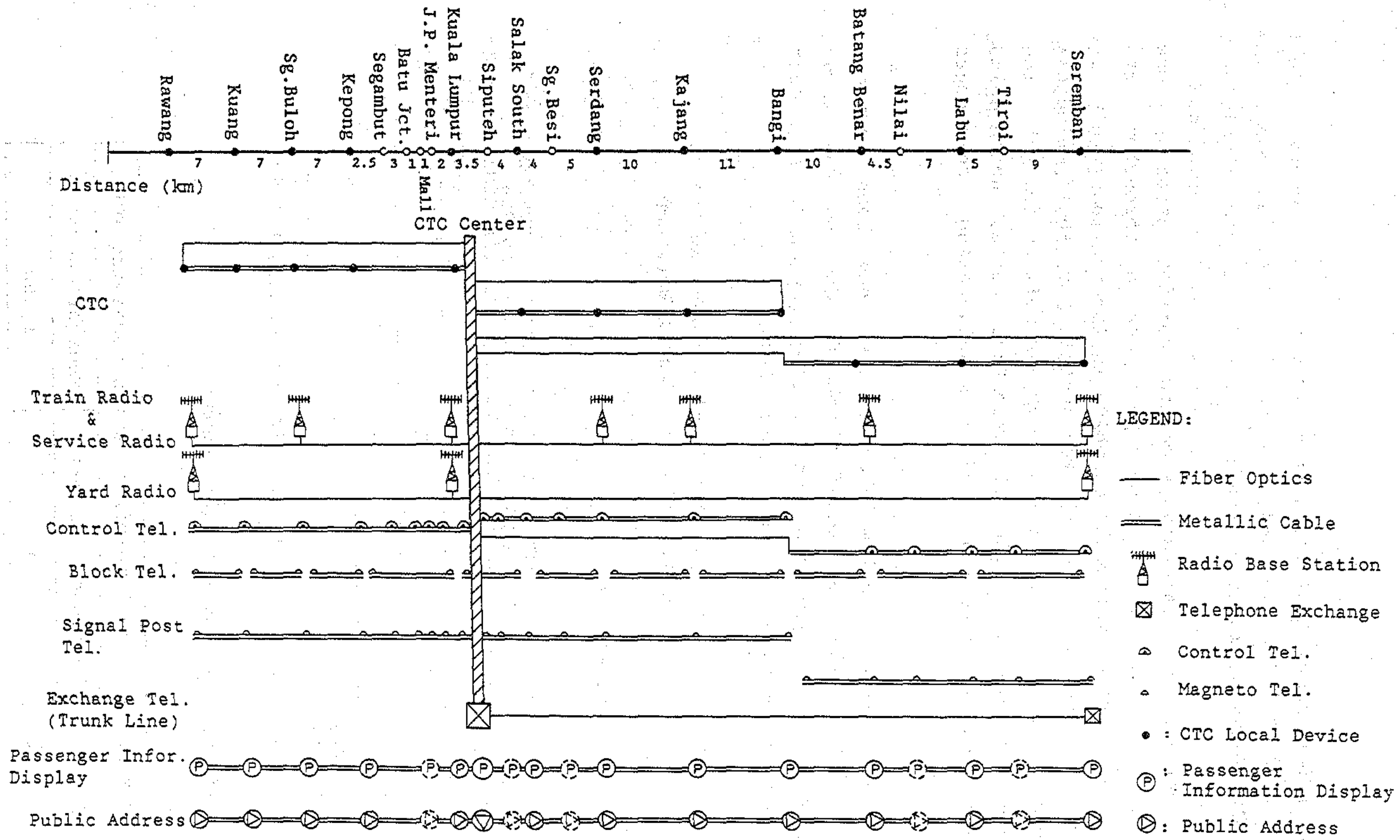


Fig. 7-2-5 Telecommunication Circuit Plan

7-3 DMU Maintenance Facilities

7-3-1 Current Situation

MRA carries out maintenance on its rolling stock at one workshop and six maintenance depots located throughout the country. As for the workshop which is located in Sentul, it employs 1,500 workers and is responsible for the periodical overhaul (POH) of all rolling stock, as well as for the intermediate overhaul (IOH) of important parts, unscheduled repairs and modifications, and the manufacturing components and parts.

It should be noted that maintenance costs have been increasing, particularly for temporary repairs, due to the large number of aging cars that have yet to be replaced. A recent maintenance record is shown in Table 7-3-1.

Table 7-3-1 Recent Periodical Overhaul Record of Rolling Stock at Sentul Workshop

1. Diesel locomotives

Year	Annual number of units receiving POH
1986	29
1987	36
1988	32
1989	(14)

Note: ( ) denotes a recording up to August 1989.

2. Passenger coaches/freight wagons

Year	Annual number of units receiving POH	
	Passenger coaches	Freight wagons
1988	73	1,000

The workshop was founded in 1906, and in general its maintenance machinery and equipment has aged and deteriorated, resulting in occasional delays in maintenance work. Although it has sufficient work space when one considers the present annual work volume.

The diesel engine repair shop, however, are equiped with the modern facilities. To cope with a large number of DMU engines to be introduced in RBCS, this engine repair shop must be expanded.

7-3-2 Maintenance Facilities for DTP DMUs

Some facilities for the daily inspection and repair of DTP DMUs are planned in DTP. They include inspection pits and maintenance sheds at the DMU bases at Rawang, Seremban, Port Klang, and Sentul.

Additional stabling tracks are also planned at K.L. loco-shed, while execution of monthly inspeciton and repair will be conducted at the Sentul DMU depot.

As stated before, 54 DMUs are to be introduced in DTP, but their maintenance facilities plan have not been finalized as of September, 1990.

7-4 Maintenance Facilities of DMUs for RBCS

7-4-1 DMU Maintenance Plan

The DMUs of this maintenance plan is the 172 DMUs, including 33 DMUs introduced in DTP, to be operated in 2005 between Rawang and Seremban stations.

(1) Classification of the maintenance work

The inspection and repair work can be classified into the following four types.

1) Periodical overhaul (POH)
2) Intermediate overhaul (IOH)
3) Monthly inspection and repair (M-I/R)
4) Pre-operation inspection (P-O/I)

Of these 4 types of inspeciton and repair, POH and IOH will be done at the workshop, while the M-I/R and P-O/I will be executed at the DMU depot.

(2) Inspection/repair cycle

In view of the cycles and contents of the inspection/ repair works for the existing rolling stock of MRA, the following inspection/repair cycles are planned for the DMUs.

1) POH: Every 6 years or 500,000 km
2) IOH: Every 6 years or 500,000 km
3) M-I/R: Every 30 days or 10,000 km
4) P-O/I: Every 2 days (48 hours)

However, POHs and IOHs shall be executed alternately every 3 years, and the first IOH shall be conducted 4 years after the introduction of DMUs, since they are new.

(3) Location of maintenance place

1) POH and IOH: Sentul workshop

2) M-I/R: Sentul DMU depot

Regarding M-I/R, Sentul Workshop will be able to assist Sentul DMU depot in supplying of spare parts, correction of wheel treads, unscheduled repairs, etc.

3) P-O/I: DMU depots (Rawang, K.L., Bangi, Seremban)

Since stabling tracks are provided at Rawang, K.L., Bangi, and Seremban stations, to stable early-morning departure trains, DMU depots are to be constructed there, where daily inspections, lubrication, refueling, water supply, cleaning, etc. are to be conducted.

(4) Duration required for overhaul and inspection/repair

1) Sentul Workshop:

POH : 15 days (power car)
13 days (trailer)

IOH : 12 days (power car)
10 days (trailer)

Regarding inspection and maintenance work at the workshop, due to using unit recycling of such units as engines, bogies, air-conditioners, etc., the overhaul duration will be widely reduced. Unit recycling means replacing a major equipment with a standby to shorten overhaul duration time of a car.

Body repair and painting work will be reduced by introduction of light-weight stainless-steel bodies.

There is no large difference between IOH and POH in regards to actual repairing work, however IOH inspection is conducted mainly focusing on car accessories (for example, electric wiring, pneumatic piping, etc.).

2) Sentul DMU depot

M-I/R : 6 hours (7-car train)
(Simultaneous work by 3 inspection squads)

M-I/R mainly deals with inspection and adjustment of equipment, and special attention is paid to the inspection of safety devices and wheels such as brake block exchange. It is executed at the pit line of the Sentul DMU depot.

3) DMU depot (except for the Sentul DMU depot)

P-O/I : 40 min (7-car train)
(Simultaneous work by 3 inspection squads)

The work time does not include the time for refueling, water supply, and cleaning. The P-O/I is executed during the non-peak hours at the stabling tracks.

(5) Inspection/repair contents

The contents of each inspeciton/repair works are shown in Appendix 7-4-1.

7-4-2 Maintenance Facilities

(1) Sentul Workshop

In consideration of emergency maintenance work, etc., DMU maintenance facilities, including workplace for a large number of DMUs, must be prepared within three years after start of DMU operation in 1997.

The annual average number of DMUs to be inspected and repaired in 2005 will become 58 cars, presuming that inspection/repair cycle of POH and IOH are set at three years:

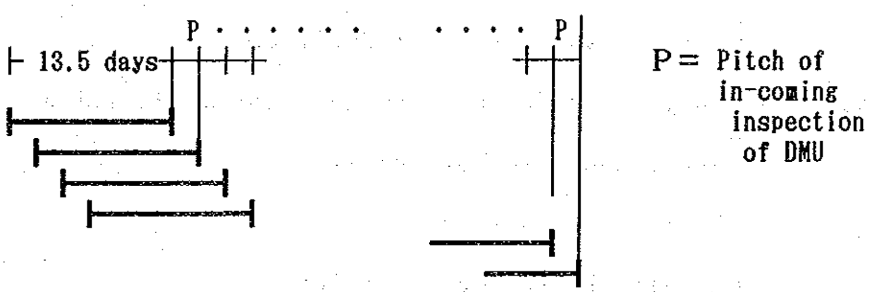
172 cars ÷ 3 years = 57.333 ≒ 58 cars/year

Under the RBCS Project, the duration of inspection/repair works are shortened through unification of car types, standardization of components, unit recycling system, etc.

Assuming that the shop is operated for 269 days,

(= 365 - (52 + 18 + 1.5 x 52))

and that each car stays 13.5 days in average (15 days for the POH of a power car and 12 days for the IOH of a power car), the total number of cars which stay concurrently in the shop will be calculated as shown in Fig. 7-4-1.
(As the duration of a trailer is smaller, it is not taken into consideration.)



(58 cars − 1) × P + 13.5 = 269 ∴ P=4.482

13.5 ÷ 4.482 = 3.065 ≒ 3 Cars

Fig. 7-4-1 Average Number of Cars Concurrently Staying at the body shop

Considering average 3 cars which concurrently stay, and additional one car for unscheduled repair, the space of the shops, are planned so that four cars can stay at the same time.

Hence, DMU repair shop of 4340 m^2 is planned to be annexed to the existing new coach repair shop. (Refer to Table 7-4-2, Fig. 7-4-2)

The general view of the main building, and the plant and machinery layout drawing and their list in the main DMU repair shop are shown in Appendices 7-4-2 and 7-4-3, and 7-4-4.

Table 7-4-2 Shop Areas for DMU Maintenance Work

	Name of the Shops	Shop Area (Sq.m)
Secsion	De-mounting Work Position	440
	Car body Work Position	770
	Pre-work and Seving Work Position	104
	Electrical Parts Work Position	320
	Engine, Engine Performance Testing Position	540
	Wheel and Axle Work Position	416
	Bogie Work Position	1,012
	Machine Parts Work Position	264
	Air brake Parts Work Position	120
	Store	250
	Office	64
	Others	40
TOTAL		(Sq.m) 4,340

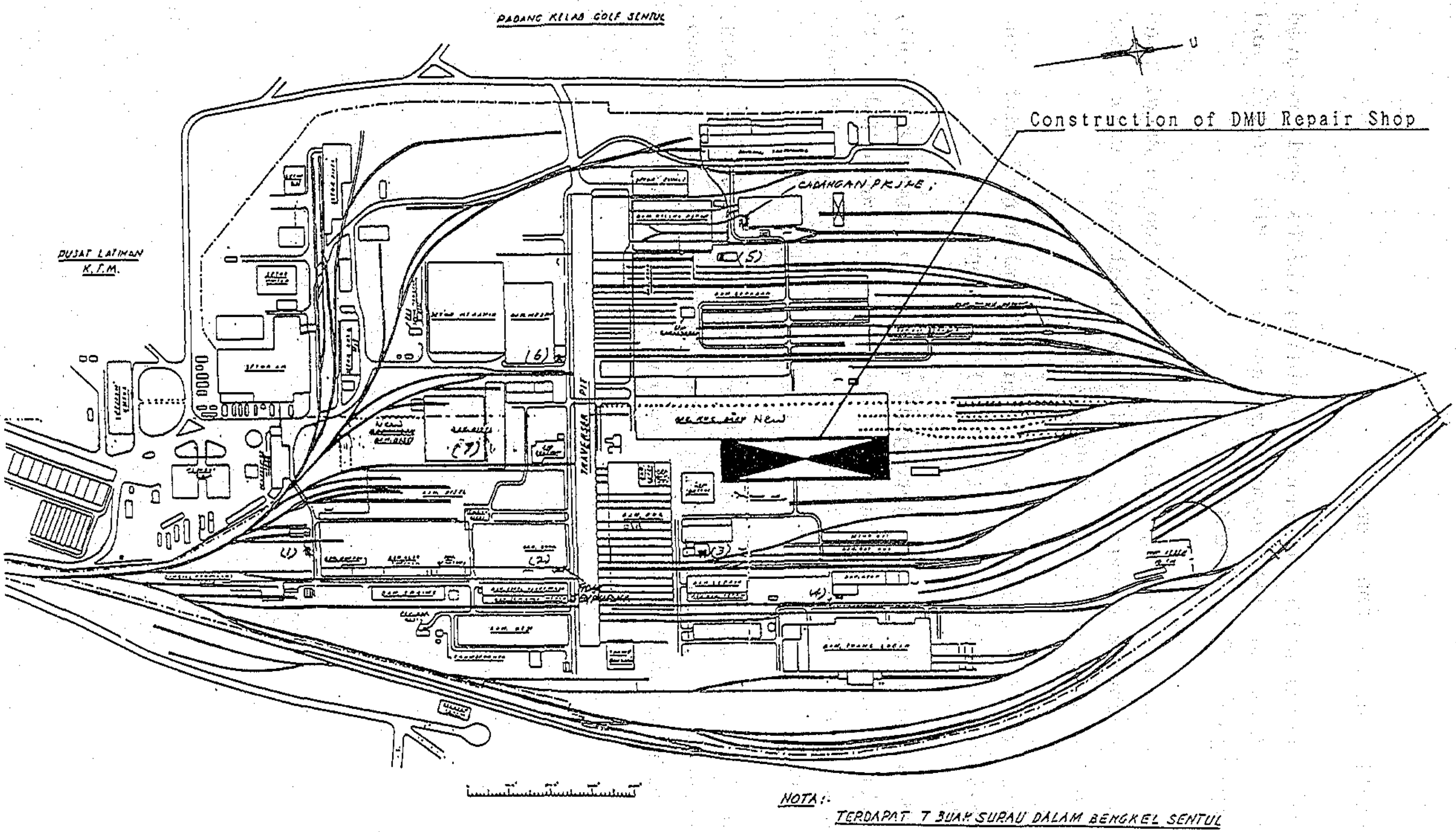


Fig. 7-4-2 Plan View of the Maintenance Facilities Installed in the Sentul Workshop

(2) Facilities for DMU's depot

The installation layout of stabling tracks and related facilities of DMU depots are shown in Fig. 7-4-3 and Appendix 7-4-5 respectively.

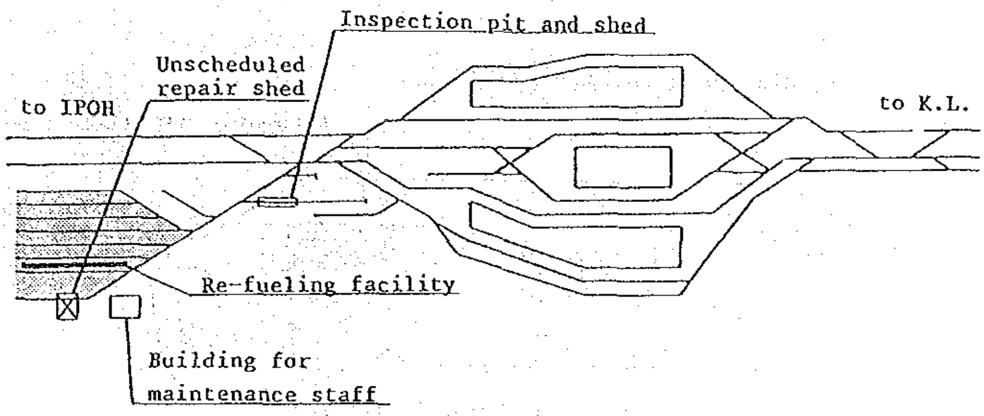
Automatic car washing machines are installed in Bangi and K.L. depot, although the stainless steel cars will not require a large amount of detergent.

From the environmental viewpoint, the machine which use only water will be installed at Bangi depot.

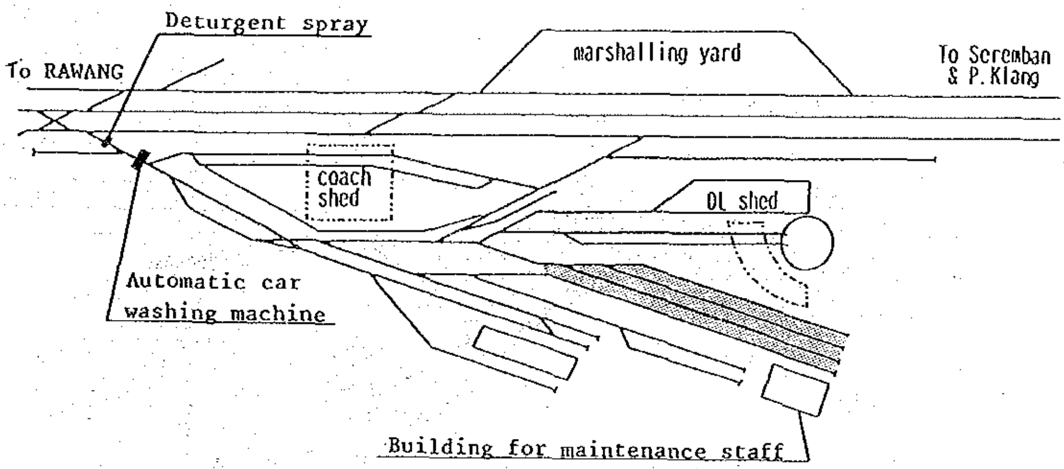
The machine which use detergent (refer to Appendix 7-4-6), will be installed in the K.L. DMU depot, to wash DMUs with detergent, if necessary, and to wash other passenger coaches.

Underfloor wheel lathes will not be installed in RBCS, because they are already installed at the K.L. loco-shed/passenger coach depot and in the Sentul Workshop.

1) Rawang DMU depot.



2) K.L. DMU depot



3) Sentul DMU depot

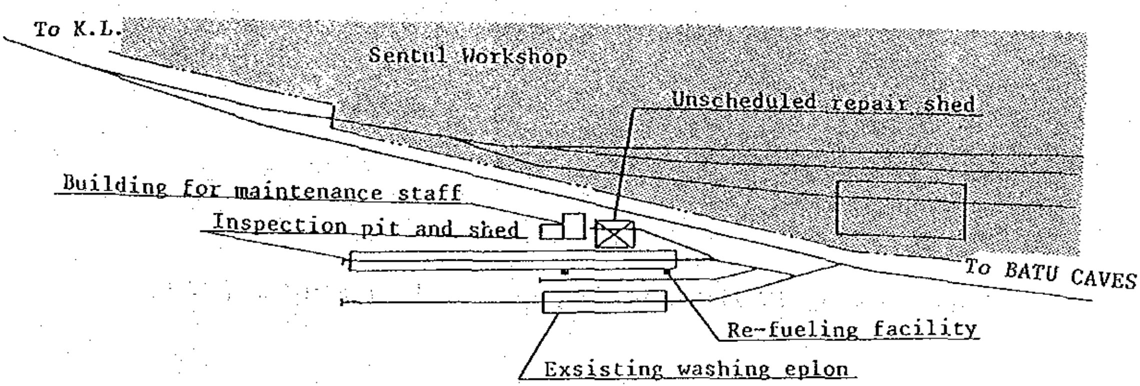
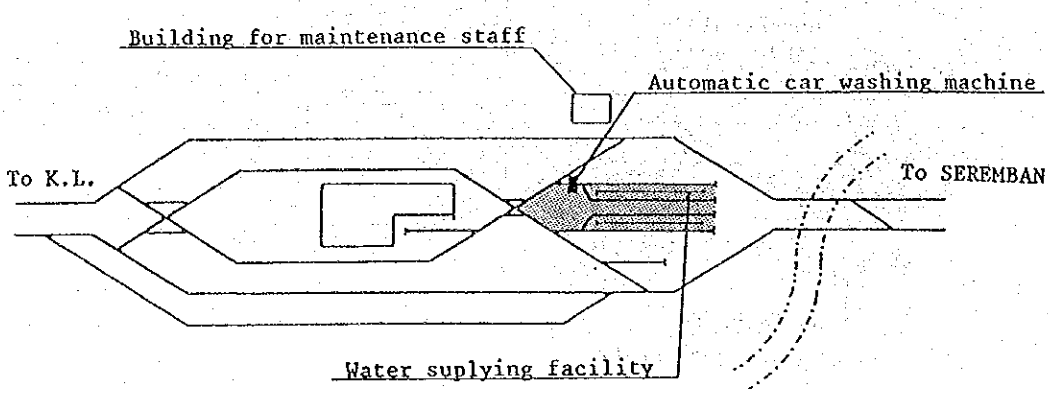


Fig. 7-4-3 Equipment Layout of DMU Depot (1/2)

4) Bangi DMU depot



5) Seremban DMU depot

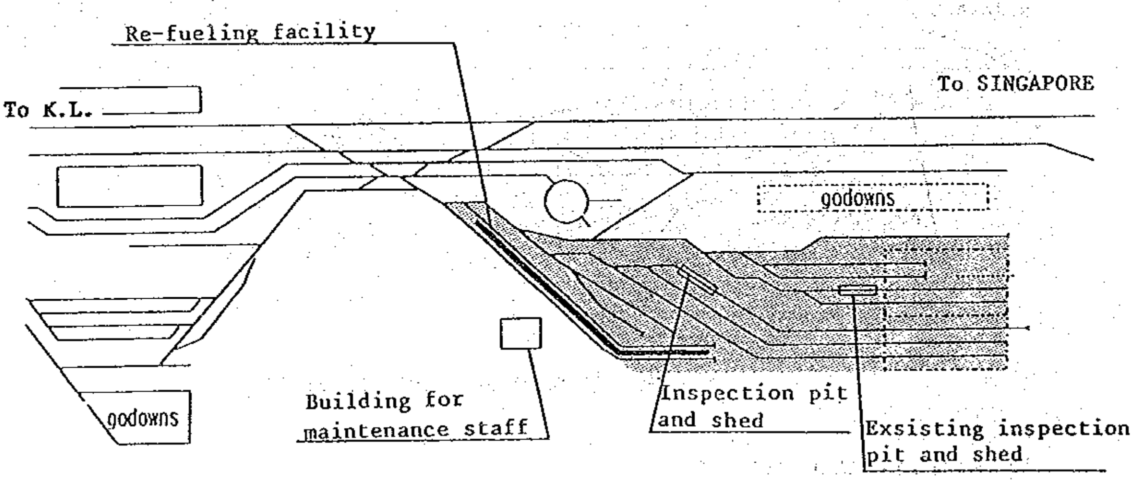


Fig. 7-4-3 Equipment Layout of DMU Depot (2/2)

(3) Facilities for pollution control

In the car maintenance work, pollutant may be discharged mostly at the time of discharging the waste oil.

Hence, a waste oil receiver will be installed at workshop as a countermeasure against outflow of waste oil due to car maintenance work. In regard to the oil-poluted waste water, a package-type waste water treatment facility will also be used.

The configuration of the waste water treatment facility of the floating-air separating type is shown in Appendix 7-4-7.

At the Rawang and Seremban DMU depots, the refueling equipment are installed on the concrete surfaces as shown in Appendix 7-4-8, so that the overflowing oil will not flow out of the DMU depot with water.

Capacities, of the water tank estimated in reference with the local rain fall data is stated in Appendix 7-4-9.

7-5 Improvement Plan of K.L. Station

In the DTP, independent shuttle train services are planned between Rawang - K.L. and K.L. - Seremban, and both ends of the platform at K.L. station are used as departure and arrival platforms respectively.

Since, the platform for the Rawang - K.L. section lies outside the main building of the K.L. station, environmental deterioration will not cause severe problems.

Table 7-5-1 tabulates the number of trains passing the main building of the K.L. station in the RBCS Project. Although the trains are scheduled to stop outside the main building of the K.L. station on the Rawang side, about half of them will pass through the station accelerating speed. Thus, exhaust gas released from those DMU cars (believed to total 742 cars in 2005) will deteriorate the environment inside the station.

Table 7-5-1 Number of DMU cars Passing K.L. Station in the RBCS Project

Year	Total Number of cars passing K.L. station	50%
1997-2000	955	477
2001-2004	1,146	573
After 2005	1,484	742

Note: North-bound trains will slow down before pulling into K.L. station and come to a stop outside the station building, emitting a much smaller amount of exhaust gases than south-bound trains.

7-5-1 Present Status and Environment of K.L. Station

(1) Structure of station building

Set forth on Fig. 7-5-1 and Fig. 7-5-2 are a ground plan of the K.L. station buildings and its arrangement.

The station is situated in a north-south way and has three platforms and four tracks.

The main building stands on the west and the platforms are covered with a slate roof (about 178m x 48m) along the whole length of the station building. The roof is an assembly of small long roofs, each about six meters in width. (Appendix 7-5-1, Photo 1)

These small roofs have a function of natural ventilation. Besides, a lot of small windows which are designed for transverse ventilation are found on the upper part of the wall on the east side of the station building.

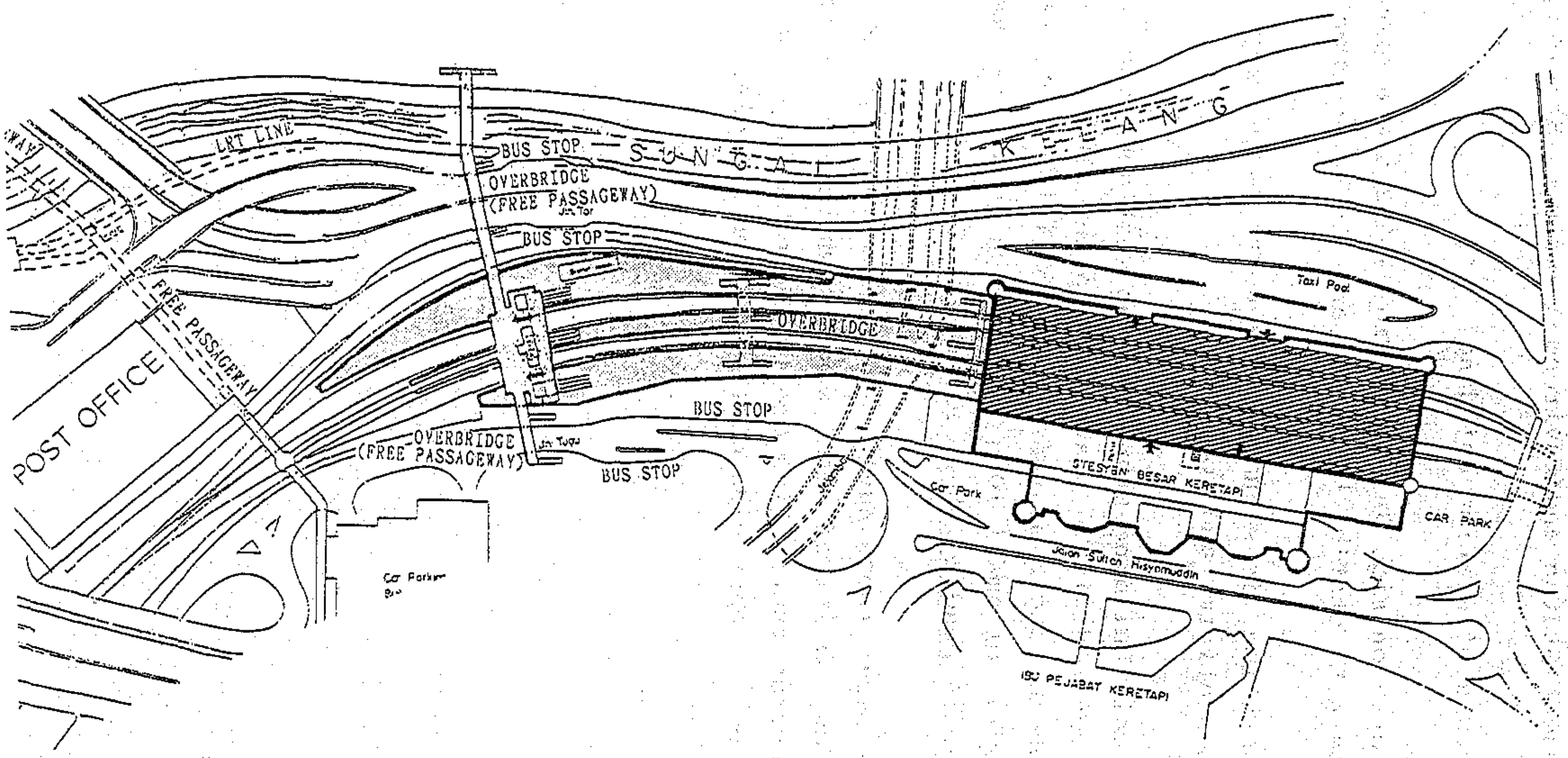


Fig. 7-5-1 Ground Plan of K.L. Station Building

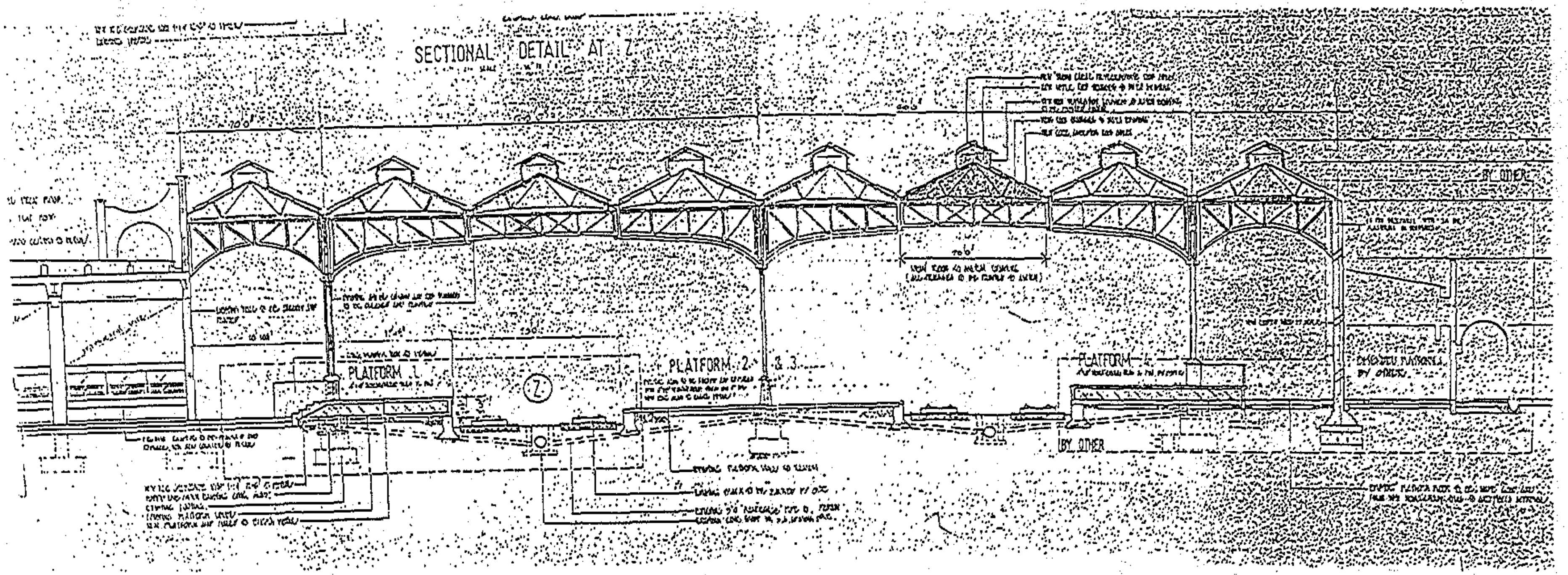


Fig. 7-5-2 Cross Section Drawing of K.L. Station Building

(2) Weather Condition

The atmospheric conditions are important environmental factors within the K.L. station.

The average of temperature for each month in the Klang Valley exceeds 30°C in some districts throughout the year and sometimes in April and May rises to 32.9-33.5°C.

The average relative humidity swells to 96.2-98.4% in these months, indicating that the discomfort index will reach an extremely high level. (See Appendix 7-5-2)

Moreover the temperature rises to the peak value during the time zone from 14:00 to 16:00.

7-5-2 Allowable Environmental Limits

Emissions from the diesel engine of DMU trains are mostly harmless CO_2 and H_2O.

Main harmful substances of it are NOx (nitrogen oxide), SOx (sulfur oxide) and CO (carbon monoxide).

In Japan, the permissible levels of NOx is set at 0.04-0.06ppm (parts per million), and the CO level below 10 ppm.

7-5-3 Amount of Exhaust Gas from DMU Engine

(1) Harmful Emission Concentration

The relationships between the concentrations of NOx and CO discharged from the engine and the number of its revolutions are shown in Appendices 7-5-3 and 7-5-4.

The number of engine revolution is supposed to be kept at 1,500 rpm when trains depart the station at 0-30 km/h. Then the engine is supposed to rotate at the rate of 2,100 rpm with maximum output to accelerate to about 50 km/h. Under above presupposition, the amount of NOx and CO concentrations in the exhaust gas are estimated as shown in Table 7-5-2:

Table 7-5-2 Representative Values of NOx and CO Concentrations in Exhaust Gas from DMU Engine

Harmful gas	Maximum torque (1500rpm)	Maximum output (2100rpm)
NOx	1,650 ppm	1,400 ppm
CO	880 ppm	260 ppm

(2) Time of Train Passages

The average time for a departure train bound for Seremban starts and get out of the station building is estimated at 23.0 seconds (better case is 20.0) as shown in Fig. 7-5-3. (Refer to Appendix 7-5-5.)

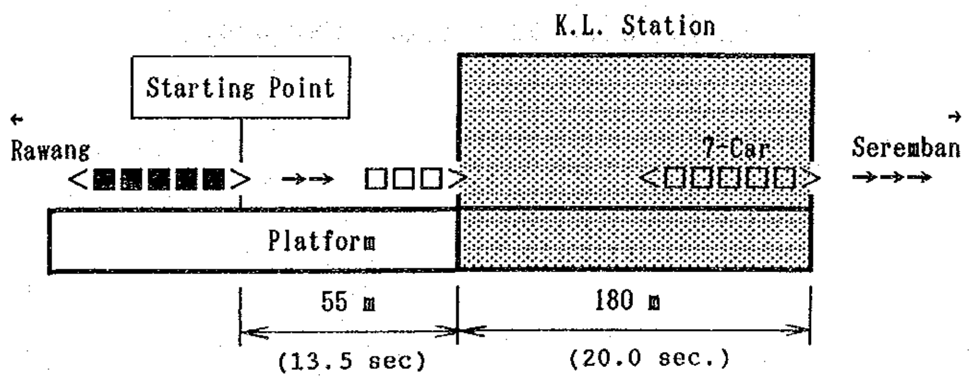


Fig. 7-5-3 Train Run-Through Time at K.L. Station

(3) Amount of Harmful Exhaust Gas

One train will emit exhaust gas of 67.28m^3/train, during the departure period stated above. (See Appendix 7-5-6 for calculations)

The amount of NOx and CO contained in the above are calculated to be 0.04299 m^3 and 0.009383 m^3 respectively. (See Appendix 7-5-7 for calculations)

7-5-4 Environment in K.L. Station During the Evening Peak-Hour

In 2005, a total of 23 down trains, i.e. 14 Seremban-bound trains and 9 Port Klang-bound trains, will leave the K.L. station in the evening peak-hour zone from 16:00 to 19:00 as shown in Tables 5-4-6 and 5-4-10.

Listed on Table 7-5-3 are concentrations of harmful gas in the K.L. station (a capacity of 178m (L) x 48m (W) x 8.6m (H) = 73,478.4m^3) during evening peak hours, accumulated when it is not ventilated.

The above calculations indicate that concentration of NOx gas exceeds the allowable level by 75.1 times. Hence, the station will have to be ventilated 75.1 times per hour.

Table 7-5-3 Amount and Concentration of Harmful Gas in the K.L. Station Building without Ventilation (in 2005: Per Hour during Evening Peak Hours)

Harmful gas	Amount of harmful gas emitted (m^3/hr)	Concentration of harmful gas in station (ppm)	Allowable limits of harmful gas (ppm)	Ratio to allowable limits
NOx gas	0.3310	4.505	0.06	75.083
CO gas	0.0722	0.983	10.0	0.098

Note 1: Atmosphere temperature is supposed to be 33°C and 1 atm.
Note 2: Station building with all its outlets closed.

However, the necessary frequency of forced ventilation could be reduced due to the following reasons:

(1) the temperature of the exhaust gas is very high
(2) the roof of the station has a natural ventilation function
(3) the passage of a running train will cause air ventilation.

Due to convection resulting from the hot exhaust gas, their concentration on the ground level will considerably reduce.

Presuming that the reduction factor for these reasons is 80%, the remnant NOx gas will reduce to about 0.0662 m^3 per hour. To decrease the level below the permissible limit of 0.06 ppm, it is necessary to ventilate the station at least 7.5 times every hour.(Adopting NOx gas diffuser efficiency 0.5 per hour)

In short, ventilation capacity of about 9,200m^3 per minute will be required.

7-5-5 Outline of Ventilation Facilities

The most desirable ventilation system for the K.L. station might be the forced discharge system using a duct with an exhaust booth above the track. However, this system will necessitate large investment and will cause a heavy load on the structure of the station building, requiring its reinforcement.

Hence, a roof ventilator of the scuttle fan type is adopted.

As shown in Fig. 7-5-4, in consideration of train operation direction of each track five electrically-driven roof ventilators (each with a ventilating capacity of 615 m^3 per minute) are to be installed per one row.

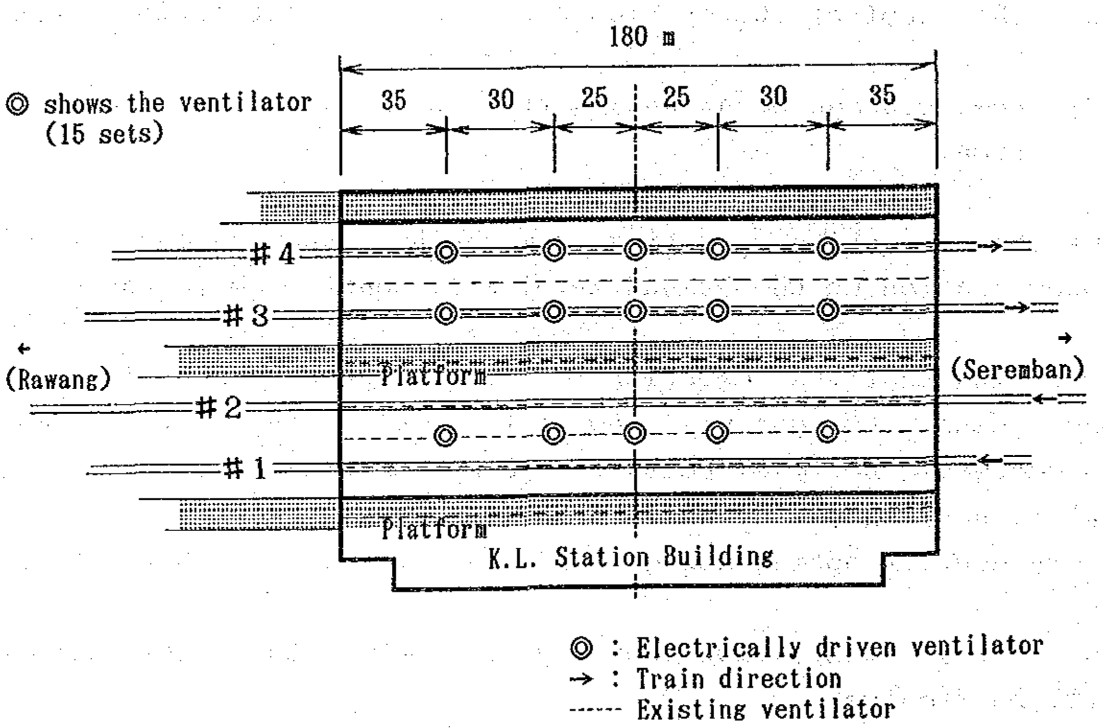


Fig. 7-5-4 Installation Plan of Ventilators at K.L. Station

Should some powered roof ventilators be installed together with the natural ventilators currently used, they would not deteriorate the beauty of the station. (Refer to Fig. 7-5-5)

For energy-saving purpose, they should be able to work by row, and during off-peak-hours they should start working only when approaching trains are detected.

A cover is to be installed over the slit of the natural ventilator system five meters in front and behind the powered roof ventilators to add to the ventilation effect. This is designed also to prevent the recirculation of already discharged air.

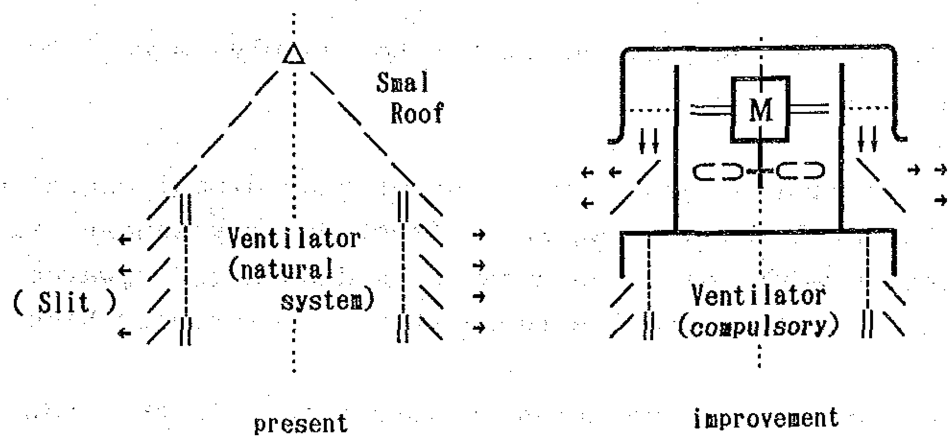


Fig. 7-5-5 Installation Plan of Electrically-Driven Roof Ventilators

7-5-6 Countermeasures to Heat Discharged from Train

The high temperature in the daytime inside K.L. station is another nuisance due to highly dense train operation. Below, is an assessment of heat released from the trains.

The following are the major sources of heat released from trains:

a) Exhaust gas from diesel engine

b) Radiator of diesel engine

c) Heat exchanger for DMU air-conditioner

d) Radiator of engine generator to supply power to air-conditioner

As for the exhaust gas from a) the driving diesel engine of a DMU, it will have a neglible effect on passengers if the ventilators work well. Because it is discharged upwards from the roof of a DMU, and its temperature is extremely high.

The most discomforting thing for passengers is the heat from b), which released from a radiator mounted under the floor of a DMU, and the heat from c) and d), which is emitted from an engine generator for air-conditioners.

(1) Heat from b) radiator of diesel engine

Table 7-5-3 contains data on the 600-PS driving engine as regards radiator heat.

Table 7-5-4 Amount of Heat Released from a DMU Radiator (600-PS Engine)

Condition of use	Engine revolution (rpm)	Engine water flow (Liter/sec.)	Heat radiated (kcal/hr)
Max. output	2100	14	229,000
Max. torque	1500	10	153,000

The amount of heat emitted from a radiator per hour is computed from the above data in the same way as in section 7-5-3:

$$(153,000 \times \frac{2.5}{3,600} + 229,000 \times \frac{17.5}{3,600}) \times \frac{550}{600} \times 5 \times \frac{23}{3}$$

$$= \underline{42,849 \text{ Kcal/hr}} \quad .... \text{(A)}$$

23/3=7.7 shows the number of down trains per one hour.

(2) Heat from c) heat exchanger for DMU air-conditioner

The capacity of the air-conditioning system is about 50,000 kcal/hour per car. Accordingly, hourly heat brought into the K.L. station is calculated as follows, assuming an 80% air-conditioning efficiency:

$$50,000 \times 1.25 \times 7 \times (\frac{20}{3,600} \times \frac{23}{3} + \frac{40}{3,600} \times \frac{23}{3})$$

$$= \underline{55,903 \text{ Kcal/hr}} \quad .... \text{(B)}$$

Note: In computing heat from air-conditioners, it is necessary to consider both up and down trains. For passing-through the K.L. station, down train takes 20 seconds, while up train takes 40 seconds due to turnout speed-restriction.

(3) Heat from d) radiator of engine generator for air-conditioners.

The energy conversion rate is about 2,000 kcal per kw in the case of an air-conditioner of an air cooled type. Therefore, about 33 PS is necessary and a diesel engine generator with a capacity of some 300 PS is needed to supply power to four DMU air-conditioners.

Supposing that heat from the radiator of the engine generator is the same as per-horsepower heat from a radiator for a 600-PS engine to drive a DMU, its amount is calculated as follows:

$$229{,}000 \times \frac{(20+40)}{3{,}600} \times \frac{300}{600} \times 2 \times \frac{23}{3}$$
$$= \underline{29{,}261 \text{ Kcal/hr}} \;.... \;(C)$$

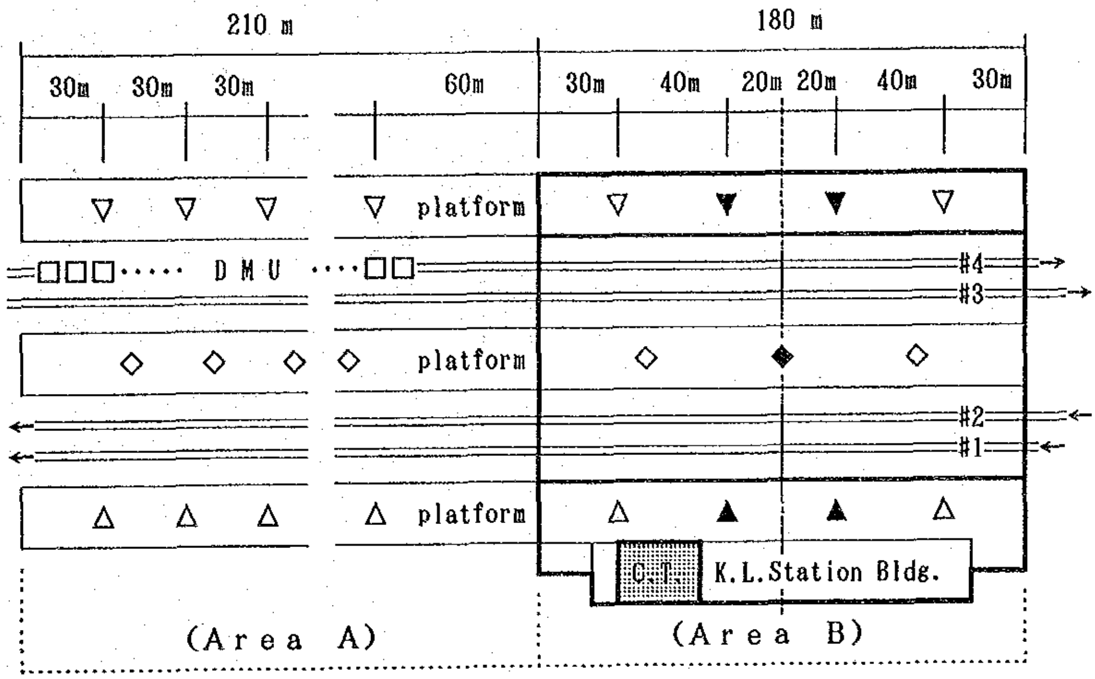
The capacity required for an air-conditioner to maintain station temperature at some level of atmosphere is derived as follows;

$$(A) + (B) + (C) = \underline{128{,}013 \text{ Kcal/hr}}$$
$$= \underline{42.33} \text{ refrigerating tons.}$$

7-5-7 Upgrading the Air-conditioning Capacity to Provide Better Passenger Service

The RBCS Project envisages equipping the platforms of K.L. station with an air-conditioning system, taking into consideration the importance of providing better passenger service. (See Appendix 7-5-8.)

An effective air-conditioning system for an open-air place is the spot cooling system. As shown in Fig. 7-5-6, 25 package-type coolers will be set on the platforms to make passengers comfortable. (Refer to Appendix 7-5-8)



▲or▼or◆ : Air-conditioner (Water Cooled Package Type)
20 RT (x 5 sets)

△or▽or◇ : Air-conditioner (Water Cooled Package Type)
10 RT (x 20 sets)

C.T. : Cooling Tower (for 300 RT)
◆ and ◇ indicate air-conditionrs that blow from the front and rear.

Total Cooling Capacity 20 RT x 5 + 10 RT x 20 = 30 RT

Note : 1 Refrigerating ton (RT) = 3,024 Kcal/hr)

Fig. 7-5-6 Outline of Cooling System at K.L. Station

The water-cooled package air-conditioners of direct blow type will be installed, and control system will be composed of 2 subsystems.

Chapter 8

FEEDER-BUS COMMUTER TRANSPORT

Chapter 8 FEEDER-BUS COMMUTER TRANSPORT

8-1 Objectives and Policy of the Study

The passenger demand on the railway system will increase if a superior means of access to the railway station is provided, so that the whole transit system from origin to destination is attractive.

The objective of this chapter is to examine a Feeder-Bus System.

To formulate a Feeder-Bus System plan, the following studies were conducted.

(1) Passenger interview surveys of the existing feeder transport system were conducted in order to obtain basic data, which was used to plan the criteria for a feeder service.

(2) Establishment of criteria for Feeder-Bus System planning.

(3) Using the results of the traffic demand forecast and according to the established criteria, examine feeder-bus routes and bus operating plans. Representative stations were selected and the feeder-bus operation plans examined.

(4) Examine the requirements for the types and number of buses and related facilities using formula developed during this study.

(5) An investment and operation costs study from which an investment schedule for the implementation of the Feeder-Bus System was planned. Some important issues in the implementation of the System were identified from this study.

8-2 The Interview Survey

8-2-1 Introduction

This survey was conducted primarily to determine the parameters of the modal split formula in the demand forecast study.

At the same time the survey was intended to determine the passenger service level required; to find out the degree of improvements required of the rail transport service; and to determine the criteria which would make present bus and private car commuters transfer to rail.

The survey was conducted for about two weeks from January 19, 1990 on the Port Klang/Rawang-Seremban railway corridor.

The survey was conducted on railway passengers, bus passengers, and private car commuters (a total of 1,630 persons). The questionnaire covered their travel attitudes and also data on their socio-economic background.

8-2-2 Rail/Bus Passenger Interviews

The survey of the rail passengers revealed that more than 70 % of the respondents lived in an area within 20 minutes of access time taken from home to railbus station (Refer to Fig. 8-2-1) and most of them walked to the station (Refer to Fig. 8-2-2).

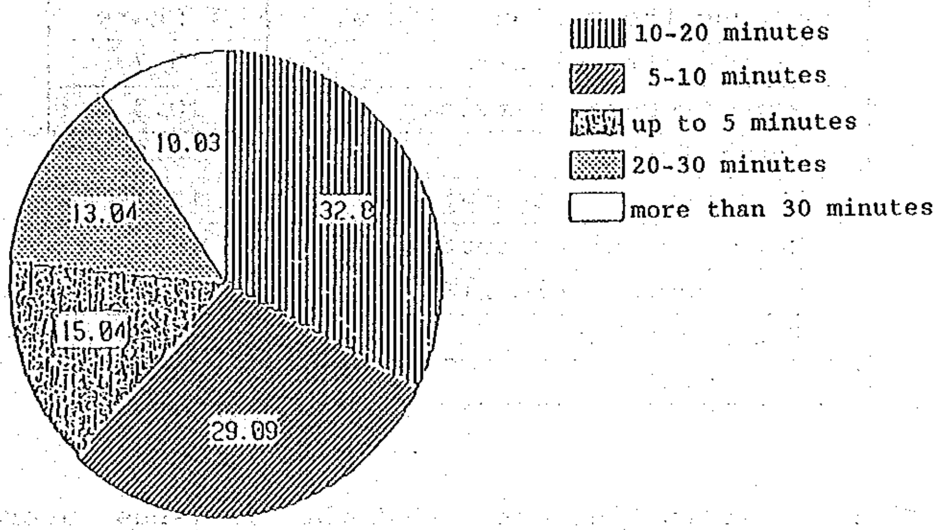


Fig. 8-2-1 Access Time from Home to Railway Station

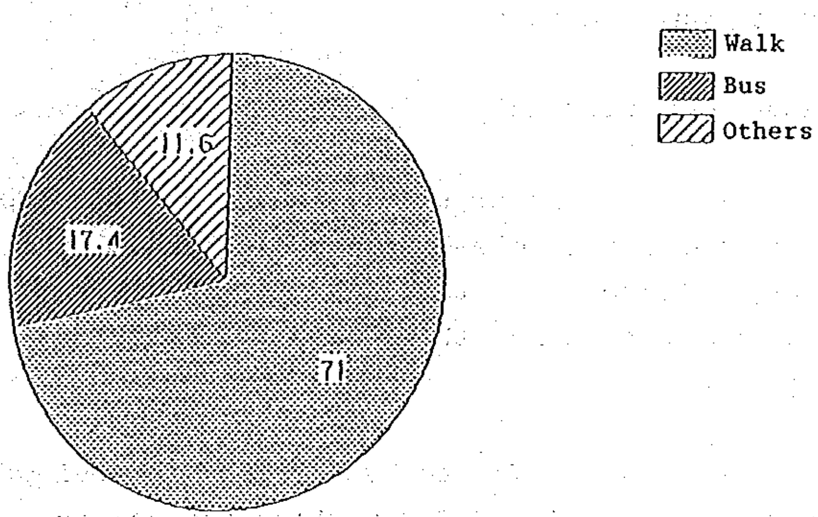


Fig. 8-2-2 Transport Facilities for Access to Railway Station

The rail-bus passengers gave their reasons for using the rail-bus mode as follows.
Refer to Table 8-2-1.

Table 8-2-1 Reasons for Using Railbus

Because the railbus offers;	% Share
Shorter travel time	15.7
More frequent service	10.3
Lower fare	16.6
More punctual operation	13.7
More convenient route	15.7
More comfortable ride	11.2
Safer service	16.8
Total	100 %

These results indicate that the rail-bus users are generally limited to those persons living near to the railway stations. Stated conversely, it suggests that if a feeder-bus system is provided, the rail-bus ridership would increase.

8-2-3 Bus Passenger Interviews

Commuters either walk or take a feeder-bus to reach the bus terminal for middle-distance or long-distance bus services, travel to the bus terminal near their destination and finish their trip by feeder bus or by walking.

This survey was conducted by holding interviews with passengers who use long/middle stage-bus services. The survey indicated that most of the passengers either used a feeder bus system or walked from their homes to the bus terminal. The maximum time required to get to the local bus terminal was between 20 and 30 minutes. Refer to Fig. 8-2-3 and 8-2-4.

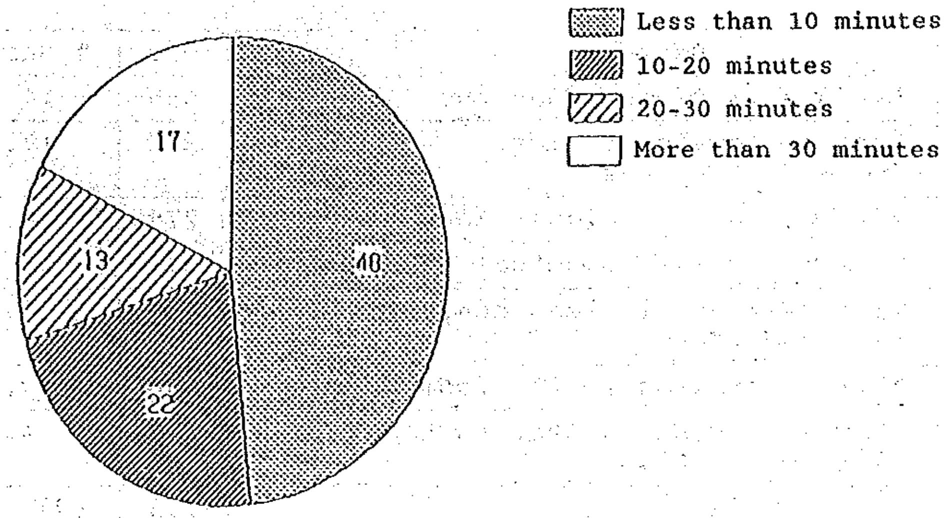


Fig. 8-2-3 Access Time from Home to Bus Terminal

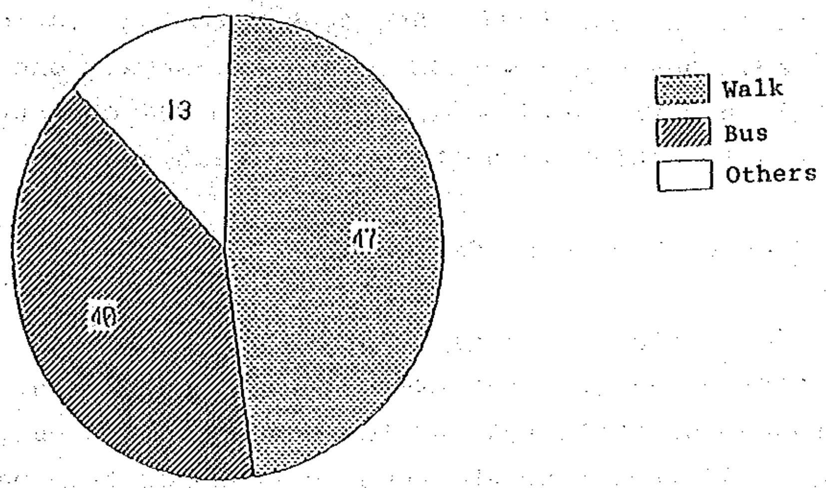


Fig. 8-2-4 Transport Facilities for Access to Bus Terminal

When asked for their reasons why they did not use the railways, respondents replied that the railway stations were too far from their homes and the train services were infrequent. Refer to Table 8-2-2.

Table 8-2-2 Reasons for Not Using Railbus

Because	No.	% Share
Railbus is slower than bus	455	14.3
Railbus service is less frequent than bus	552	17.4
Railbus fare is higher than bus	275	8.7
Railbus is less punctual than bus	394	12.4
Railbus route is less convenient than bus route	455	14.3
Railbus station is far from home	590	18.6
Access service is poor to the rail way station	452	14.3
Total	3173	100 %

In the same survey, 70 % of those surveyed stated that if a better access feeder-bus system to the station were provided, they would change to the railways. one reason for this answer could be attributed to the congestion of road traffic which is getting worse each year.

8-2-4 Interview with Private Car Owners

Most of the persons interviewed stated their dissatisfaction with the present road congestion. When queried about their reasons for not using the bus, they stated that it was troublesome to transfer from one bus system to another, the bus stands are far from their place of work, and bus rides are not comfortable. Their reasons for not using the railways was that railway service was poor and the railway stations were few and inconvenient for them, and that the bus/railway transfer system was unsatisfactory. While on the other hand, 64 % answered that if commuting by railway could shorten the travel time they would consider transferring to rail. In short, this indicates that if the railway system were improved, many private car owners would change to rail transport.

8-3 Criteria for Feeder-Bus Planning

The survey has revealed that the introduction of a Feeder-Bus System is an essential element of an RBCS system. A Feeder-Bus System consists of an access transport system from the point of origin (home) to the railway station, or from the railway station to the destination (office). The system would consist of the bus route, the bus operating system, and the facilities (bus vehicle, roads, bus stands). The scale of the bus operating system is subject to the bus ridership estimated by the traffic demand forecast conducted for the railway, the housing layout in the service area, the road network, the condition of the roads, etc.

The criteria for Feeder-Bus System planning have been established by considering the data obtained from the results of the interviews, the data given in the JICA M/P 87, and the data obtained from the bus companies and related Government Agencies.

(1) Feeder-Bus Service Area:

The service area of the Feeder-Bus System was assumed to be within an area of, in general 5 km radius from the railway station (i.e. 20-30 minutes travel time).

(2) Walking Distance:

The distance that passengers can walk to a railway station, and the distance that passengers can walk from their homes to feeder-bus stands are important factors in determining the feeder bus routes. From the results of the surveys, the maximum reasonable distance that passengers can walk was assumed to be less than 400 meters.

(3) Bus routes:

The feeder-bus routes must consider the effective operation of the bus, walking distance to the bus stands, and the layout of the housing areas where the passengers reside.

(4) Bus-operating frequencies:

The bus operating frequencies must be assimilated to that of the railway trains. These will be more frequent than railway, sometimes, with bus headways of between 5 to 20 minutes.

(5) Bus operating speeds:

The operating speed of feeder-buses considering the dwell time at bus stands, the reduction of speeds near the bus stand, was assumed as about 10 km/h in urban areas, and 15 km/h in suburban areas.

(6) Passenger carrying capacities:

The types of the feeder-buses, considering the passenger traffic demand and the purpose of this service, were considered to be stage bus and mini bus. The stage bus will have a capacity of 60 passengers (including standees), and the mini bus 35.

(7) Bus stands:

Bus stands or stops were planned to be installed with about 400 meters spacing to comply with the regulations.

8-4 Operation of Feeder-Bus System

8-4-1 Planning Factors and Method

(1) Planning factors

The following items are basic requirements in the planning of the feeder-bus operational plan:

- Passenger demand forecast of feeder-bus system
- Feeder-bus routes
- Bus operating hours and frequency
- Bus operating speed
- Number of buses
- Number of bus operating at peak hours
- Ratio of traffic concentration at peak hours
- Type of bus
- The vehicle-km passenger-km

(2) Method

To support this operating plan, various sets of facilities, such as passenger waiting facilities, new roads, road improvements etc., were prepared and based thereupon, economic and financial test calculations have been repeated until the operating plan proved the feasibility.

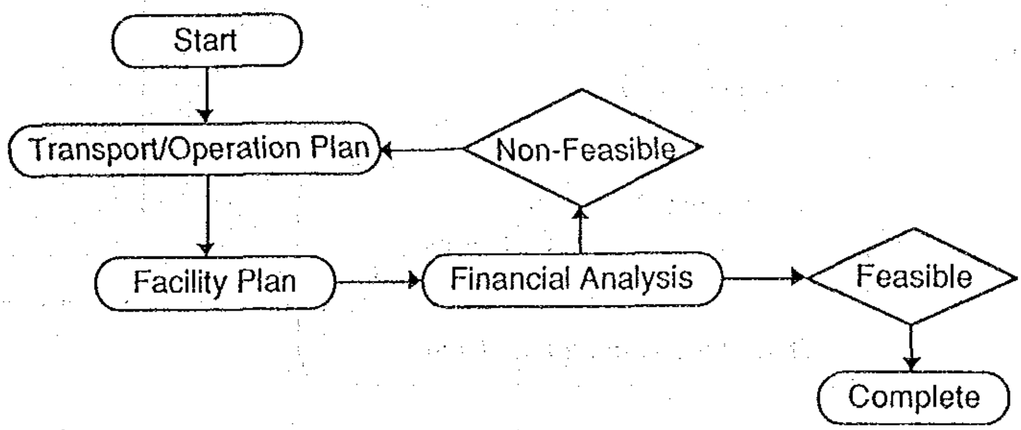


Fig. 8-4-1 Work Flow for Operation Plan

Fig. 8-4-2 gives the work flow plan including the estimating of costs.

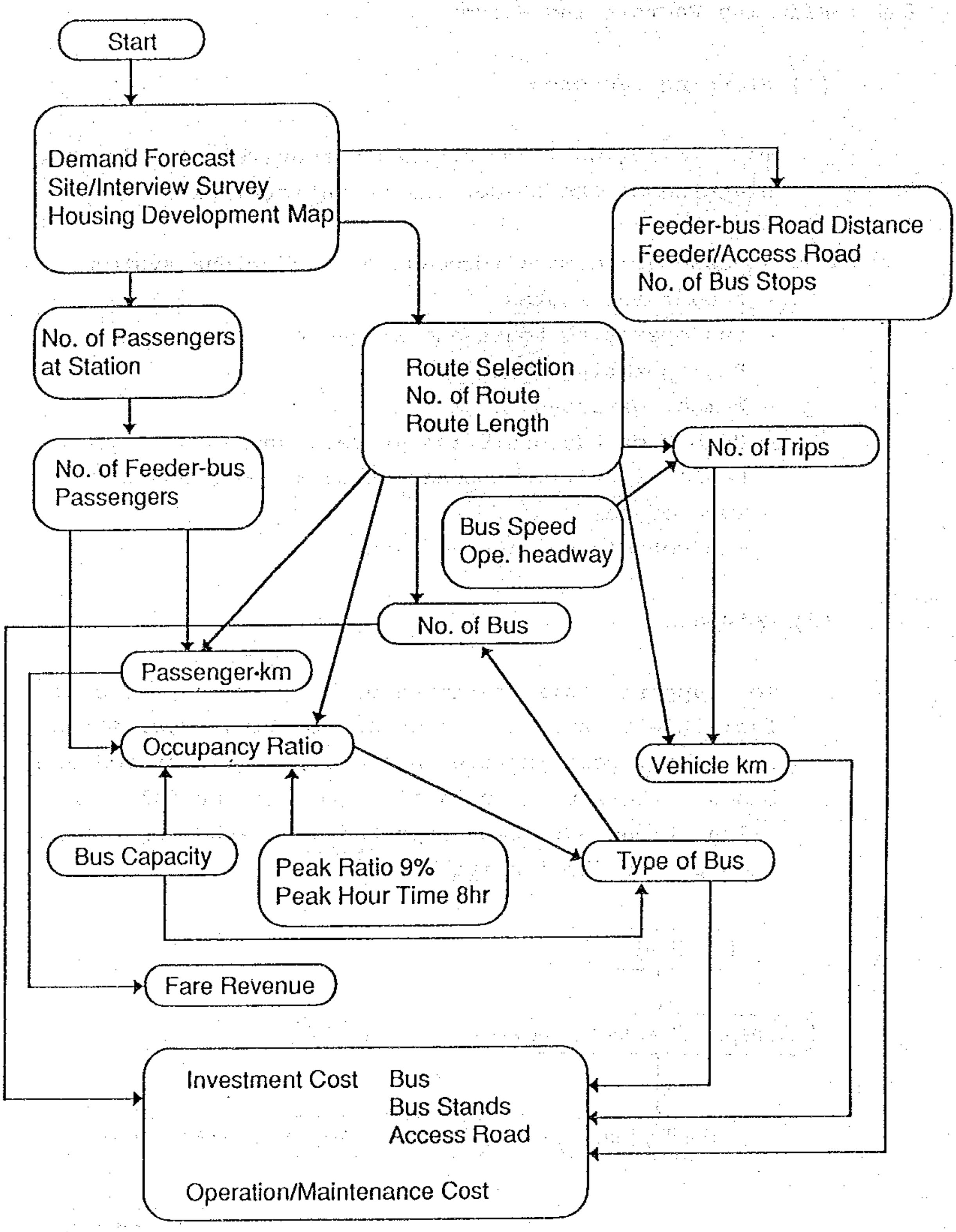


Fig. 8-4-2 Feeder-Bus Planning Work Flow

8-4-2 Operation Plan

(1) Passenger demand forecast of feeder-bus system

The number of passengers disembarking at the railway station (N) is given by the passenger demand forecast in Chapter 4. The number of passengers transferring to feeder-bus (n) was calculated by the following formula:

$$n = P \times N$$

Where, P: Bus usage ratio. The ratio is empirically determined observing the housing and road layout of the areas more than 400 m separated from the station

The number of passengers using the feeder-bus in the year 2005, of each station of the corridor was estimated as follows:

Table 8-4-1 Number of Bus Passengers

	No. of Passengers at Station/Day	Bus Usage Ratio (p)	No. of Bus Passengers/Day
Rawang	31,500	90 %	28,500
Sg.Buloh	6,500	70 %	4,500
Kepong	14,000	90 %	12,500
Segambut	51,000	90 %	46,000
Mall	28,500	90 %	25,500
Kuala Lumpur	87,500	90 %	78,500
Salak South	75,500	90 %	68,000
Sg.Besi	67,000	70 %	47,000
Serdang	28,000	90 %	25,000
Kajang	36,000	90 %	32,500
Bangi	13,000	80 %	10,500
Serembang	17,500	90 %	16,000

(2) Feeder-Bus Routes

The feeder-bus routes have been set up considering not only the present bus also future layout of housing and road layouts. So that an effective bus operation may become possible and to transport the largest possible number of passengers some new feeder roads and access roads are required to improve the service capability.

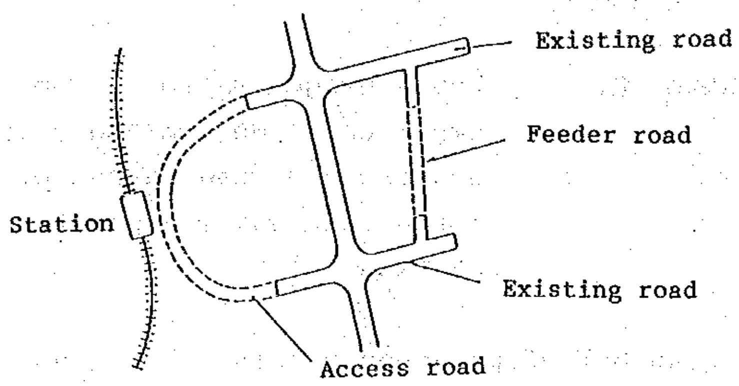


Fig. 8-4-3 Road Network for Feeder-Bus Service

In the selection of feeder-bus routes, the criteria that the service area will be within a radius of 5 km from the station, and distances between stops of 400 m, etc. have been respected. The planned front and rear entrances to the stations has also been considered.

The feeder-bus routes thus set up to serve the representative stations of Rawang, Kuala Lumpur, Kajang, Serembang stations in 2005, are given in Figs. 8-4-4 through 8-4-7.

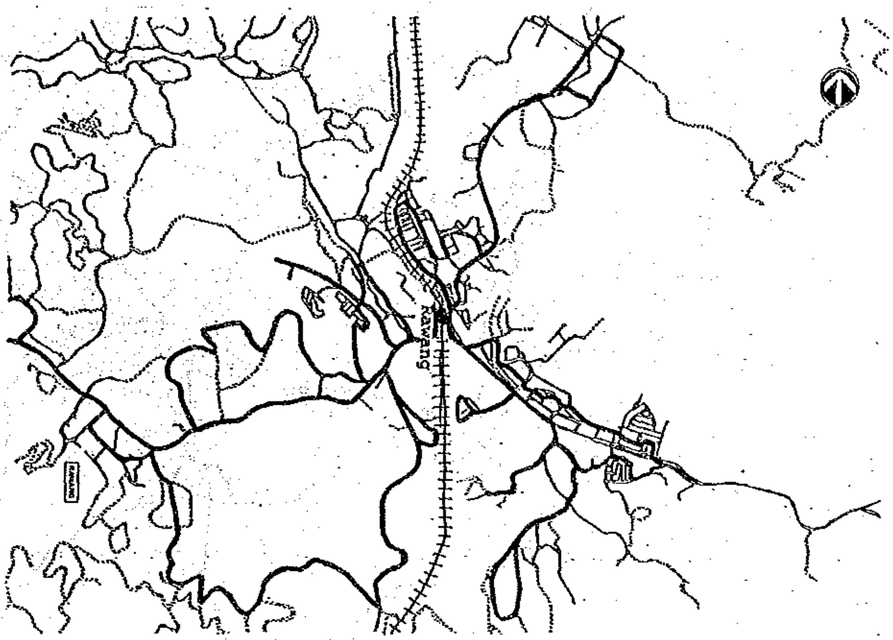


Fig. 8-4-4 Feeder-Bus Network at Rawang

Fig. 8-4-5 Feeder-Bus Network in K.L.

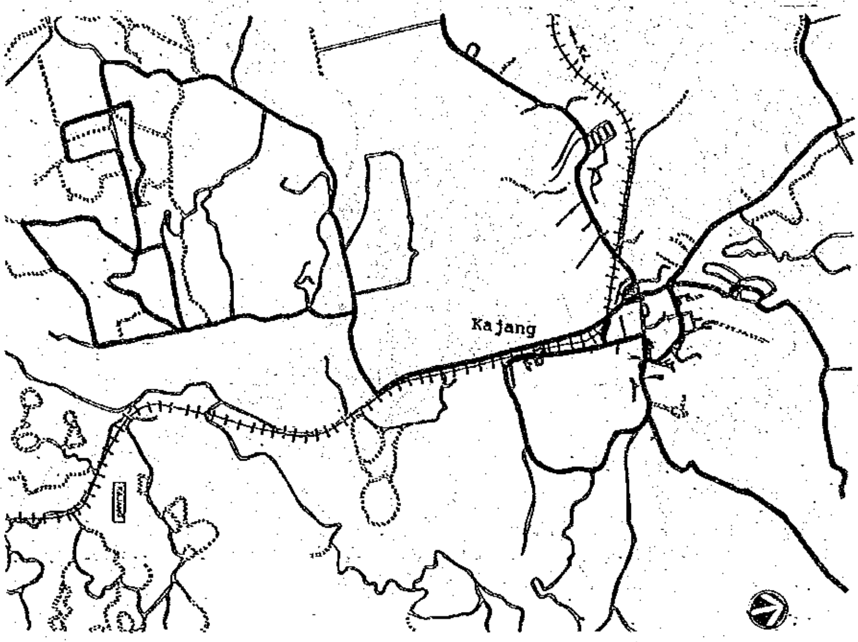


Fig. 8-4-6 Feeder-Bus Network at Kajang

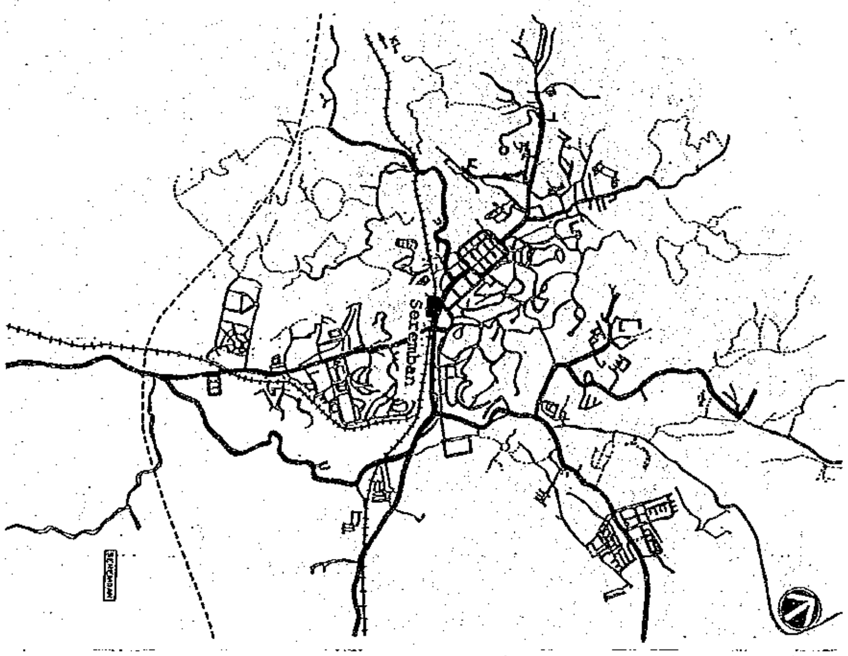


Fig. 8-4-7 Feeder-Bus Network at Seremban

(3) Bus Operating Hours and Frequency

The bus operating hours will increase pro-rata with the railway operating hours. 8 hours will be the morning and evening peak commuter hours and 11 hours will be non-peak hours. The frequency of bus service will be higher than that of trains starting earlier in the day than the first train, and ending after arrival of the last train. The number of bus services per hour was planned to be more than three in 1997, and more than six in 2005.

(4) Bus Operating Speed

Dwell time at bus stands, and the traffic congestion were considered in determining the bus speed. Based on JICA M/P 87, it was planned to be 15 km/h in the suburbs, and 10 km/h in the down town area.

(5) Number of Buses

The required number of buses has been determined by the bus route length (L km), the bus headway (T hours), and the bus operating speed (V km/h). The following formula is used:

$$\text{Number of Buses} = \frac{L \times (1 + \alpha)}{V \times T}$$

where:

α = Number of buses in reserve including buses under repair. Tentatively, it was assumed to be 10 % of the fleet.

(6) Number of Bus Operating at Peak Hours

Supporting that the bus headway at peak hours (8 hours) is T_1, and 2T, during the off-peak hours (11 hours), the number of bus n_1, to be operated per day will be:

$$n_1 = \frac{8}{T1} + \frac{11}{2T_1}$$

If the number of routes which serve the station is n_2, the total number of bus operating at peak hour (n_3) will be:

$$n_3 = \frac{8}{T_1} \times n_2 \times \frac{1}{8} = \frac{n_2}{T_1}$$

(7) Ratio of Traffic Concentration at Peak Hour (β)

From the results of the bus transport survey of Klang Valley, the ratio of traffic concentration for the main traffic direction will be 8 - 10 %. The value for β was assumed at β = 9 %.

(8) Type of Bus

The type of bus will be determined by the road conditions or by the passenger demand forecast either as a stage bus or as a mini bus. For this study the factor of passenger demand forecast was used. The roads were assumed to be improved good for use by either type of bus.

In order to avoid the road traffic congestion and to transport the largest number of passengers, and to use a minimum number of vehicles, a large size bus would be better suited. On the other hand, in the housing areas where road conditions are not good, and in other areas where large size buses have difficulty in negotiating traffic, it will be better to use the mini bus which can offer frequent runs and provide more services to the passengers.

For the feeder bus system stage bus with a capacity of 60 persons, and the mini bus with capacity of 35 persons are selected. This selection is based on the passenger demand. The feeder bus roads were assumed to be well maintained by the Government.

The number of passengers per bus n_4 was determined by the number of passengers at peak hours and number of bus services during peak hours.

$$n_4 = \frac{N \times \beta}{n_3}$$

where:

N : the number of passengers per day per route

β : the rate of traffic concentration at peak hours, 0.09

n_3 : the number of bus operated per hour at peak hour

The carrying capacity of stage bus is 60 passengers/bus, and mini bus, 35.

when $n_4 < 35$,	mini bus will be used.
when $35 < n_4 < 60$	a mixture of mini bus and stage bus will be used
when $60 < n_4$,	the bus frequencies will be shortened, and n4 will be made smaller

The number of buses of each type, thus estimated to serve each representative station is as follows;

Table 8-4-2 Number of Buses

	Bus	Mini Bus
Rawang	0	70
Mall	21	22
J.P.M	54	0
KL	63	0
Salak South	126	0
Kajang	42	19
Serembang	0	63
Other Stations	145	236
Total	451	410

Fig. 8-4-8 shows a representative type of stage bus and mini bus that are presently used in the Klang Valley area. No special type was considered.

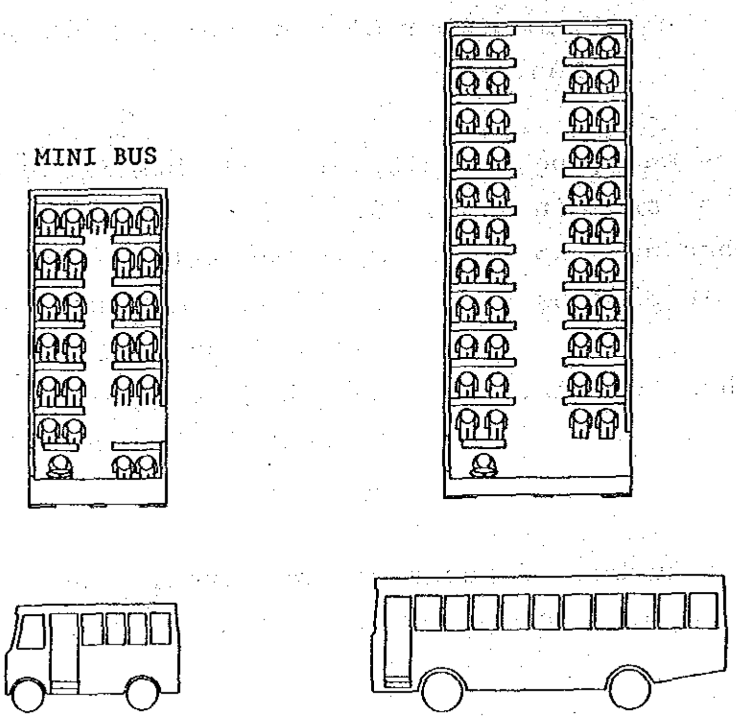


Fig. 8-4-8 Standard Stage Bus and Mini Bus

(9) The vehicle-km and passenger km

The vehicle-km/day is calculated by multiplying the number of cars (n_1) with the route lengths (1).

The vehicle-km/day = $n_1 \times 1$

This result was used for calculating the frequency of bus repair, maintenance costs, and car operating personnel costs.

Passenger-km/day by multiplying the number of passengers per day (N_1) with the average riding distance (ℓ_1)

Passenger-km/day = $N1 \times \ell 1$

This result was used to calculate the income and benefits.

Results of the calculation:

	1997	2005
Number of Passengers km/year	417 million	594 million
Number of Vehicle-km/year		
Bus	13 million	22 million
Mini Bus	21 million	24 million
Average riding distance	3.1 km	3.2 km
Running km/vehicle·day		
Bus	160	149
Mini Bus	156	176

8-4-3 Ground Facilities Plan

Based on the bus operation plan described in 8-4-2 above, the ground facilities required for a Feeder-Bus System were determined.

(1) Bus Stands

The spacing of 400 meters between bus stands, the practice presently adopted by the regulations will be used also for the Feeder - Bus System. The facilities to be provided at bus stands on feeder roads are the shelters, waiting benches, lights, etc. At bus stands where traffic is heavy and at Railway Stations, Bus Lay-By's will be provided. Fig. 8-4-9 shows a representative bus stand presently under consideration, and Fig. 8-4-10 is a bus stand with a Bus Lay-By.
The number of bus stands for the Feeder-Bus System between Rawang - Serembang in the year 1997 for a service of 550 km routes will be 2,700, and in 2005 for a service of 610 km will be 3,000.

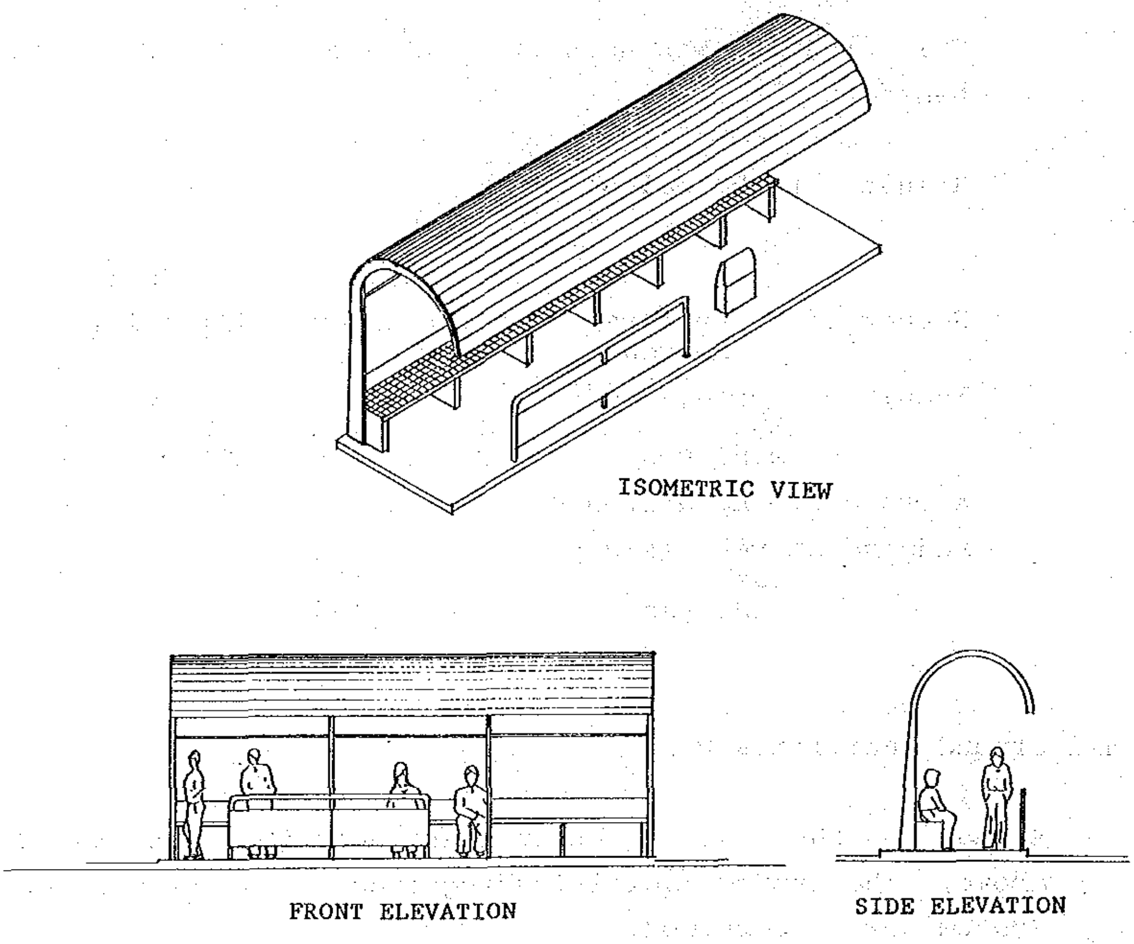


Fig. 8-4-9 Bus Stand Facilities

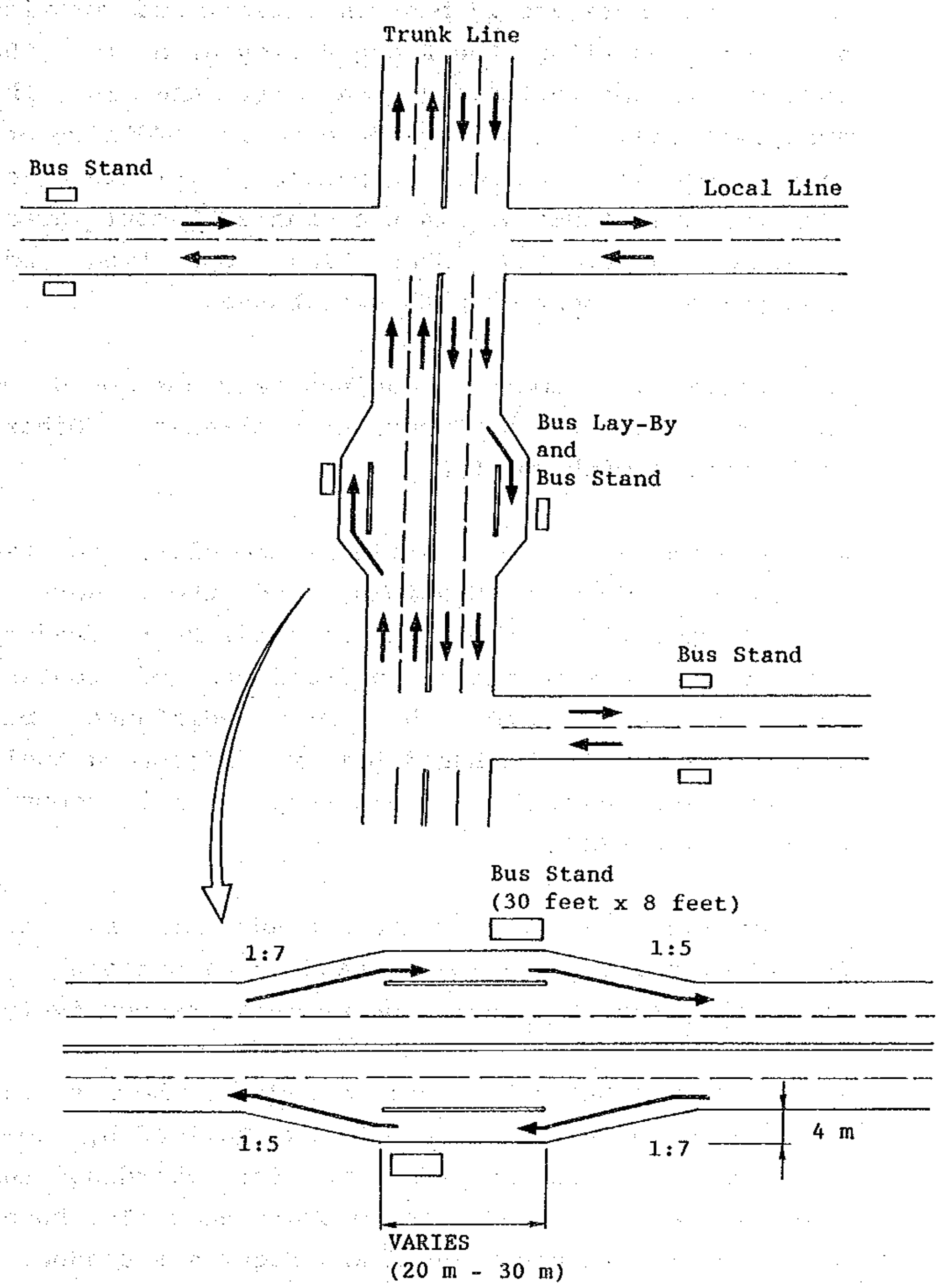


Fig. 8-4-10 Bus Stand with a Bus Lay-By

(2) Present state of bus transportation

At present there are 13 bus companies which provide bus services within the Klang Valley area for the public transportation in the city and in the suburban areas with stage buses. In addition to this, there are other bus companies of various sizes and private firms within the Kuala Lumpur area, Petaling Jaya, and Shah Alam operating bus transportation service with mini buses.

Theoretically, some of these bus services could be integrated into the RBCS currently planned. Others will compete with the RBCS.

As an example, the bus terminals are close to the Rawang and Seremban Stations, and their service could be readily incorporated into the RBCS feeder-bus operation with minor modifications of routes. On the other hand, the middle-distance bus operations of Rawang-Kuala Lumpur, Serembang-Kuala Lumpur, and Port Klang-Kuala Lumpur will compete with the new RBCS.

The design size of the stage bus and mini bus are for 42-44 seating and 14-15 standing passengers, and 25 seating and 10 standing passengers, respectively.

The old type buses have only one door, whereas the newer buses with 2 doors are being provided by some bus companies so that the time for boarding and alighting at bus stands can be shortened. The buses with 2 doors are also manned and require a conductor to collect fares. These are causing problems because passengers often fail to use the proper door when entering and leaving the buses.

In 1985, One Man Operation Ticketing Service (OTS) was tested for the mini buses by some bus companies. Consortium Minibus Sdn. Bhd. gave up the system after one month's trial period. The high cost of installation ($8,000 per machine), uncooperative and indisciplined passengers were reasons given by Consortium for the OTS fail. Sri Jaya Kenderaan Sdn. Bhd. (SJK) continued with the system by installing OTS machines on all its mini buses. Although SJK is confident of its success, there has been no decision to install the machines on its stage buses.

(3) Bus maintenance facilities

The feeder-bus maintenance is proposed to be carried out by the sub-contractors who have experience in maintaining mini buses and stage buses at present. The feeder-bus operating companies were not planned, therefore, to have their own maintenance facilities including inspection pits and maintenance sheds.

8-5 Investment Plan

Based on the bus operation plan (8-4-2 above) and the ground facilities plan (8-4-3 above), the investment cost and operating/maintenance cost have been estimated (Table 8-5-1). The calculation was made presuming as if the feeder bus services were to be performed by a sole entity. The unit price data were based on the information on a bus company operating primarily in the Klang Valley area. Data furnished by Local Authorities were also taken into account. (Refer to Appendix 8-5-1)

Table 8-5-1 Investment Cost and Operation/ Maintenance Cost (Million Ringit)

	1997	2005
Investment Cost		
Bus Procurement	60(650 buses)	27(Additional 210 buses)
Bus Stand/Stop	33(2730 bus stands)	4(Additional 320 bus stands
Feeder/Access Road	0.8	0.3
Land Acquisition	0.5	0.2
Operation/Maintenance Cost/Year		
Operation/Maintenance	4	6
Wage	24	32
Fuel	3	5
Bus Stop/Road	4	4

8-6 Implementation Plan

(1) Schedule:

The Feeder-Bus System is an indispensable factor for the success of RBCS. The two systems, railway and feeder bus, should be implemented simultaneously. First of all, under strong government encouragement, the feeder-bus operating companies must be decided. Refer to 14-4-4(2) 1) in this respect. Then the new feeder/access roads must be constructed. The required land acquisition being made, they will have to be completed by the target year 1997. The same with the initial fleet of 650 buses, and with the 2730 bus stands, Remaining 210 buses and 320 stands can be provided according to the actual growth of the demand. The purchase of buses will constitute 63 % of the initial investment --- if everything must be newly procured, and bus stands, 35 %.

(2) Vital issues:

The matters which need to be considered with care are as follows:

1) The construction and maintenance of the new feeder/access roads should be performed by close supervision of the local governments, according to the feeder-bus route plan. Close contacts are desired between the local government and the bus operating entities. It will be necessary to advise the MOT Licence Board who will administer the bus routes to see to it that the routes might not conflict with existing bus routes and cause unnecessary competition.

2) Bus garages and repair facilities must be constructed making effective use of the existing land of the bus companies.

3) The bus stands at railway station must be of the Bus Lay-By type. They should be constructed together with the station plazas which will also provide parking lots for taxi and private vehicles. Bus Lay-bys will not be installed on the feeder-roads. However, exceptions will be made on main trunk roads and at railway stations where the bus will have to be removed from the main traffic flow.

4) In order to reduce personnel costs, it is proposed to install an automatic fare collection machine in each bus on the future.

Refer to the investment Schedule in Fig. 8-6-1.

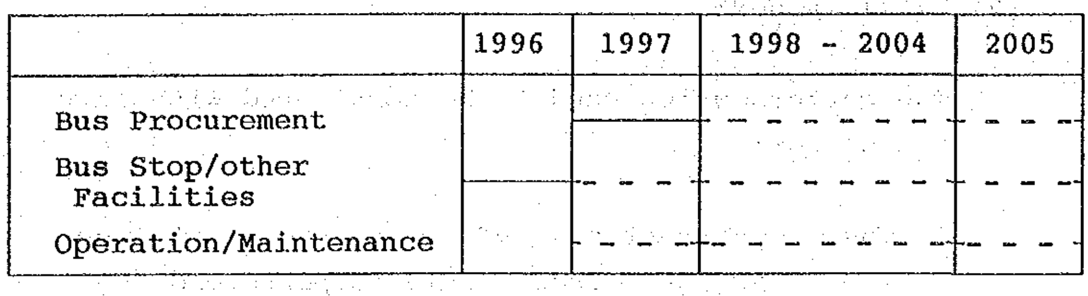


Fig. 8-6-1 Investment Schedule