(7) Axle Load Weighing Bridge

Pavement design is usually based on the allowable axle-load of large trucks. If such allowable axle load is exceeded, the strain on the pavement surface will increase, hence causing damages and cracks to the road pavement. It is important to prohibit large trucks with axle load of more than 10 ton from using the highway so as to preserve the pavement conditions. Besides, overloaded trucks often face brake failure, slow travelling speed which may pose danger to other road users.

Axle load weighing bridges installed on the truck lane (extreme left lane) at entry booths are to screen off overloaded trucks from entry into the highway. When the truck is overloaded, the weighing device sets off a siren and simultaneously displays the "overloaded" message in red. Traffic management officer at the toll plaza will order the overloaded truck to unload some of its cargo before allowing it to proceed or alternatively prohibit the truck to use the highway.

3.7.3 Traffic Information Dissemination Equipment

The conveyance of traffic information to road users is aimed at warning drivers of potential dangers or hazards on the road, thus alerting on-coming vehicles and facilitating traffic control and management. Detour, congestion and road closure information are to forewarn drivers to effect traffic dispersal before they reach the congested area.

The provision of traffic information can be done by various means. However, to produce the best effect, certain guidelines must be followed.

1) Information is to be given by a media that is easily understood;

2) If visual communication is used, such media must be located at places that are easily visible to drivers;

3) Information provided must be accurate and prompt (inaccurate information can produce negative effect instead);

4) Information given must follow a consistent pattern or format;

5) Irrelevant and outdated information must not be given;

6) To ensure that the intended information reaches the drivers, a combination of various media in conveying the information is desirable. Their coordination, however, has to be appropriately planned.

Five different yet complimentary media are used for conveying traffic information to drivers.

a) Changeable Message Sign,
b) Changeable Speed Limit Sign,
c) Radio Broadcasts,
d) Highway Radio,
e) Information Board/Counter at Service Area.

(1) Changeable Message Sign

Changeable message sign (CMS) board is one of the most commonly used means of conveying traffic information to drivers. They are classified into four (4) different types according to their location (Figure 3.7.11).

(a) Mainline CMS

- Mainline CMS are installed at about 400 m before exit ramps or tapers;
- Mainline CMS are used to warn drivers of road conditions ahead, such as "Accident Ahead", "Congestion 3 km Ahead", "Fog 2 km Ahead", etc.;
- Mainline CMS are remotely controlled at the traffic control center by the traffic management officer on duty;
- Incidents that greatly affect travel on the expressway, such as "Accident.Road Closure.20 km Ahead", "Congestion.Caution. 5 km Ahead", are displayed in advance using a few Mainline CMS to enable drivers to exit or choose alternative routes.

(b) Access Road CMS

- Access Road CMS are installed along ordinary access roads to the interchanges, giving traffic information to potential highway users;
- Information on unfavorable road conditions or traffic conditions can prompt users to change their travel plans before they enter the highway;
- Access Road CMS are also remotely controlled at the traffic control center by the traffic management officer on duty.

(c) Toll Gate CMS

- Toll Gate CMS are message sign boards installed at the toll plaza before the toll booths;
- Toll Gate CMS message signs are installed at 1 sign in between every 2 booths;
- The signs are aimed at giving the latest traffic or road conditions to highway users as they enter the highway;
- Messages like "Accident.Congestion.Northbound 10 km", "Roadwork. Caution.Southbound 5 km" will give prior warnings to the road users so that they may take extra precautions as they approach those locations.
- Toll Gate CMS are also activated by traffic management officers at the traffic control center.

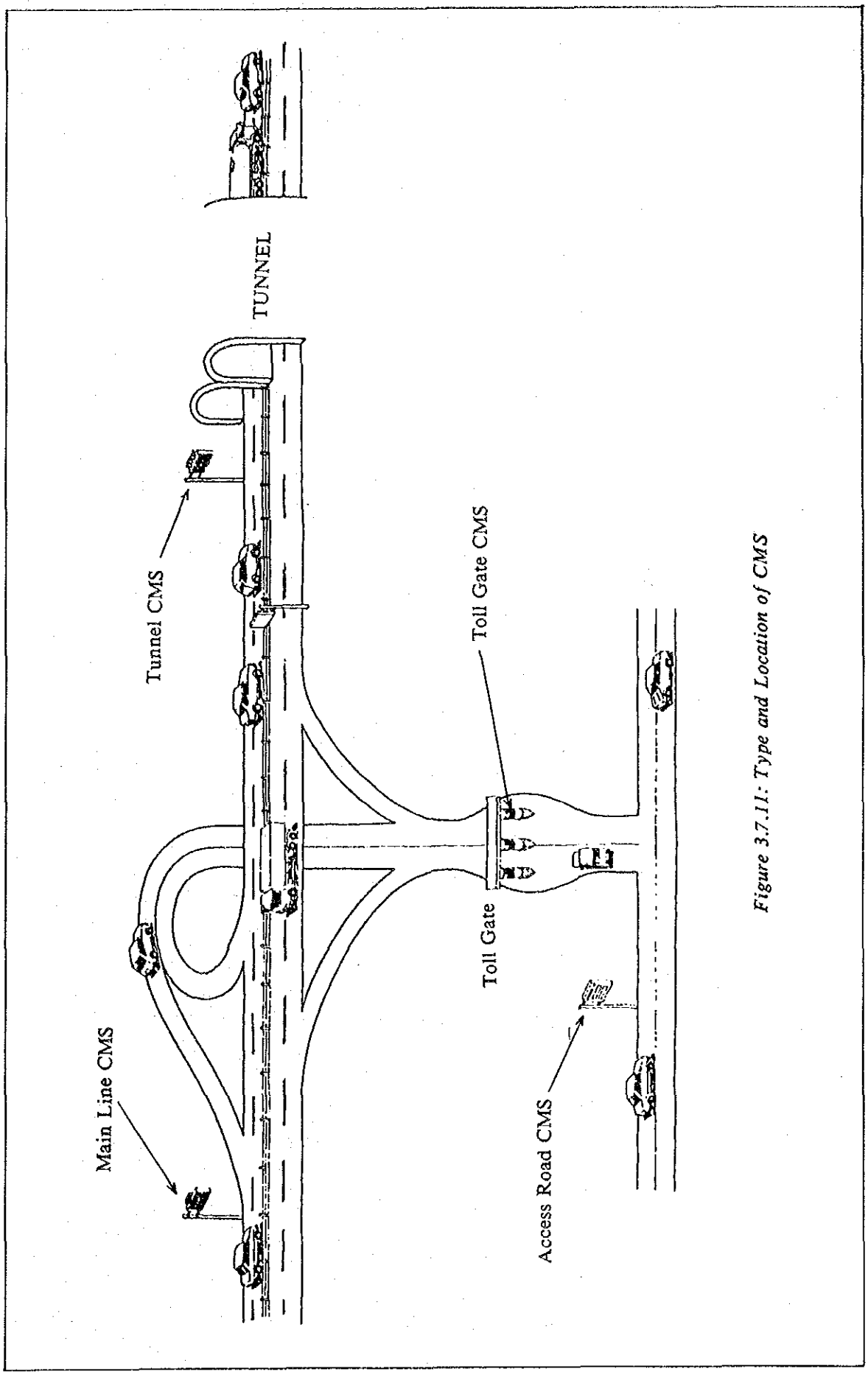
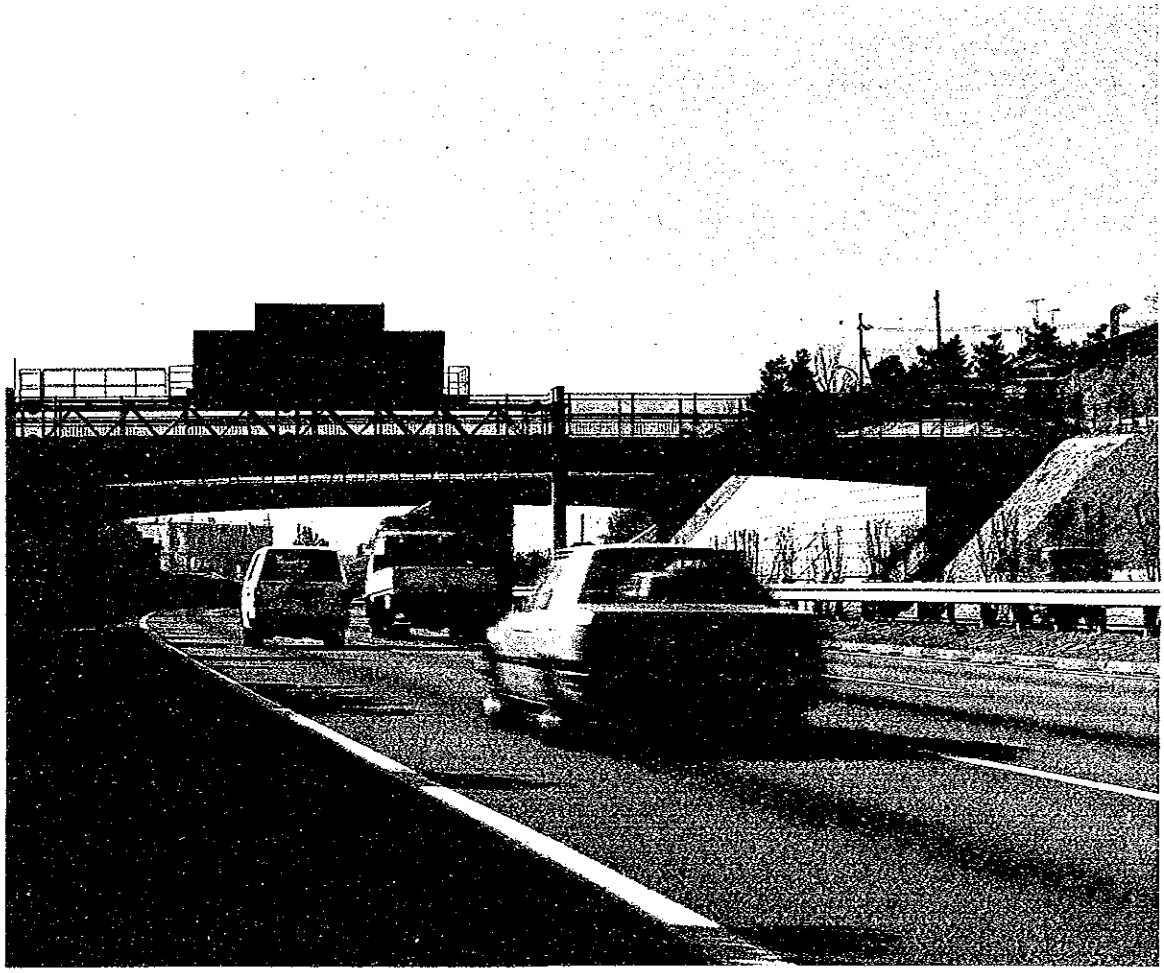
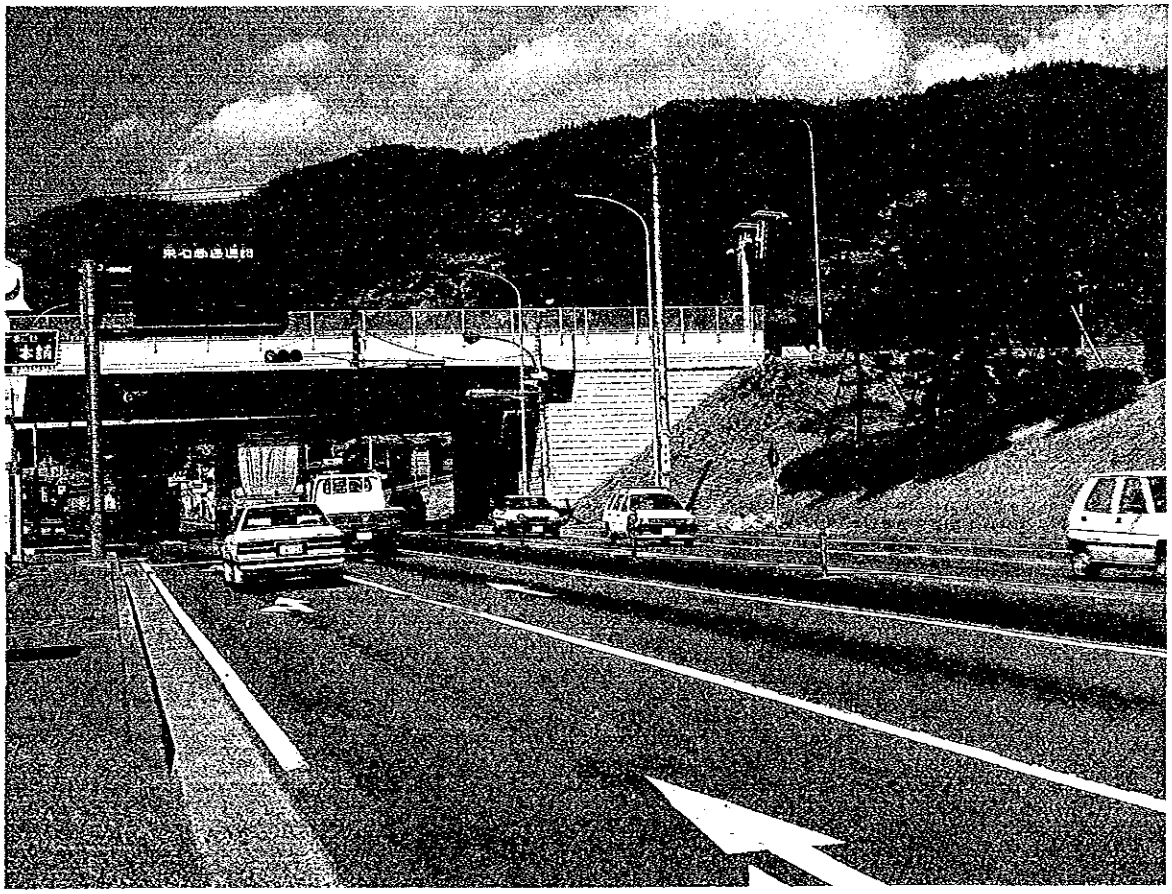


Figure 3.7.11: Type and Location of CMS



An Example of A Gantry Mounted Mainline CMS

"Wary of Rear Collision - Keep to Safe Headway"



An Example of An Overhanged Type of Access Road CMS

"Hatono-Yokohama: Congestion"

An Example of A Rotating Drum Type of Toll Gate CMS

Close-up View of A Toll Gate CMS
"Traffic Regulation: Shiozawa Ishiuchi - Muikamachi : Road Work"

(d) Tunnel CMS

- Tunnel CMS are exclusively installed at locations of 300 m from the entrance to tunnel on the expressway;
- Tunnel CMS are therefore aimed at giving warning on adverse traffic conditions that have occurred in the tunnel to on-coming vehicles. Messages such as "No Entry: Accident" or "No Entry : Fire" are given to stop on-coming vehicles in preventing any secondary accident;
- Because of their location, Tunnel CMS can also be used as an Intermediate CMS in giving information on sections beyond the tunnel;
- Tunnel CMS are activated at the tunnel traffic control centers established at the tunnel maintenance offices by the traffic management officers.

(2) Changeable Speed Limit Signs

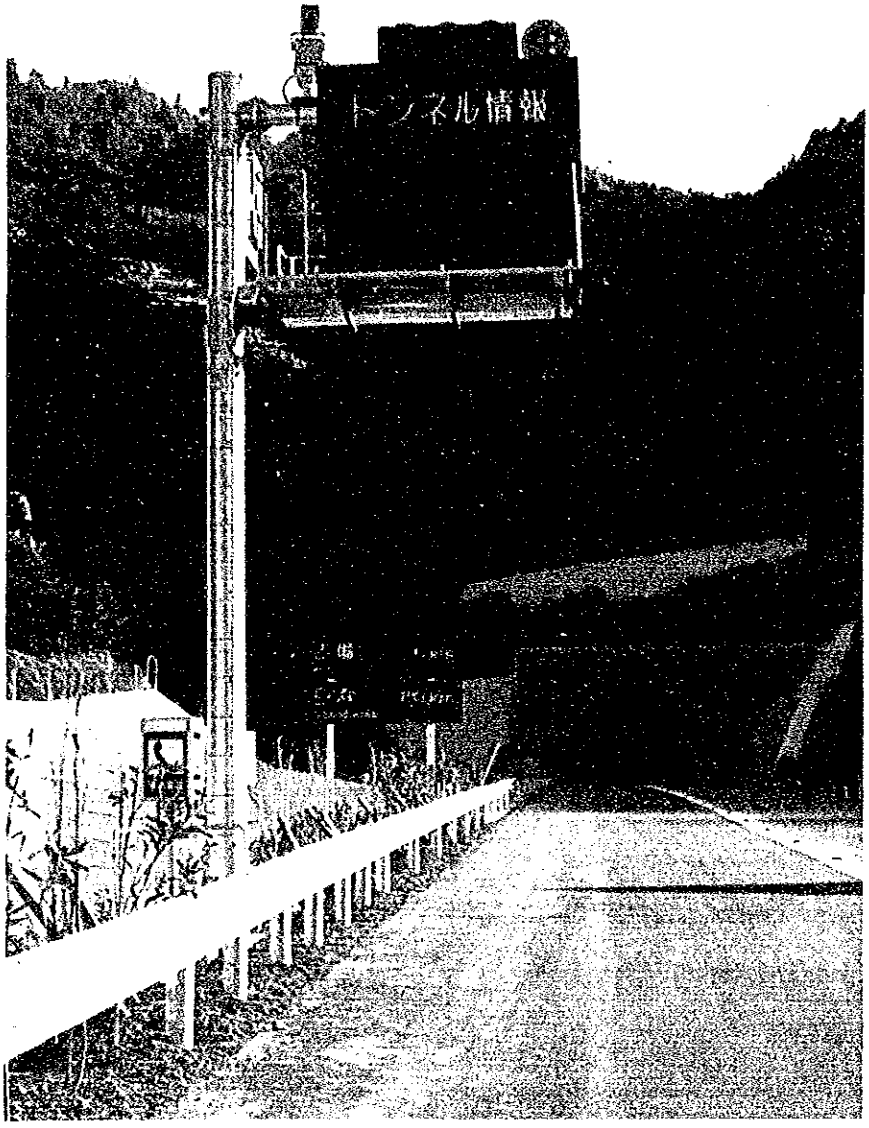
- Changeable speed limit signs are advisory signs aimed at regulating travel speed along dangerous sections of the highway, such as severe up and down slopes, winding sections, sections that are frequently affected by adverse weather conditions;

- Changeable speed limit signs are installed at regular intervals (every 2 km) along the section between Changkat Jering IC and Jelapang IC (45.9 km) on the North-south Expressway;

- When the speed limit of '50 km/hr' is in effect, such as due to heavy rain along certain mountainous section, all the changeable speed limit signs along that particular section will be simultaneously activated to advise drivers in reducing their travel speed;

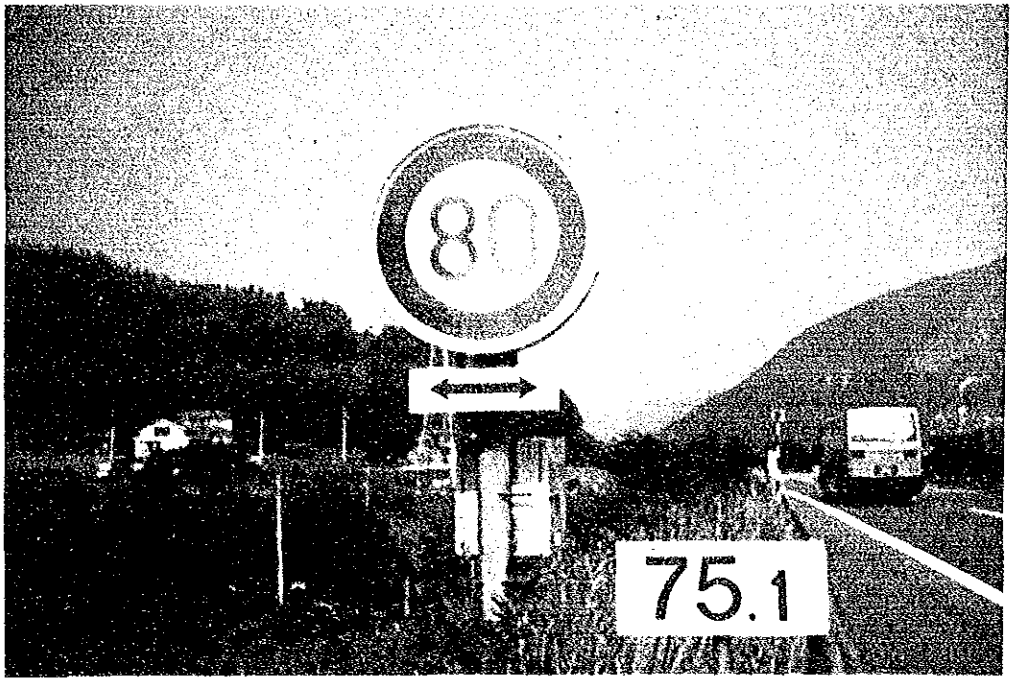
- In addition to the changeable speed limit sign, messages indicating such a speed limit regulation currently in effect shall also be displayed on Mainline CMS, Access Road CMS and Toll Gate CMS to warn on-coming drivers at the respective locations;

- Changeable speed limit signs are activated by traffic control officer from the traffic control center.

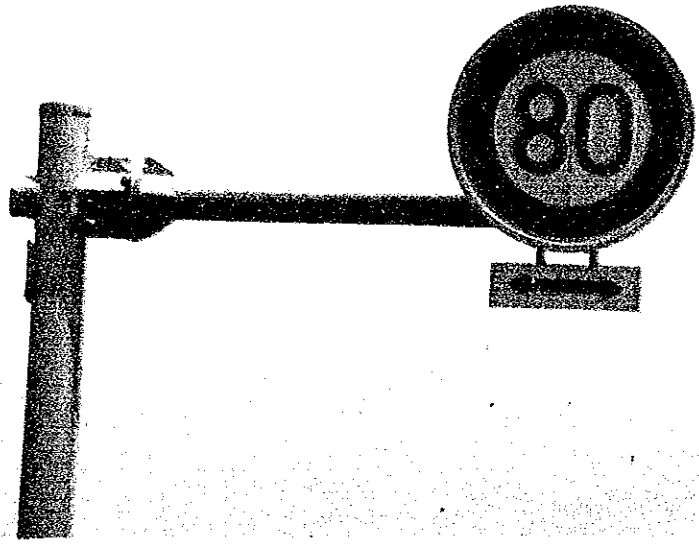


Courtesy of Japan Highway Public Corporation

An Example of A Tunnel CMS



Rotating Disk Type Changeable Speed Limit Sign



An Overhanged Type of Rotating Disk Changeable Speed Limit Sign

(3) Radio Broadcasting

Even though information on traffic and road conditions can be disseminated to the road users by means of changeable message signs, it is difficult to update the messages minute by minute. Information dissemination by means of radio broadcasting can be used to enhance this function by giving drivers who tune in to the specific frequency at certain fixed time, the latest traffic information on all sections and routes of the expressway network.

For this media of information dissemination, an exclusive traffic information center is established and attached to the radio broadcasting station to gather information and to broadcast them at specific allotted time.

(4) Highway Radio

Information dissemination by means of changeable message sign and radio broadcasting can be limited in terms of details and contents. For highway sections carrying large volume of traffic in the vicinity of large metropolitan area, for example, highway radio can be used to supplement traffic information given to the drivers.

Broadcasting units are installed at roadside along the identified sections, transmitting constantly updated details and extensive information to drivers at a specific frequency. Sign boards are installed several kilometers in advance to urge drivers to tune in to the specific frequency for the broadcast, e.g. "Tune to 567 khz for Traffic Information".

(5) Information Board/Counter at Service Area

Besides providing the necessary services such as fuel refilling, rest facilities, refreshment, etc. to road users, service area can be effectively used to provide information on traffic and road condition to road users.

Information counter or boards are set up at strategic points to attract attention of the service area visitors to these counters/boards. The counter staff must be able to provide information on the road and traffic condition as well as tourist information, recreation, etc. to visitors.

At important and large service area, panels' television or request-type terminals are installed to provide various information .

3.7.4 Information Display

(1) Methods in Displaying Traffic Information

Drivers need to be informed as to where an incident has occurred, what kind of incident and what precautions to take or what regulations that have been implemented by the traffic management personnel. The method in displaying such messages and where to display them depends on the type and seriousness of the incidents.

The three basic messages to be conveyed to drivers are:

(a) Nature of Incidents

eg.
* Traffic Accident
* Disaster
* Fire
* Adverse Weather Condition
* Traffic Congestion/Queue
* Breakdown
* Roadwork
* Fallen Object

(b) Location Where The Incident Has Occurred

eg.
* Alor Setar to Gurun Section
* Bukit Tempurung Tunnel
* 5 km Ahead
* Ayer Keroh Service Area

(c) Caution, Traffic Regulation, Instruction

eg. * Caution
* Type of Traffic Regulation Imposed (eg. Left Lane Closed)
* Travel Instructions (eg. Exit Here)

The appropriate message to be conveyed to drivers depends on the contents and level (seriousness) of the incident in question. Examples of such messages by type of incidents are indicated below. Messages displayed to warn drivers of accident ahead may vary from "Caution" for minor accident to "Road Closure" for major accident.

Type of Incident	Caution, Traffic Regulation and Instruction	Location
Disaster	* Road Closed	* Section * oo km Ahead
Fire	* No Entry (Tunnel) * Road Closed	"
Traffic Accident	* Caution * Two way Traffic * Road Closed	"
Adverse Weather Condition	* Caution * Speed Limit * Road Closed	"
Traffic Congestion	* Caution	"
Breakdown	* Caution	"
Roadwork	* Caution * Lane Control * Two-way Traffic * Road Closed	"
Fallen Object/ Spill Load	* Caution * Lane Control * Road Closed	"

(2) Contents of Message

The contents of the three category of messages, namely "Nature of Incident", "Regulation and Instruction" and "Location" are listed below.

(a) Nature of Incidents

* Disaster
* Fire
* Traffic Accident
* Roadwork
* Fallen Object/Spill Load
* Breakdown Vehicle
* Rain
* Wind
* Fog
* Animal

(b) Caution, Traffic Regulation and Instruction

(i) Instruction Messages

* Exit Here
* Reduce Speed
* No Entry
* Keep Right
* Keep Left

(ii) Traffic Regulation Messages

* Road Closed
* Left-lane Closed
* Right-lane Closed
* Two-way Traffic
* 50 kph Speed Limit
* 80 kph Speed Limit

(iii) Caution Messages

* Caution
* Slippery Road
* Congestion

(c) Location

* oo - oo Section
* Near oo
* oo SA
* oo PA
* Northbound
* Southbound
* Eastbound
* Westbound
* Ahead
* 5 km Ahead
* 10 km Ahead
* 15 km Ahead
* oo Ahead

The abbreviations of interchanges used to define "oo - oo Section" are given below. All interchange names have to be abbreviated to within an average of 8-12 alphabets to allow the display of two names within the maximum 24 alphabets.

NO.	INTERCHANGE NAME	ABBREVIATION	
1.	Bukit Kayu Hitam	BKT. K.HITAM	11
2.	Jitra	JITRA	5
3.	Darul Aman	DRL AMAN	8
4.	Kepala Batas	KP BATAS	8
5.	Alor Setar Utara	A SETAR U	9
6.	Alor Setar Selatan	A SETAR S	9
7.	Gurun	GURUN	5
8.	Sungai Petani Utara	SG PETANI U	11
9.	Sungai Petani Selatan	SG PETANI S	11
10.	Butterworth	B'WORTH	7
11.	East West Highway	E-W HWY	7
12.	Bukit Tengah	BKT TENGAH	10
13.	Bukit Tambun	BKT TAMBUN	10
14.	Jawi	JAWI	4
15.	Bandar Baru	BANDAR BARU	11
16.	Alor Pongsu	ALOR PONGSU	11
17.	Taiping	TAIPING	7
18.	Changkat Jering	CT JERING	9

19.	Kuala Kangsar	K KANGSAR	9
20.	Jelapang	JELAPANG	8
21.	Ipoh Utara	IPOH U	6
22.	Ipoh Selatan	IPOH S	6
23.	Simpang Pulai	SMP PULAI	9
24.	Gopeng	GOPENG	6
25.	Tapah	TAPAH	5
26.	Bidor	BIDOR	5
27.	Sungkai	SUNGKAI	7
28.	Slim River	SLIM RIVER	10
29.	Benarang	BENARANG	8
30.	Tanjong Malim	TJ MALIM	8
31.	Rawang	RAWANG	6
32.	Sungai Buloh	SG BULOH	8
33.	Bukit Lanjan	BKT LANJAN	10
34.	Salak Selatan	SALAK S	7
35.	University Pertanian Malaysia	UPM	3
36.	Kajang	KAJANG	6
37.	Bangi	BANGI	5
38.	Nilai	NILAI	5
39.	Seremban Utara	SEREMBAN U	10
40.	Port Dickson	P DICKSON	9
41.	Senawang	SENAWANG	8
42.	Pedas Linggi	PEDAS LINGGI	11
43.	Simpang Ampat	SMP AMPAT	9
44.	Ayer Keroh	AYER KEROH	10
45.	Tangkak	TANGKAK	7
46.	Pagoh	PAGOH	5
47.	Yong Peng South	Y PENG S	8
48.	Yong Peng East	Y PENG T	8
49.	Air Hitam	AIR HITAM	
50.	Machap	MACHAP	6
51.	Simpang Renggam	SMP RENGGAM	11
52.	Sedenak	SEDENAK	7
53.	Kulai	KULAI	5
54.	Skudai	SKUDAI	6
55.	Kempas	KEMPAS	6
56.	Port Access Road	PORT ACCESS	11
57.	Kota Tinggi Road	KOTA TINGGI	11

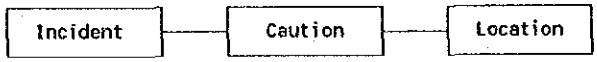
(3) Display Format

The Changeable Message Sign (CMS) display format differs slightly according to the message contents and CMS type and location. The sequence of messages for each of the three types of display are given below.

(a) Instruction-type Messages

(b) Traffic Regulation-type Messages

(c) Caution-type Messages



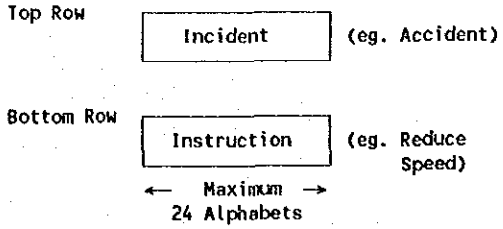
All displays on CMS are organized into two rows, each with a maximum capacity of 24 alphabets. For instruction-type messages, therefore, the "incident" is displayed on the top row and the "instruction" on the bottom row.

For the other two types of messages, there is an added information of "Location". As such, the top row will display the "Incident" AND "Caution" or "Traffic Regulation" while the bottom row is to display the message on "Location". These are further illustrated below.

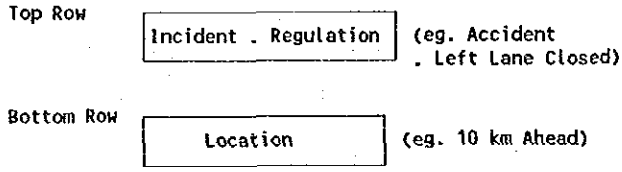
(i) Mainline CMS

Mainline CMS are aimed at providing traffic information to users travelling on the mainline. All the three types of messages are used.

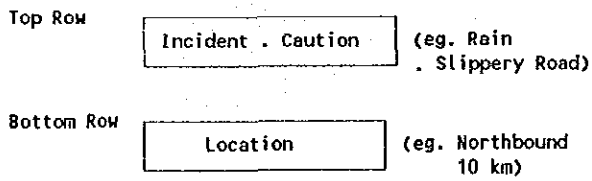
(a) Instruction-type Messages



(b) Traffic Regulation-type Messages



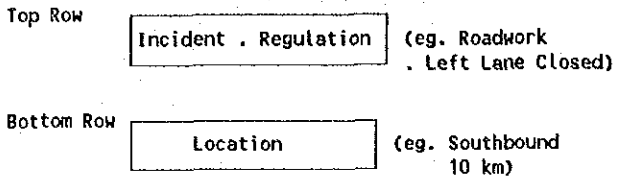
(c) Caution-type Messages



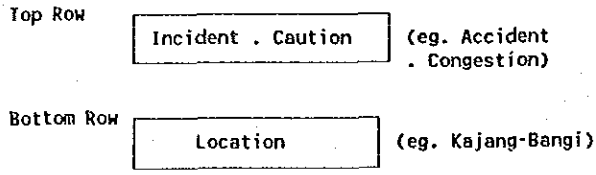
(ii) Access Road CMS

Access Road CMS is used to provide highway traffic information to potential users. Instruction-type messages are therefore not applicable here. Access Road CMS are to display traffic regulation type and caution-type messages.

(a) Traffic Regulation-type Messages



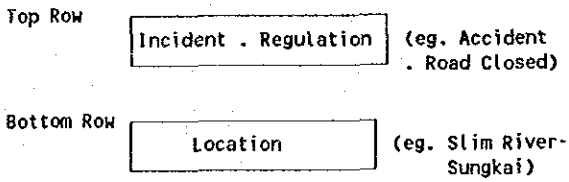
(b) Caution-type Messages



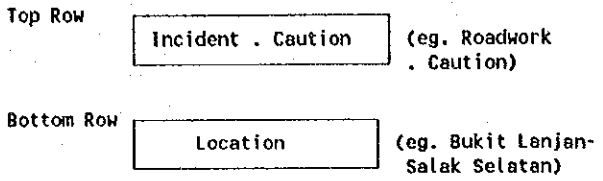
(iii) Toll Gate CMS

Toll gate CMS are to provide highway traffic information to users at the start of their journey, i.e. as they enter the highway through the tollgate. Instruction-type messages are also not applicable here.

(a) Traffic Regulation-type Messages



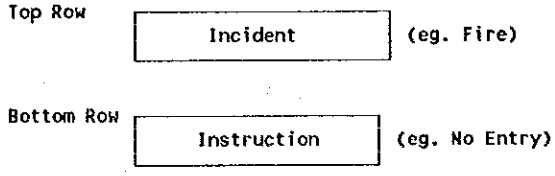
(b) Caution-type Messages



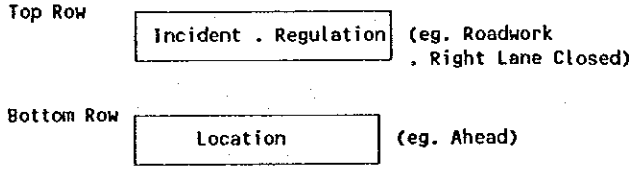
(iv) Tunnel CMS

Tunnel CMS is actually a sub-category of Mainline CMS where all three types of messages are applicable.

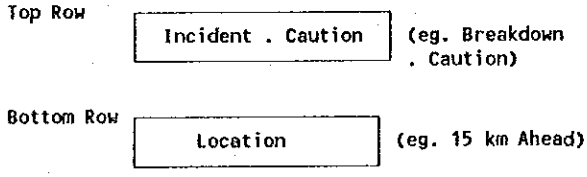
(a) Instruction-type Messages



(b) Traffic Regulation-type Messages



(c) Caution-type Messages



(4) Priority Ranking of Messages

(a) Mainline CMS

When several incidents occur simultaneously along a certain section of the highway, it is not advisable to try to display all the incidents on the message boards. Such a practice will confuse the road users. Instead, the highest priority message should be selected according to the ranking as given below:

Nature of Incident	Rank	Examples of Display Messages	Remarks
Section closed to traffic	1	"Accident, Exit Here"	IC before closure point "Exit Here"
Traffic accident Fire, Disaster	2	"Accident, Caution oo km Ahead" "Fire, Caution oo km Ahead" "Land-slip, Caution oo km Ahead"	
Fallen object on Carriageway Break-down vehicle	3	"Fallen Object, Caution oo km Ahead" "Break-down Vehicle, Caution, oo km Ahead"	
Congestion	4	"Accident, Congestion oo km Ahead"	
Civil Works	5	"Work in Progress, Left Lane Closed oo km Ahead"	
Slow moving vehicle Carrying out work	6	"Slow Moving Vehicle, Caution oo km Ahead"	
Speed Limit Regulation	7	"Accident, Keep to 50 kph, oo km Ahead"	
Fog	8	"Fog, Caution, oo km Ahead	(Upgrade to rank 7 when condition worsens)
Strong Wind	9	"Strong Cross Wind, Caution, oo km Ahead"	(Upgrade to rank 7 when condition worsens)
Rain	10	"Heavy Rain, Caution, oo km Ahead"	(Upgrade to rank 7 when condition worsens)
General information	11	"Road to oooo Closed"	

The message "oo km ahead" is given in 5 km , 10 km, 15 km, upstream from the location of incident so as to provide ample warnings. For the cases of accident and heavy rain, it is also desirable that the location defined by the section, eg. "Kajang-Bangi" be given to drivers.

(b) Access Road CMS

Since Access Road CMS is aimed at giving information to drivers who intend to use the highway, the priority ranking of messages is somehow different. Information on Access Road CMS must be given according to the following priority:

Incident	Priority Ranking	Example of Display Messages
Section closed	1	"Incident, Section Closed, Southbound 10 km"
Congestion	2	"Congestion, Caution, Northbound"
50 kph Speed Limit	3	"Fog, 50 kph Speed Limit, Southbound"
80 kph Speed Limit	4	"Rain, 80 kph speed limit Southbound 10 km"
Lane Control	5	"Accident, One Lane Closed, Northbound"

(c) Toll Gate CMS and Tunnel CMS

The ranking for Toll Gate CMS and Tunnel CMS follow those for the Mainline CMS in (a).

(5) Display Messages According to Weather Conditions

Messages given to warn drivers of adverse weather conditions varies according to the actual seriousness of rain, wind or other phenomena. Examples of these messages in relation to weather conditions are given below.

Phenomena	Conditions	Messages			
		Caution	80 kph Speed Limit	50 kph Speed Limit	Section Closed
Rain	Rain has started	•			
	Raining at about 20 mm/hr or more	•			
	Continuous rainfall for 8 hours reaches 110 mm or more		•		
	Continuous rainfall for 8 hours reaches 150 mm or more			•	
	Continuous rainfall for 8 hours reaches 200 mm or more (or 25 mm/hr)				•
Strong Cross Wind	Reports on influence of safe driving by strong wind	•			
	Wind velocity 5.0 - 8.0 m/sec		•		
	Wind velocity 10.0 - 15.0 m/sec			•	
	Wind velocity 20.0 m/sec or more				•
Fog	Fog has started	•			
	Visibility 400 m	•	•		
	Visibility 100 m			•	
	Visibility 50 m				•

3.7.5 Display of Changeable Speed Limit Signs

As described in the earlier section, changeable speed limit signs are installed along sections with severe vertical or horizontal alignment, mountainous areas and areas subject to frequent adverse weather conditions.

According to the seriousness, travel speed on the highway should be lowered from the gazetted speed of 110 kph on the motorway to 80 kph or 50 kph to ensure traffic safety.

The changeable speed limit signs are designed to have two step-down displays, i.e. 80 kph and 50 kph for those on motorway. For expressways or Karak Highway where the gazetted speed limit is 80 kph, changeable speed limit sign should have one step down display of 50 kph.

When no speed limit regulation is needed, i.e. under normal circumstances, changeable speed limit signs must be left 'blank', that is, they must not be used to display the gazetted speed limit like a normal speed limit sign.

3.7.6 Display Messages on Changeable Message Signs

All messages on the changeable message signs are displayed using the national language. In general, messages have to be as short as possible because long messages require longer reading time and such long lapse of time where drivers' concentration are diverted from the wheels is dangerous.

The actual wordings in examples of all the three types of messages are given below. Similar to the abbreviation of interchange names, abbreviations such as "JLN" for "JALAN" or "LRG" for "LORONG" or "BAHAN JATUH" instead of "BAHAN TERJATUH" are used in order to fit the messages within the maximum 24 alphabets on each row. Each of the messages has to be limited to within an average of 8 to 11 alphabets.

(1) Mainline CMS

(a) Instruction-type Messages

This type of message is made up of "incident" on the top row and "Instruction" on the bottom row.

(i) Top Row Message: "Incident"

		1 5 10 15 20 24
1	"Blank"	
2	Disaster	BENCANA
3	Fire	KEBAKARAN
4	Accident	KEMALANGAN
5	Roadwork	PEMBINAAN
6	Fallen Object	BAHAN JATUH
7	Breakdown	KERETA ROSAK
8	Rain	HUJAN
9	Wind	ANGIN
10	Fog	KABUS
11	Animal	BINATANG

(ii) Bottom Row Message: "Instruction"

		1 5 10 15 20 24
1	"Blank"	
2	Exit Here	KELUAR DI SINI
3	Reduce Speed	KURANGKAN LAJU
4	Keep Right	IKUT KANAN
5	Keep Left	IKUT KIRI

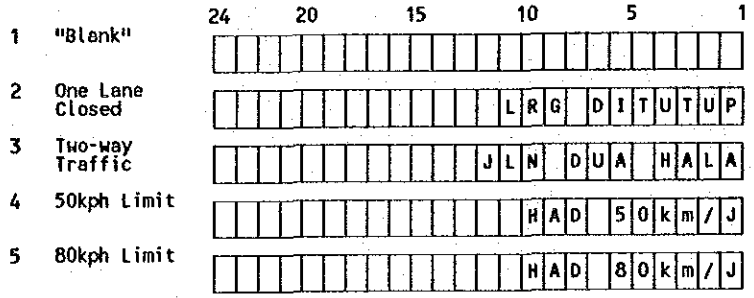
(b) Traffic Regulation-type Messages

The top row of this type of message is displayed with the "Accident" on the left and "Regulation" on the right. The bottom row is to display the "location" only.

(i) Top Row Messages

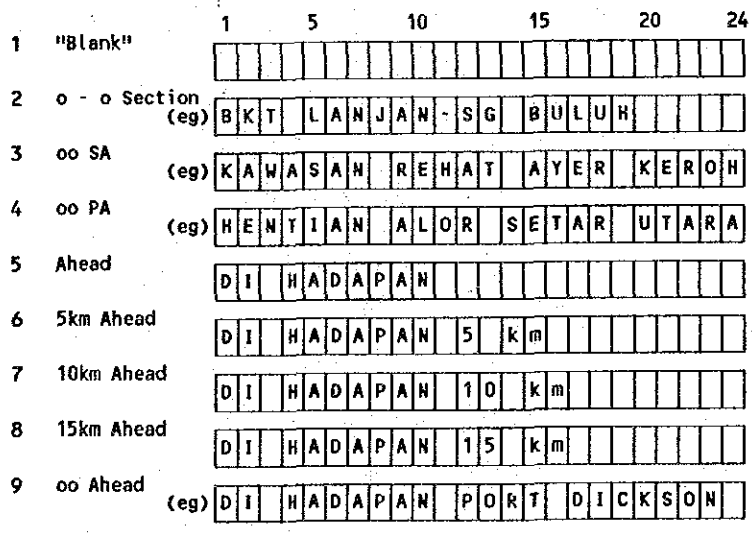
Top-Left Message: "Incident"
As in (a) (i)

Top-Right Message: "Regulation"



(c) Bottom Row Message: "Location"

The display of "location" may utilize the full length of the bottom row, i.e. 24 alphabets. All the interchange names have been abbreviated to about 11 alphabets or less to fit (see Section 3.7.3).



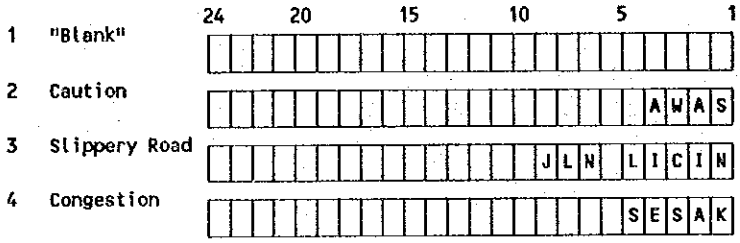
(d) Caution-type Messages

Similar to the Traffic Regulation Type Messages, the top row has to display two messages, "Incident" and "Caution". The bottom row is to display the location.

(i) Top Row Messages

Top-Left Message: "Incident"
As in (a)(i)

Top-Right Message: "Caution"



(ii) Bottom Row Message: "Location"

As in (b) (ii)

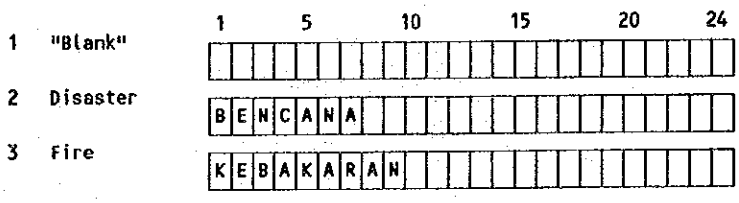
(2) Access Road CMS

(a) Traffic Regulation Type Messages

Similar to those for Mainline CMS, the top row is to display "incident" and "regulations" while the bottom row is to display "locations".

(i) Top Row Messages

Top Left Message "Incident"



4	Accident	KEMALANGAN
5	Roadwork	PEMBINAAN
6	Rain	HUJAN
7	Fog	KABUS

Top-Right Message: "Regulation"

		24 20 15 10 5 1
1	"Blank"	
2	Road Closed	JLN DITUTUP
3	One Lane Closed	LRG DITUTUP
4	Two-way Traffic	JLN DUA HALA
5	50kph Limit	HAD 50km/J
6	80kph Limit	HAD 80km/J

(ii) Bottom Row Message - "Location"

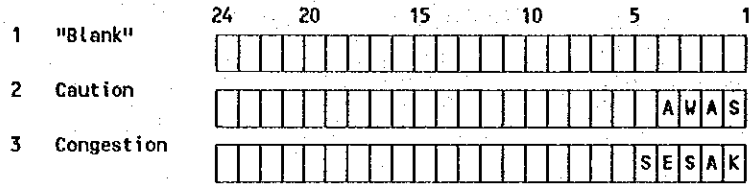
		1 5 10 15 20 24
1	"Blank"	
2	o - o Section (eg)	BKT LANJAN-SG BULUH
3	Northbound o km	DI ARAH UTARA 5 km
4	Southbound o km	DI ARAH SELATAN 10 km
5	oo Ahead	DI HADAPAN PORT DICKSON

(b) Caution-type Messages

(i) Top Row Messages

Top-Left Message: "Incident"
As in (a)(i)

Top-Right Message: "Caution"



(ii) Bottom Row Message: "Location"

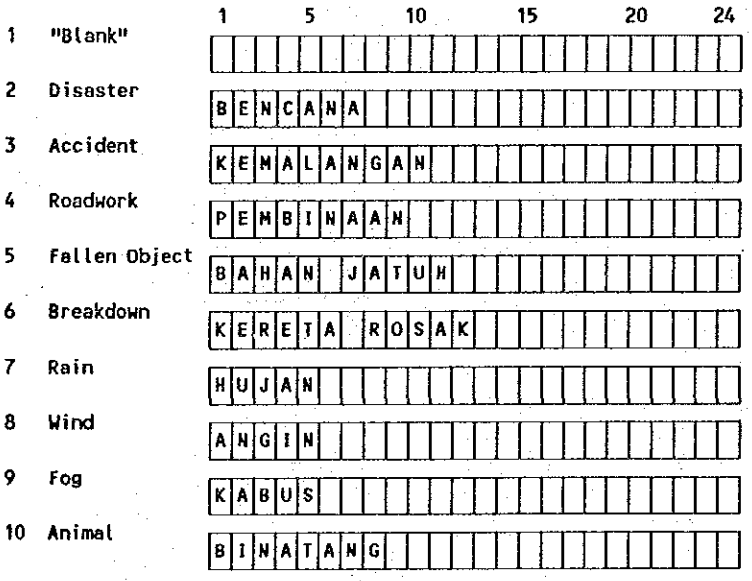
As in (a) (ii)

(3) Toll Gate CMS

(a) Traffic Regulation Type Messages

(i) Top Row Messages

Top Left Message "Incident"



Top-Right Message: "Regulation"

		24 20 15 10 5 1
1	"Blank"	
2	No Entry	DI LARANG MASUK
3	One Lane Closed	LRG DITUTUP
4	Two-way Traffic	JLN DUA HALA
5	50kph Limit	HAD 50km/J
6	80kph Limit	HAD 80km/J

(ii) Bottom Row Message: "Location"

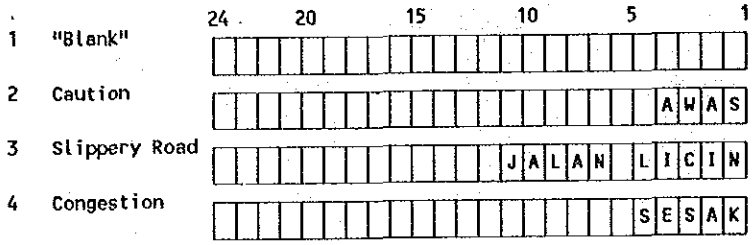
		1 5 10 15 20 24
1	"Blank"	
2	o - o Section (eg)	BKT LANJAN-SG BULUH
3	Northbound o km	DI ARAH UTARA 5 km
4	Southbound o km	DI ARAH SELATAN 10 km
5	oo Ahead	DI HADAPAN PORT DICKSON

(b) Caution-type Messages

(i) Top Row Messages

Top-Left Message: "Incident"
As in (a)(i)

Top-Right Message: "Caution"



(ii) Bottom Row Message: "Location"

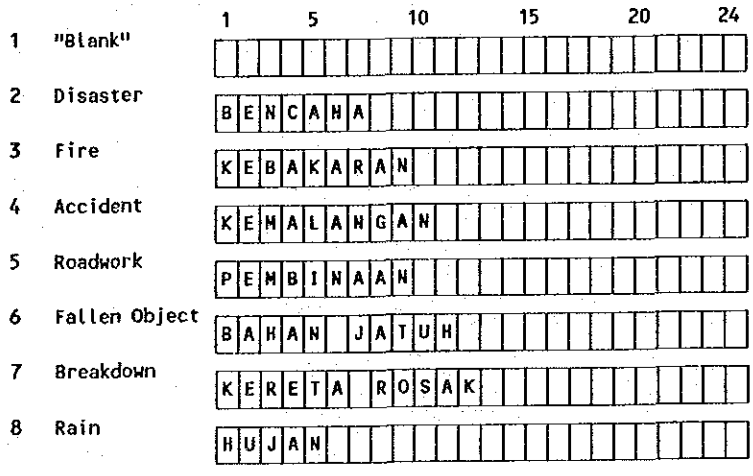
Similar to those used for Access Road CMS.

(4) Tunnel CMS

Messages to be displayed in Tunnel CMS are basically similar to those for the Mainline CMS except for a few instructive messages.

(a) Instruction Type Messages

(i) Top Row Message: "Incident"



9	Wind	ANGIN
10	Fog	KABUS
11	Animal	BINATANG

(ii) Bottom Row Message: "Instruction"

		1 5 10 15 20 24
1	"Blank"	
2	No Entry	DI LARANG MASUK
3	Reduce Speed	KURANGKAN LAJU
4	Keep Right	IKUT KANAN
5	Keep Left	IKUT KIRI

(b) Traffic Regulation-type Messages

(i) Top Row Message: "Incident" and "Regulation"

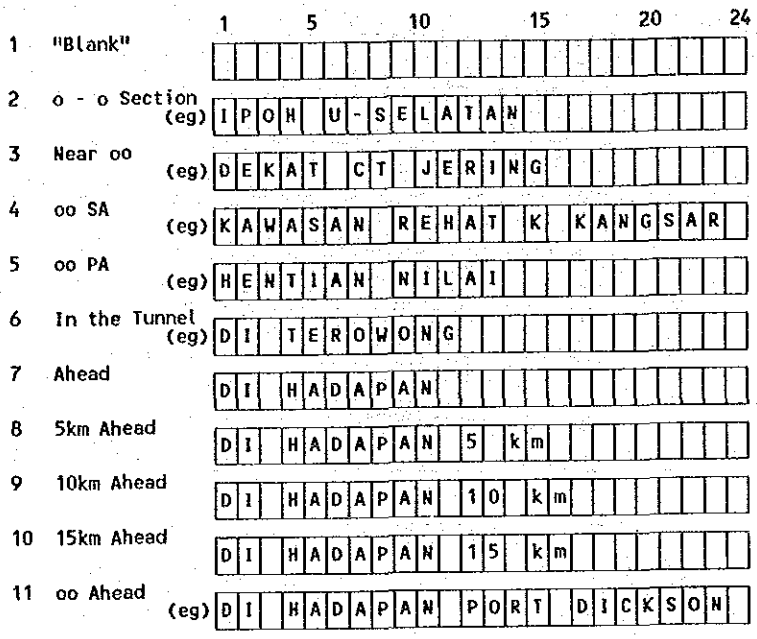
Top-Left Message: "Incident"
As in Mainline CMS

Top-Right Message: "Regulation"

		24 20 15 10 5 1
1	"Blank"	
2	One Lane Closed	LRG DITUTUP
3	Two-way Traffic	JLN DUA HALA
4	50kph Limit	HAD 50km/J
5	80kph Limit	HAD 80km/J

(c) Bottom Row Message: "Location"

Tunnel CMS is used not merely to give traffic and road information within the tunnel but also as an Intermediate CMS, giving information on highway section just beyond the tunnel for example.

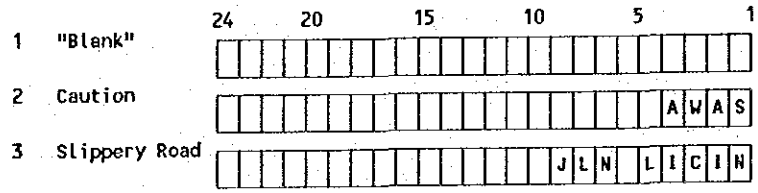


(c) Caution-type Messages

(i) Top Row Messages: "Incident" and "Caution"

Top-Left Message: "Incident"
As in Mainline CMS

Top-Right Message: "Caution"

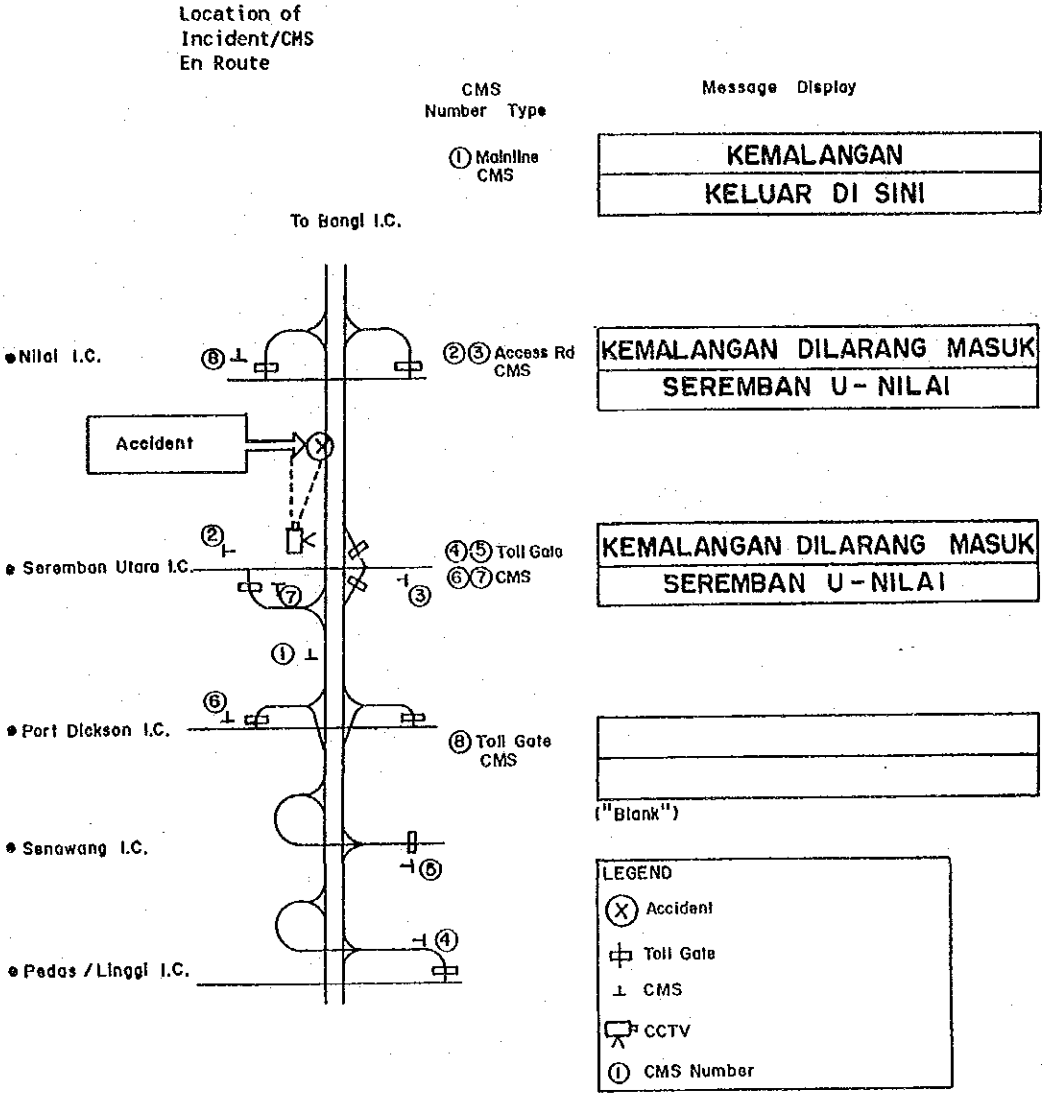


(ii) Bottom Row Message: "Location"

As in (b) (ii)

(5) Sample of Message Display in CMS

Messages less than 24 alphabets when employed will be centralized on the CMS. An example of how the CMS displays will look like if a major accident near Nilai has occurred that requires the temporary closure of the highway section is illustrated below:



3.8 Statistical Data Processing and Its Management

3.8.1 General

3.8.2 Traffic Volume and Related Data
(1) Importance of Traffic Statistics
(2) Traffic Related Data Required

3.8.3 Highway Accident Data
(1) General
(2) Accident Statistics

3.8.4 Breakdown
(1) General
(2) Statistics on Breakdown

3.8.5 Obstacles on Road Surface
(1) General
(2) Statistics on Obstacles

3.8.6 Traffic Regulation During Road Works
(1) General
(2) Statistics on Traffic Regulation During Road Works

3.8.7 Traffic Congestion and Road Closure
(1) General
(2) Statistics on Traffic Congestion and Road Closure

3.8.8 Weather and Disaster
(1) General
(2) Statistics on Weather and Disaster

3.8.9 Publication
(1) Annual Traffic Statistical Report
(2) Annual Traffic Control and Management Statistical Report

3.8 Statistical Data Processing and Its Management

3.8.1 General

Various data are needed for the planning of traffic operation, improvement works and the management activities on the expressways. Some of the basic data required can be listed as:

a) Traffic volume and related data,
b) Traffic accident data,
c) Vehicle breakdown/incident records,
d) Obstacles records
e) Weather data,
f) Adverse weather and disaster records,
g) Traffic regulation records,
h) Traffic congestion/road closure records.

These basic data are collected by each maintenance office in the form of output from terminal equipment or daily activity records (patrolling records, incident records, etc.). These data are then forwarded to the respective regional office for compilation and statistical processing. The processed data from each regional office are then in turn forwarded to the headquarters to be used for planning and decision making and to be published into monthly and annual bulletins.

3.8.2 Traffic Volume and Related Data

(1) Importance of Traffic Statistics

Traffic volume data is one of the most fundamental and indispensable data needed for traffic management. Its use is not limited just to the planning of daily traffic control and management measures but are also essential for the setting of standards in devising traffic safety measures, anti-disaster measures, emergency traffic control regulations and others.

Depending on the objectives of usage, different format in data analysis is to be adopted. Generally, all traffic data are aggregated in units of one hour and above.

Vehicle running speed is another much needed statistics for the planning of traffic safety measures. Running speed, particularly that of heavy trucks must be monitored to avoid large speed differences on the highway. Vehicle running speed is also used as a traffic congestion indicator when monitoring traffic flow on the highway.

(2) Traffic Related Data Required

(a) *Annual Average Daily Traffic (AADT)*

Daily traffic volume generated by vehicle detectors installed at representative spots along sections between each two interchanges throughout the entire highway network are to be processed into an annual average figure in unit of vehicles as well as PCU. This sectional AADT forms the very basic traffic data required for comparing level of highway usage between sections as well as for traffic volume projections, for determining the traffic management level of each section and hence the types of equipment or facilities needed to meet the traffic demand.

(b) Entry and Exit AADT at Each Interchange

These data are collected by vehicle detectors installed on the off-ramp and on-ramp of each interchange. Similar to (a), they are to be processed into AADT format in analyzing the annual changes of such traffic. These data are essential, for example, in planning interchange improvement schemes.

(c) Monthly Average Daily Traffic (MADT)

The analysis of average daily sectional traffic volume by each calendar month enables traffic management officer to pin-point suitable time period when traffic is at its lowest for carrying out maintenance and repair works so as to minimize their effects on traffic flow. Months having very high traffic demand (such as during major festive seasons) on the other hand may warrant careful personnel scheduling to respond to the likely higher occurrence of incidents.

(d) Entry and Exit Monthly Average Daily Traffic at Interchanges

For similar usage and reasons to the above, the entry and exit daily traffic volume at each interchange is analyzed by monthly average to display the monthly fluctuation of traffic demand.

(e) Daily Maximum and Minimum Traffic

The daily traffic volume over a year for each section are arranged in descending order to reveal the daily maximum and minimum traffic and their occurring dates.

(f) Entry and Exit Daily Maximum and Minimum Traffic at Interchange

Similarly, the daily entry and exit traffic at each interchange is arranged in descending order to obtain the maximum and minimum traffic and their date of occurrence.

(g) Weekly and Monthly Traffic Volume Indices

The weekly traffic volume index for each section is to reveal the average daily traffic variation by day of the week and is obtained by:

$$\frac{\text{Average Daily Traffic Volume by Day of Week}}{\text{Weekly Average Daily Traffic Volume}}$$

Similarly, the monthly traffic volume index is to display monthly traffic variation from the average monthly traffic volume.

$$\frac{\text{Average Daily Traffic Volume by Month}}{\text{Annual Average Daily Traffic Volume}}$$

These indices are useful in analyzing the traffic volume variations along sections of the highway.

(h) Daily Traffic Volume Indices

The daily traffic volume over a year for each section is arranged in descending order as described in (e).

These volumes are then divided by the AADT to obtain the indices.

(i) Traffic Volume by Vehicle Type

Traffic volume data breakdown by vehicle type can be obtained from the following three sources:

* Traffic Census Data
* Vehicle Detector Data
* Toll Unit Data

Data from these sources, however, may differ in their vehicle classification due to their respective needs. Their aggregate and analysis have to be carried out respectively.

(i) Traffic Census Data

Traffic census as carried out by HPU has classified vehicles into six categories, namely:

* Car and Taxi
* Light Van
* Medium Lorry
* Heavy Lorry
* Bus
* Motorcycle

(ii) Vehicle Detector Data

Vehicles are basically classified into "large vehicles" and "small vehicles" by the detector. Motorcycles are not counted.

(iii) Toll Unit Data

Vehicle classification at toll plazas is done using the number of axles and wheels:

* 2 axle with 3 wheels or 4 wheels
* 2 axles with 5 or 6 wheels
* 3 axles and above
* Taxi
* Bus
* Motorcycle (depending on route)

(j) IC Pair Traffic Volume

Using the toll coupon that shows the entry and exit point, traffic volume by vehicle type between IC pairs can be aggregated. This data is useful in understanding trip length, trip behavior on the highway and therefore useful for planning of future highway network or routes.

(k) Weekday and Weekend Hourly Traffic Volume

Using data collected by vehicle detector, traffic is analyzed in terms of the average weekday and weekend hourly traffic volume. This data is to show hourly fluctuation of traffic both on weekdays and on weekends.

(l) Running Speed at Selected Spots

Using vehicle detectors installed at selected spots, data on running speed of vehicles are obtained and analyzed into speed distribution curves.

Some examples of traffic volume and related data analysis are given below.

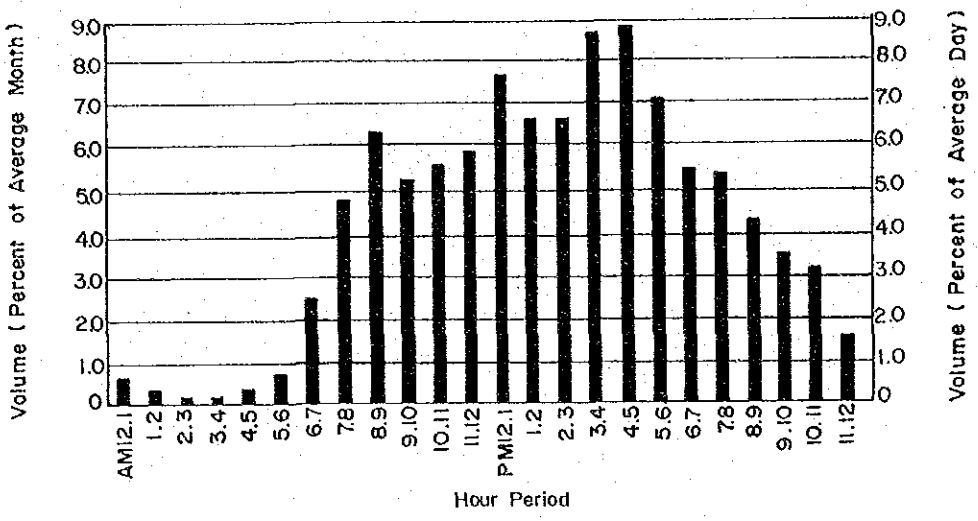


Figure 3.8.1: An Example of Hourly Traffic Variation Pattern

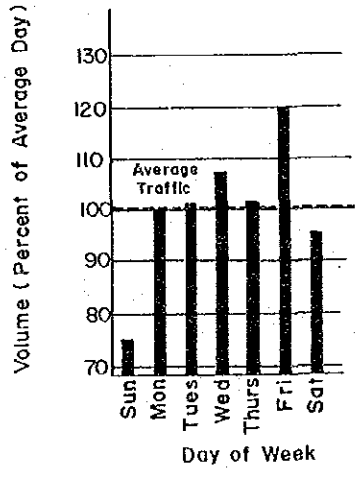


Figure 3.8.2: An Example of Daily Traffic Variation Pattern

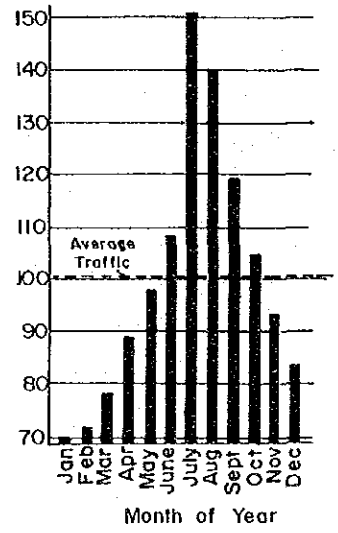


Figure 3.8.3: An Example of Monthly Traffic Variation Pattern

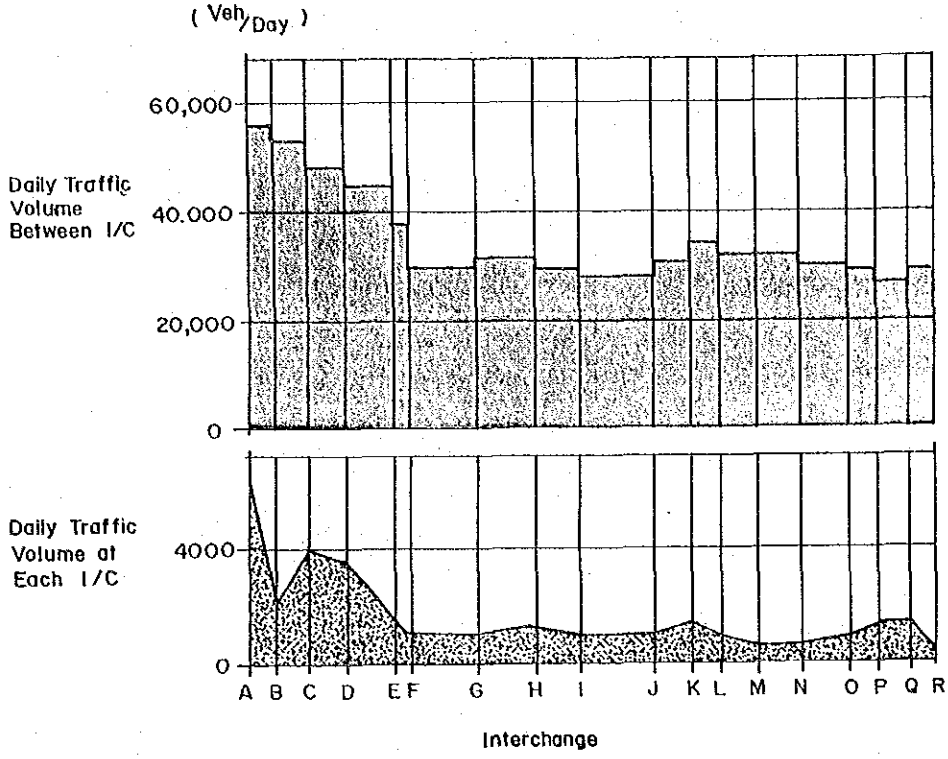


Figure 3.8.4: Examples of Daily Traffic Volume Variations between IC and At IC

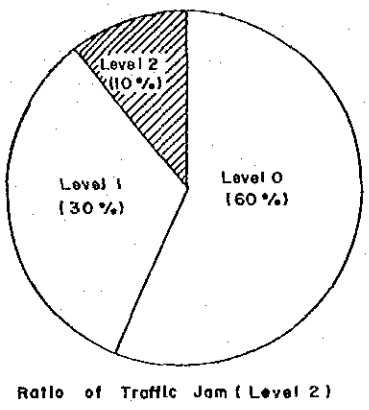


Figure 3.8.5: An Example of Traffic Jam Analysis

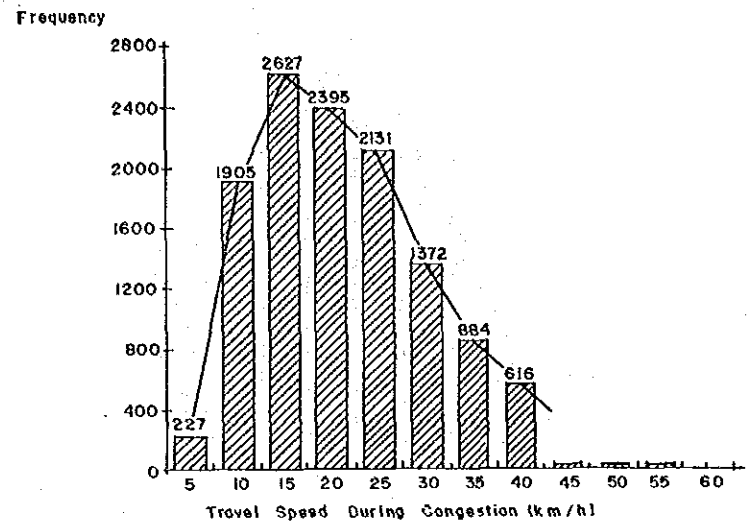


Figure 3.8.6: An Example of Traffic Congestion Speed Analysis

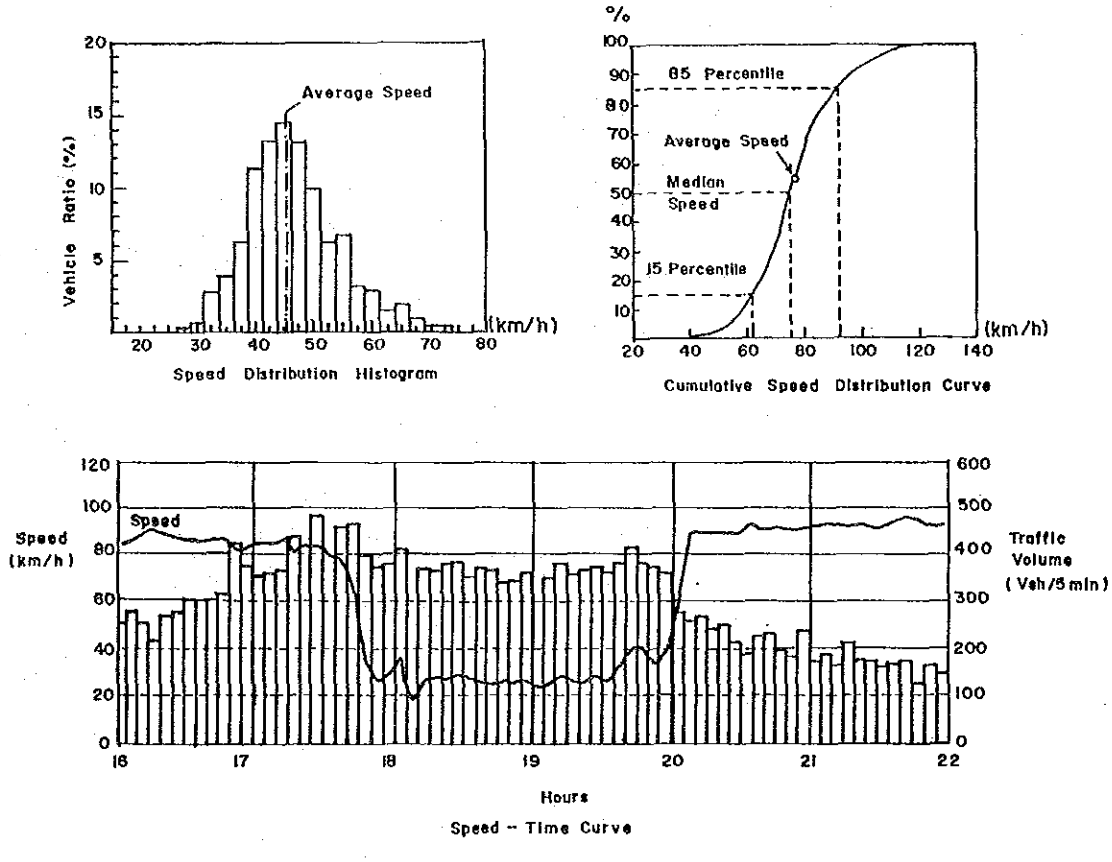


Figure 3.8.7: Examples of Vehicle Running Speed Analyses

3.8.3 Highway Accident Data

(1) General

Highway accident statistics are essential for understanding the nature and type of highway accidents in relation to highway section. This may help in identifying any problematic areas or sections of the highway that require more stringent traffic safety measures.

Highway accident data are obtained from the "Highway Accident Investigation Sheets" filled in by the patrol personnel as described in Section 3.5.

(2) Accident Statistics

(a) Number of Accident by Highway Section and Accident Rate

Accident data are to be processed into number of accidents by each section of the highway. For comparative analysis between section, accident rate is used instead.

Accident rate is obtained by dividing the total number of accident for that section by the total annual vehicle kilometer for that section (in number of accident/million veh.km).

These data are to be compiled by years to show the annual fluctuation pattern. Furthermore, the number of accidents are to be further breakdown into those with fatal injury, property damage, etc.

(b) Monthly Accident Statistics

The number of accidents by section are to be analyzed in terms of monthly variation to find out if there is any specific occurrence pattern.

(c) Nature of Accident by Section

For selected sections (sections having relatively high accident rates), the number of accident in a year are analyzed by nature of accidents.

* Rear Collision Accident
* Side Swipe Accident
* Front Collision Accident
* Collision with Objects
* Collision with Animals

This data would help to reveal to some extent, the likely causes of accidents.

(d) Accidents by Vehicle Type

The number of accidents by section in a year are also analyzed by type of vehicles. This would help to identify the target group.

* Passenger Car
* Light Truck
* Bus
* Large Truck
* Motorcycle

(e) Accident Distribution Analysis

The number of accidents occurred over a year are further analyzed in terms of their distribution for every 1 km (depending on the density of accidents) stretch. For accidents occurred outside the mainline, they are to be classified by S.A, P.A or IC.

(f) Accidents by Day of Week

The number of accidents for each section are further analyzed by different days of the week.

(g) Accidents by Direction and Hour

The number of accidents in a year for each section are further analyzed by direction of travel, i.e. northbound and southbound, or eastbound and westbound and by hour of the day.

(h) Accidents by Type of Offence

The annual number of accidents by section are analyzed by the type of traffic offenses:

* Mishandling of Steering
* Overtaking without Warning
* Following too Close
* Overtaking from the Left
* etc.

3.8.4 Breakdown

(1) General

The number of vehicle breakdowns on expressway can be expected to be several times over the number of accidents. Responses to stress calls of breakdowns have similar objectives to those for accidents, i.e. to prevent secondary accidents and to minimize effects on traffic flow. Response to breakdown thus constitute an important activity of traffic management on the expressway. To achieve the objectives, therefore, it is imperative to know where, by what cause and the extent of breakdown; and finally what response to take.

Statistics on breakdowns are to be compiled and analyzed using data from the emergency telephone records at the Traffic Control Centers.

(2) Statistics on Breakdown

(a) Number of Breakdown, Breakdown Rates by Section

The total annual number of breakdowns are processed by section of the highway and their rates (number of breakdown/100,000 veh.km) are to be computed for comparative analysis between different sections or routes.

(b) Breakdown by Causes

The annual number of breakdowns by selected sections (sections with high breakdown rates) and overall route are analyzed by causes of breakdown:

* Overheating
* Faulty Sparkplug
* Engine and other Mechanical Malfunction
* No Fuel
* Combustion System Malfunction
* Punctured Tire and Others

(c) Breakdown by Vehicle Type

The annual breakdown data for major highway sections are to be analyzed by vehicle type.

* Passenger Car
* Light Truck
* Bus
* Large Truck
* Motorcycle

(d) Monthly Breakdown Statistics

The annual number of breakdowns by section are analyzed for their monthly fluctuations.

(e) Breakdown by Day of Week

The annual number of breakdowns by section are also analyzed by different days of the week.

3.8.5 Obstacles on Road Surface

(1) General

Obstacles found on highway surface are mostly fallen objects or load from trucks, or carcasses.

Statistics on obstacles are compiled using data from the daily patrol records by each of the maintenance offices at each regional office. These data from each regional office are further combined at the headquarters. See Chapter 4 on recording format.

(2) Statistics on Obstacles

(a) The annual number of obstacle incidents are analyzed by section of the highway and type of obstacles:

* Timber Products
* Tire, Rubber Products
* Metal Pipes, Plates, Sheets, etc.
* Cloth, Clothing, Other Apparels, Shoes
* Boxes or Crates make of cardboard, Other Paper Products
* Animal Carcass
* Others

(b) Statistics on Obstacle by Month

The number of incidents on obstacle are further analyzed by section of the highway and by month.

3.8.6 Traffic Regulation During Road Works

(1) General

Among the various traffic regulation measures taken during traffic management, those related to roadwork have to be compiled and analyzed.

(2) Statistics on Traffic Regulation During Roadwork

Number of Traffic Regulation Cases by Major Highway Section and Content of Work

* Cleaning
* Vegetation Control Work
* Repair/Improvement Work
* Restoration work Due to Accident
* New Facility/Construction
* Restoration Work due to Disaster

If the number of cases for repairs/improvement work are high, further classification is necessary.

It is also a good practice that major road repairs or collective repairs be video recorded for detailed analysis and study.

3.8.7 Traffic Congestion and Road Closure

(1) General

Data on traffic congestion, road closure are gathered and compiled at the Traffic Control Center when carrying out traffic control and management measures. These data have to be analyzed for comparative study.

(2) Statistics on Traffic Congestion and Road Closure

(a) Traffic Congestion Data

Traffic congestion data have to be compiled into:

* Annual number of congestion cases by highway section
* Annual number of congestion cases by time
* Annual number of congestion cases by queue length and time
* Annual number of congestion cases by causes (recurrent, accident, roadwork , etc.)

(b) Road Closure Data

Data on road closure have to be analyzed similarly to those for congestion. The causes of road closures are accident, roadwork, traffic congestion, adverse weather conditions and road damages.

3.8.8 Weather and Disaster

(1) General

Data on weather conditions along the highway are available from the observatory stations set up at the strategic locations as well as equipment installed at each maintenance office. These weather data have to be properly recorded and compiled into statistics showing weather pattern for 1 year, 5 years, 10 years or more.

Record on disasters such as location, types, extent of damages, etc. have to be recorded by each maintenance office and compiled by the regional office.

(2) Statistics on Weather and Disaster

(a) Average Annual Rainfall by Section
(b) Annual Average Daily Rainfall by Section
(c) Annual Rain Days by Daily Rainfall Range by Highway Section

The daily rainfall is ranked according to:

i) 30 mm or less a day
ii) 30 mm or more a day
iii) 50 mm or more a day
iv) 80 mm or more a day
v) 120 mm or more a day

(d) Annual Rain Days by Hourly Rainfall Range by Section

The hourly rainfall ranges are:

i) 10 mm or more per hour
ii) 20 mm or more per hour
iii) 30 mm or more per hour
iv) 40 mm or more per hour

(e) Annual Occurrence of Strong Cross wind by Month by Section by Wind Velocity

The maximum wind velocity are ranked as:

i) 10 m/s or more
ii) 15 m/s or more
iii) 20 m/s or more

(f) Disaster Statistics

Statistics or disaster occurrences are to be compiled by regional office based on records filled and kept by the maintenance offices. Disaster statistics are to be prepared on number of cases by types (fallen structures, fire, landslide, flood, fallen rocks, etc.) and by causes (heavy rain, strong wind, etc.) and extent of damages. The types of countermeasures taken must be recorded.

3.8.9 Publication

Various types of data collected and statistics derived are to be published in yearly reports by each regional office. Such publications are to be made available for planning and research projects by other regional offices, maintenance offices and also other government agencies and departments.

Examples of such publications' contents are given below.

(1) Annual Traffic Statistical Report

This is an annual reporting to be prepared by the Traffic Engineering Department in each regional office.

Sample of Contents

Outline of Management Routes

(1) Traffic Volume

(a) Yearly changes of Annual Average Daily Traffic (AADT)
(b) Yearly changes of Annual Average Daily Exit and Entry Traffic by Interchange
(c) Entry and Exit Traffic Volume by direction by Interchange

(d) Monthly Average Daily Traffic Volume by Highway Section
(e) Monthly Average Daily Entry and Exit Traffic Volume by Interchange
(f) Monthly Average Daily Entry and Exit Traffic Volume by Direction by Interchange
(g) Maximum and Minimum Traffic Volume by Highway Section
(h) Maximum and Minimum Daily Entry and Exit Traffic Volume by Interchange
(i) Monthly and Weekly Average Daily Traffic Index by Highway Section
(j) Average Daily Traffic Volume in Descending Order by Highway Section
(k) Traffic Volume by Composition
(l) IC Pair Traffic Volume
(m) Weekend and Weekday Hourly Traffic Variation
(n) Traffic Variation by Day of Week
(o) Traffic Volume Variation on Surrounding Roads

(II) Traffic Accident

(a) Yearly Changes of Accident Rate and Number of Accident
(b) Number and Nature of Accidents by Year
(c) Number and Nature of Accidents by Month
(d) Number and Nature of Accidents by Highway Section
(e) Number and Nature of Accidents by Vehicle Type by Highway Section
(f) Accident Black Spot Analysis by Year
(g) Number of Accident by Day of Week by Highway Section
(h) Number of Accident by Hour by Direction by Highway Section
(i) Number of Accident by Type of Offence by Highway Section
(j) Accident Statistics for Temporary Completed Highway Section
(k) Accident Statistics During Monsoon Season
(l) Accident Statistics During Festive Season
(m) Accident Statistics During Holiday Season

(2) Annual Traffic Control and Management Statistical Report

This annual report is to be prepared and published by each traffic control center in the regional office in maintenance office.

Sample of Content

(1) Traffic Incident Statistics by Year by Highway Route
(2) Comparative Tables of Accident and Traffic Volume with Previous Year
(3) Monthly Statistics from Accident Verification Records
(4) Accident Graphs by Month
(5) Accident Statistics on On-Mainline and Off-Mainline
(6) Accident Statistics by Nature of Accident and Highway Section
(7) Accident Statistics by Type of Offence by Highway Routes
(8) Accident Statistics by Type of Vehicles by Route
(9) Vehicle Breakdown Statistics by Reason by Vehicle Type
(10) Obstacles Statistics by Type of Month and by Route
(11) Statistics on Measures Taken for Obstacles by Type of Obstacle
(12) Number of Emergency Telephone Calls by Month
(13) Number of Emergency Telephone Calls by Content by Route
(14) Road Closure Statistics
(15) Highway Fire Incident Statistics
(16) Fire Engine Dispatch Statistics
(17) Ambulance
(18) Wireless Delay Station Message Delay Statistics
(19) Tow Truck Dispatch Statistics by Company by Route

4.0 TASK MANUAL (TRAFFIC MANAGEMENT PERSONNEL) (By Case Study)

4.1 Setting of the Case Study

4.2 Tasks of the Traffic Control Officer

4.3 Head of Traffic Control Center

4.4 Traffic Control Police Officer

4.5 Highway Patrol Officer

4.6 Highway Police Patrol Unit

4.0 TASK MANUAL (TRAFFIC MANAGEMENT PERSONNEL) (BY CASE STUDY)

This Chapter discusses the responsibilities and tasks of the traffic management personnel, those in the traffic control center and those on site, by the use of case studies. The former include tasks carried out by the Head and his traffic control officers, and highway police officer stationed at the Traffic Control Center. The latter are tasks carried out by patrol unit personnel and highway police patrol on site.

4.1 Setting of the Case Study

To illustrate the various detailed tasks and activities of the traffic management personnel, a case study, that of a highway accident involving two vehicles is hypothetically conjured. Response from the Traffic Control Center and thus steps taken by the traffic management personnel are explained in detail.

(1) Accident Scenario

A white Toyota Sedan suddenly moved out from the left lane to overtake the front car without checking the vehicle following behind. As a result, a green Proton Saga behind smashed into the rear of the white Sedan.

Both parties suffered injuries. Both vehicles have become disabled and are blocking the right lane and part of the left lane.

Location: Northbound between Seremban North IC and Nilai IC at 48.6 kilopost

Nature : Rear collision accident with casualty

Time : Weekday, 11.00 am

(2) Emergency Call

A passer-by notifies the Traffic Control Center by the use of emergency telephone. The message was received by a traffic control officer at the Traffic Control Center in the Ayer Keroh Regional Office.

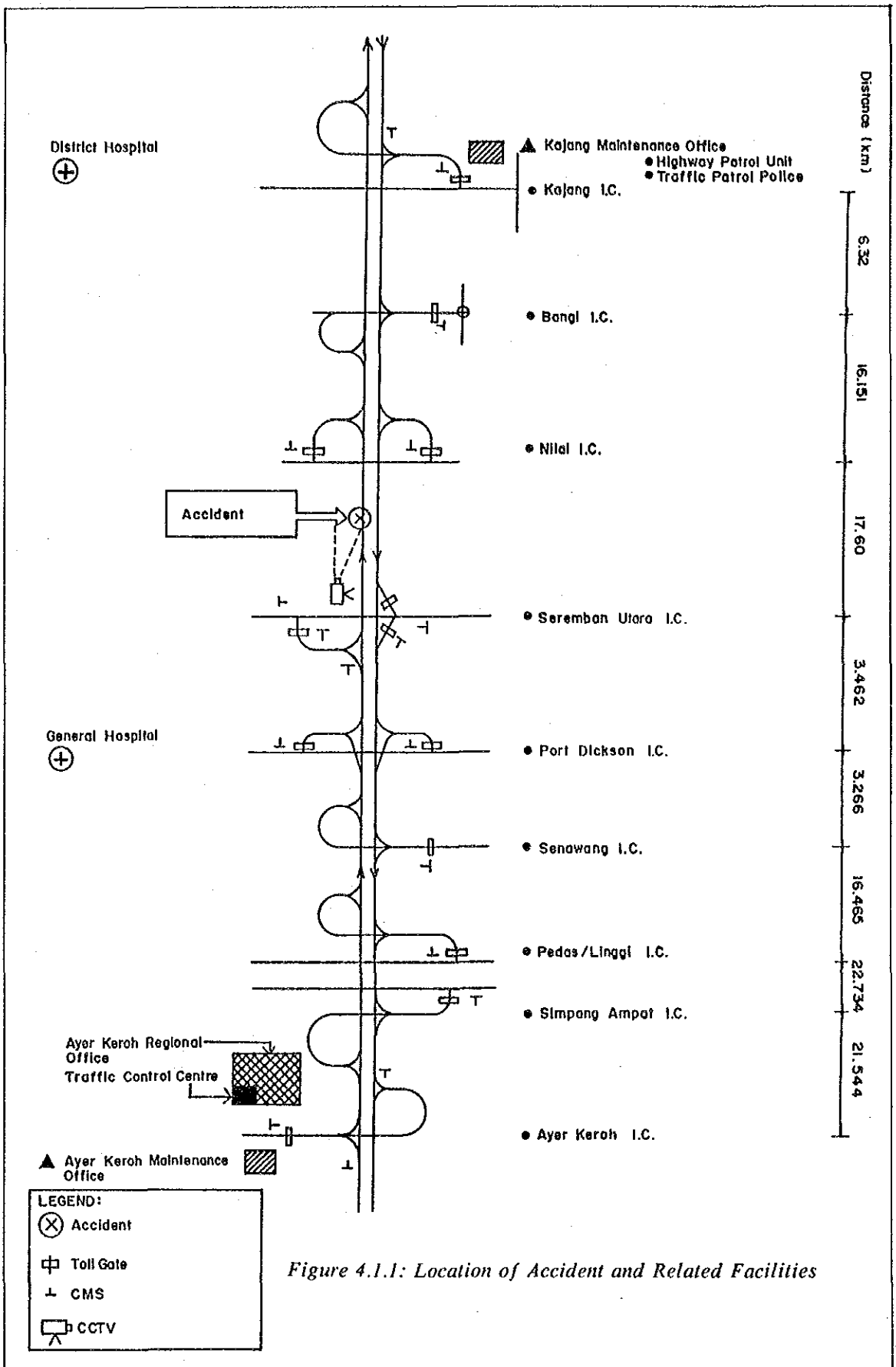


Figure 4.1.1: Location of Accident and Related Facilities

(3) Traffic Condition along the Section in Question

The section has a fairly high traffic volume. Therefore, there is danger of secondary incident.

This scenario is illustrated in Figure 4.1.1 which shows the accident location, interchange and other highway related facilities.

4.2 Tasks of the Traffic Control Officer

(1) General

When a distress call is received, either from the patrol car or emergency telephone, Traffic Control Officer at the Traffic Control Center has to perform a series of tasks that includes contacting patrol units on site using wireless and activating Changeable Message Signs (CMS).

In this section, the tasks of traffic control officer is explained using the set case study. Message displays on the CMS are also illustrated.

(2) Task Manual

The proposed team of three traffic control officers at the traffic control center are assigned different responsibilities. One officer will be responsible for receiving emergency and distress calls and transferring such calls to management office is necessary. The second officer is responsible for contacting the various agencies such as hospital, fire department, towing company, etc., during an emergency while the third officer is responsible for activating changeable message signs or speed limit signs and monitoring CCTV, etc.

(a) Response to the Emergency Telephone Calls

When the call is received, the officer responsible first has to record down details of the call, preferably on a standard form which must include the following items:

(i) Emergency Telephone Code Numbers

Even though it is possible to know at the TCC which telephone the caller is using, confirmation from the caller himself is necessary. Record the code number, such as "N-20".

(ii) Location of the Accident

* Northbound or Southbound
* Eastbound or Westbound
In this case, record as "North-bound".

If caller cannot distinguish his direction, the officer must ask for directional indications, eg. from Ayer Keroh to Kuala Lumpur.

* Kilopost
Ask for the kilopost from the caller. Record as "48.6 km" for example".

(iii) Highway Section

* Name of Interchanges
In this case, "Seremban North IC-Nilai IC".

(iv) Injury

* Number of injured persons	: 2 persons
* Seriousness of injury	: 1 very serious
* Fatal	: No
* Any one trapped in vehicle	: No

(v) Vehicles

* Number of vehicles involved	: 2
* Type of vehicles	: Passenger Car
* Nature of accident (rear collision,etc)	: Rear collision
* Damages to property (median,guardrail,etc)	: No
* Any vehicle on fire	: No

(vi) Effect on Traffic Flow

* Where are the accident vehicles	: On the carriageway
* Are they blocking traffic flow	: Yes

(vii) Spill Load/Debris

* Spilled load	: No
* Debris, broken parts from accident vehicles	: Broken Number Plates and Bumpers

(viii) Time of Reception : 11.07 am

(b) Response

Since the accident happened in the daytime where the Head of the TCC, highway police office are stationed in the same room, they are immediately made aware of the emergency call and nature of the accident. The traffic control officer has to respond to the call quickly and accurately, following the steps below.

(i) Dispatch Patrol Units

* Using the exclusive telephone on the console, the officer is to contact Kajang Maintenance Office immediately and order the dispatch of patrol units to the accident site.

* Using wireless, contact any patrol cars that is on duty on the highway nearby and order then to speed to the accident site.

* Highway Police Officer at TCC is to dispatch his police patrol unit to the accident site simultaneously.

(ii) Surveillance with CCTV

Since the accident occurred at a location that is within the range of CCTV installed at Seremban North IC, the officer is to focus the camera onto the accident scene and monitor it visually. The nature of the accident is confirmed. The officer notices that a queue of vehicle is quickly building up as the accident vehicles are blocking the carriageway.

(iii) Activate CMS

* Activate Mainline CMS
* Next, activate toll gate CMS at Bangi IC, Nilai IC and Seremban North IC
* Next, activate Access Road CMS towards Seremban North IC

At this juncture, CMS are activated to show "Accident, Caution oo km Ahead" only. These messages are pending to be upgraded later after receiving reports from patrol cars that have arrived on site.

(iv) Request Ambulance

* Officer is to check the hospital listing to see which is the nearest hospital with ambulance unit.

* Request ambulance from the nearest hospital (that is capable of treating the injured persons) which is the Seremban General Hospital located at 3 km from Port Dickson IC (see Figure 4.1.1).

(v) Receive Report from Patrol Car on Site

Patrol cars have arrived on the scene. Upon investigation, one personnel reports back to the officer using the wireless set in the patrol car.

* Actual situation of the accident, such as:
  - accident vehicles are seriously damaged;
  - persons seriously injured;
  - tow trucks needed to remove vehicles;

- vehicles are blocking the whole carriageway;
- backup queue is creating serious congestion.

The police patrol car has arrived on the scene and upon investigation, "Closure of the Carriageway" is deemed necessary. He is to report back to the police officer at TCC, stating that closure of the carriageway is necessary. The police officer at TCC is to confer with the officer for such a measure to be taken (Both the patrol car personnel and police proceed to control traffic and set up barricades).

(vi) Report to Head of TCC

If the accident has occurred at night instead, the officer has to report to the Head using a paging telephone or mobile phone. He has to inform the Head the nature of accident and what steps have been taken.

In this case, since the accident occurred at 11.00am, the Head is aware of the situation. The Head is to report the incident to the Regional Manager (or Director) at the regional office.

(vii) Upgrading of CMS Messages

The CMS messages are now upgraded from the mere "Caution" warning messages to the appropriate instructive or regulatory messages.

* Upgrade Mainline CMS message to instruct vehicle to "Exit Here" at Seremban North IC to prevent further congestion.

* Upgrade Toll Gate CMS message at Seremban North IC, Port Dickson IC, Senawang IC and Pedas/Linggi IC to "Accident.No Entry", to prevent further accesses of vehicles.

* Upgrade Access Road CMS message along access road to Seremban North IC to "No Entry".

(See Figure 4.2.1 for this illustration).

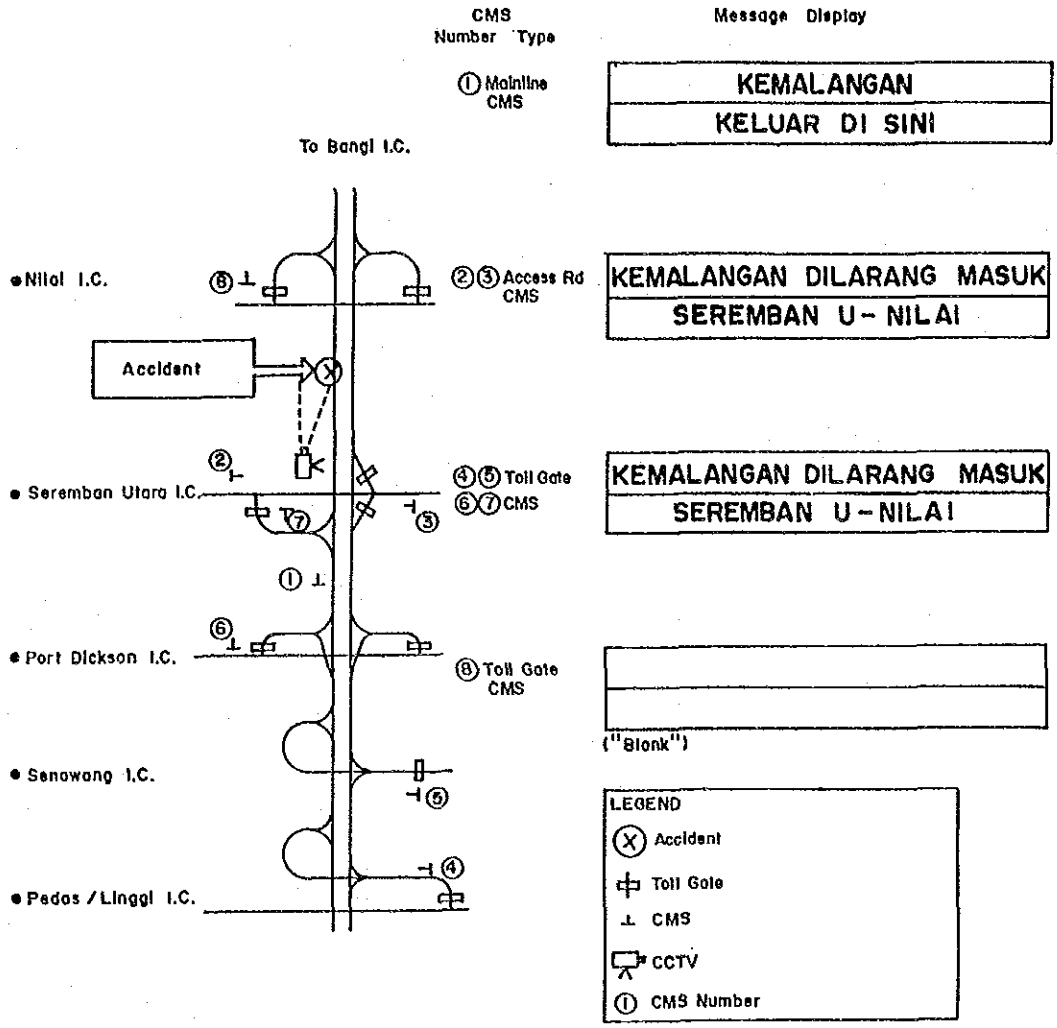


Figure 4.2.1: CMS Displays

(viii) Request Tow Trucks

The officer is to telephone and request two tow trucks (officer is to refer to list of towing company and call the one that is nearest to the accident site).

(ix) Monitor the Accident Management

The officer is to carefully monitor the rescue process, removal of damage vehicles, etc. by using wireless to maintain contact with personnel on site. He is also required to use CCTV to observe the accident scene and monitor the traffic congestion.

(x) Switch Off CMS Displays

After the accident vehicles and barricades have been removed and traffic returns to normal (confirmation from patrol cars on site), the officer is to switch off the CMS displays.

(xi) Reporting

Upon the successful handling of an accident such as this, the officer at TCC has to record down the accident and its responses or countermeasures. These records are to be compiled into a report.

* Nature of Incident and Conditions
  - Date, Location of Incident
  - Conditions
  - Consequences (Death/Injury/Damages/etc.)

* Type of Communication
  - Emergency Telephone
  - Wireless Telephone
  - Exclusive Phone

* Agencies Contacted
* Measures Taken
* Etc.

4.3 Head of Traffic Control Center

(1) General

The Head of the TCC is responsible for the overall response to incidents. His direct involvement is necessary, especially if it is a serious incident with serious injury or death.

In this case study, the closure of carriageway is only about 1 hour. But in cases where such measure is likely to take more than say 2 hours, the Head of TCC has to inform and consult with the related authorities (MHA Regional Director, etc.)

The Head of TCC has to monitor the whole process in the accident management.

(2) Task Manual

(a) Instruct/Advice the Traffic Control Officer

The Head is to make sure that the officer is taking the correct and appropriate steps in response to the emergency call. If any measure the officer has taken is not appropriate, the Head should correct and advice him.

(b) Communicate with Other Related Agencies

As the incident is a serious one, the Head is to report the incident, its nature, steps taken to PLUS regional director or manager and MHA Director at the regional office. He should keep the regional director informed of the progress in handling the accident. If he encounters any problems, he must consult with the regional office.

(c) Request Further Assistance

In case that the patrol unit personnel on site are not capable of handling the situation, the Head is to request other patrol units from other maintenance offices to assist those already on site.

(d) Monitor Traffic Flow

The Head is also responsible for ensuring smooth traffic flow at and around the accident site in preventing any secondary incident. He is to observe and monitor the accident scene using the CCTV.

(e) Confirm the Accident Responses

He is to confirm the various responses taken by the officer at TCC.

* Rescue of injured person
* Removal of accident vehicles
* Removal of any spilled load or debris
* Lifting of traffic control and regulations
* Traffic flow conditions

(f) Confirm and check the Accident Response Report prepared by the Officer

4.4 Traffic Control Police Officer

(1) General

When the emergency call comes into TCC, the traffic control police officer who is seated next to the traffic control officer is thus made aware of the accident. The police officer is therefore responsible to dispatch the police patrol unit to the scene.

After dispatching the police patrol unit, he is to keep in contact with the patrol and receive report on the accident conditions and road situation after the latter has arrived on site.

The police officer is to coordinate measures taken by the police patrol unit on site and advice him if they need any assistance.

Upon receiving the report on the accident conditions, the police officer has to inform and consult with the Head of TCC, his deputy and the traffic control officers on duty and come to an agreement of what best actions to take. All have agreed to close the carriageway and the traffic control officer is required to upgrade the CMS displays (see 4.2 (vii)).

(2) Task Manual

(a) Dispatch Police Patrol Unit

The police officer is to use wireless and dispatch the police patrol unit to the accident scene.

(b) Confirm Accident Situation on Site

Using wireless, the police officer is to confirm the situation on site with the police patrol unit.

(c) Confirm the Implementation of Traffic Control on Site

* The police officer has to confirm with police patrol unit on site on the traffic regulation taken.

* At the same time, he is to order the setting up of exit guide signs at Seremban North IC Off-ramp. In case further assistance is needed, he should contact other maintenance office or request help from local police.

* He is to inform the Head of TCC or deputy of such measures taken by the police patrol unit.

(d) Surveillance of Traffic Flow

Together with the Head of TCC, the police officer must also monitor the traffic flow at and around the accident site.

(e) Confirm Steps Taken

The police officer must also confirm that appropriate steps have been taken with regard to:

* Rescue operation
* Accident investigation and report
* Removal of accident vehicles
* Completion of handling
* Lifting of traffic control and regulations

4.5 Highway Patrol Officer

(1) General

The Highway Patrol Officer who is either on duty patrolling the highway or on standby at the maintenance office, upon receipt of order from the patrol chief or traffic control officer from TCC will rush to the accident scene.

(2) Task Manual

(a) Approach to Accident Scene

On receiving dispatch order from the traffic control officer at TCC, the patrol officer (who is on standby at Kajang Maintenance Office) is to promptly rush to the accident scene. In this case study, the patrol officer coming from Kajang IC has to make a U-turn at Seremban North IC (see Figure 4.5.1) to reach the accident site.

(b) Report to TCC

Upon arrival at the scene, the patrol officer has to quickly report the site situation to the traffic control officer at TCC. After traffic control measures have been set up, he is also required to report the progress to TCC.

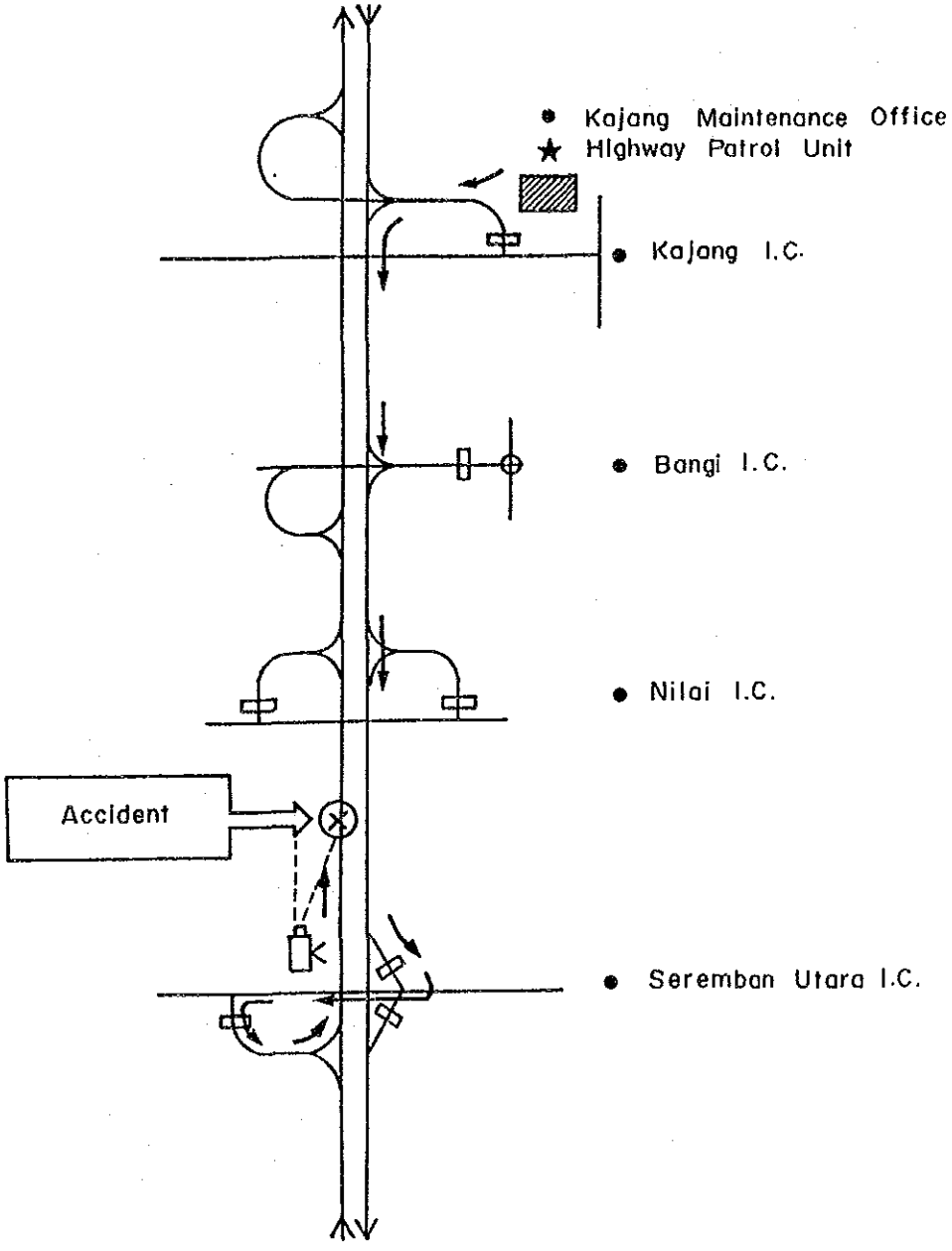


Figure 4.5.1: Approach to Accident Site by Patrol Unit from Kajang Maintenance Office

(c) Implementing Traffic Control Measures

Once the police patrol personnel has decided to implement traffic control in closing the carriageway to facilitate the removal of accident vehicles, the patrol officer and his partner (each patrol unit is staffed with two persons) are to set up barricades, etc. to stop the traffic, following the procedure below and Figure 4.5.2

*1 The patrol car is to position itself 100 m upstream from the accident vehicles

*2 The flagman is to position himself at the shoulder or median 150 m upstream from the patrol car

*3 The workman is to position himself at 30 m upstream from the patrol car and use smoking candles to stop the on-coming vehicles

*4 When the on-coming vehicles have come to a complete stop, the workman is to set up rubber cones and blinking lights in a row, starting from the shoulder towards the median and perpendicular to the median (1 to 5).

*5 Having set up the barricade, the workman is to report the condition of the accident to the traffic control center.

*6 The mobile warning sign vehicle is to position itself side by side the patrol car upon arrival.

At the same time, the patrol officer has to wire the officers at TCC to dispatch other patrol unit to the interchange upstream, i.e. Seremban North IC for implementing traffic control. Barricade is to be set up at the taper to the northbound off-ramp at Seremban North IC to divert on-coming traffic out from the highway (Figure 4.5.3).

* Position the patrol car at about 300 m from the start of the off-ramp. Position the flagman 30 m upstream from the patrol car

* Set up cones and blinking lights (1 through 13) as shown

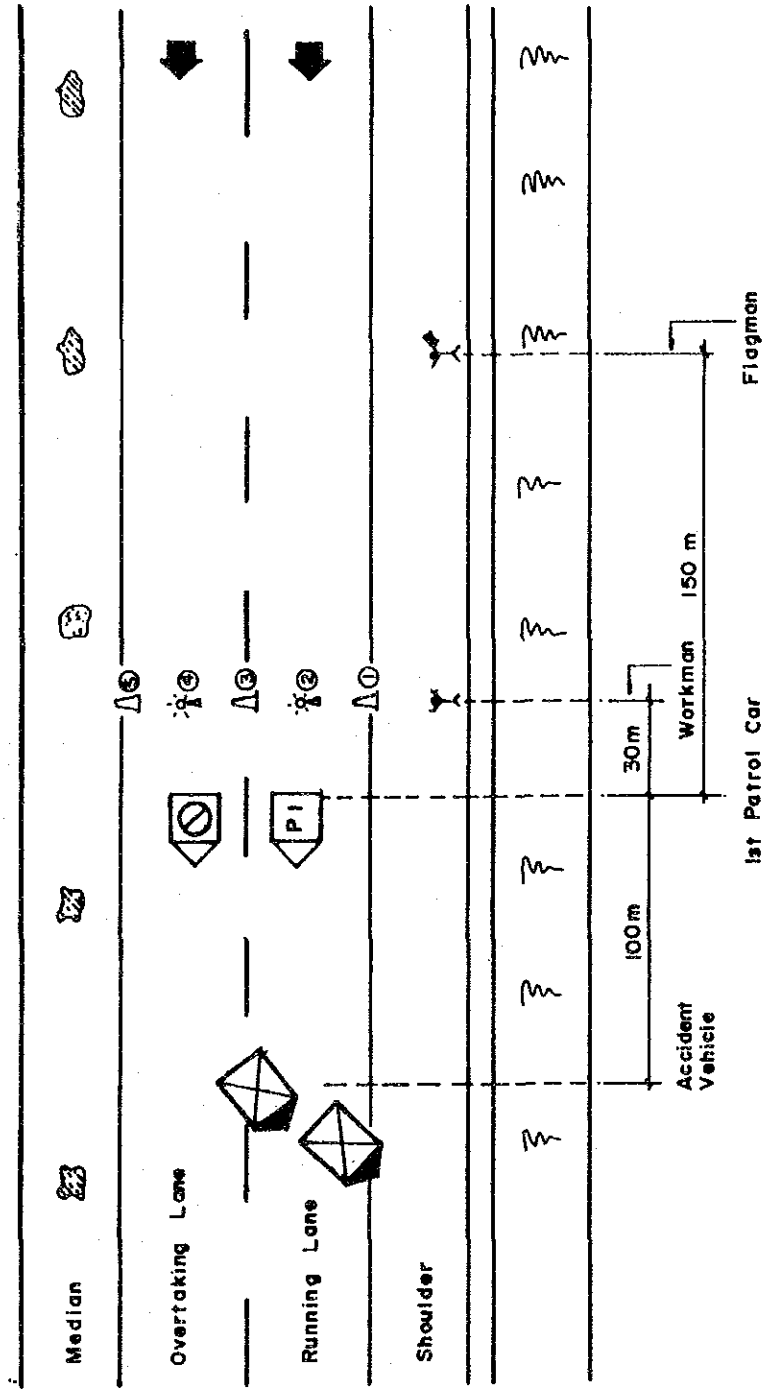


Figure 4.5.2: Traffic Control Measure for Road Closure at Incident Scene

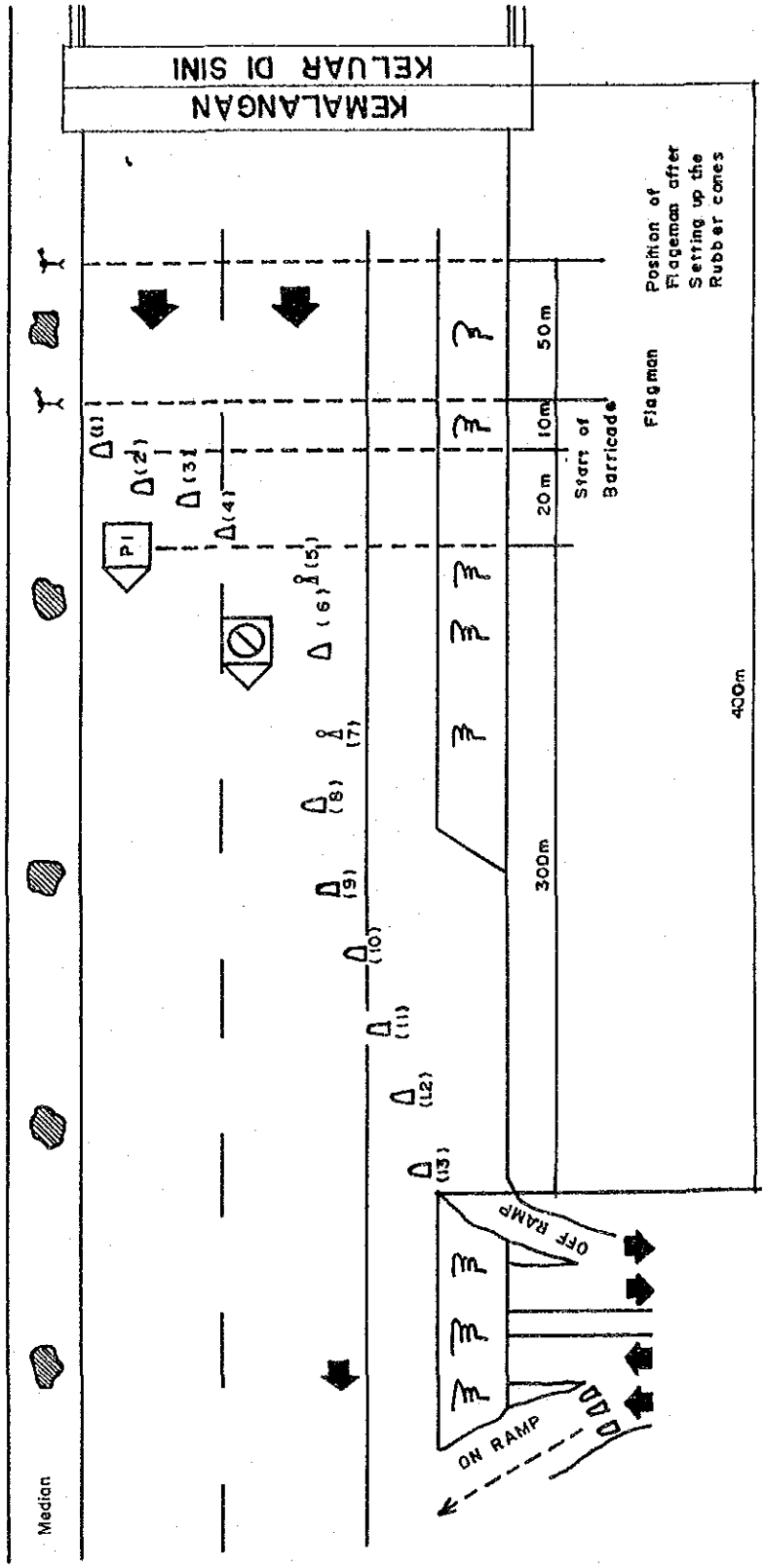


Figure 4.5.3: Traffic Control Measure for Exit from Highway at Seremban North IC

* After the mobile warning sign truck has arrived position it at about the center of the carriageway.

(d) Assist Police in Accident Investigation

(e) Inspect Safety Facilities and their Likely Damages

The patrol officer is to check for damages to safety facilities on site which may have been caused by the accident vehicles. The officer is to record down the extent of damages.

(f) Remove any Spilled Load and Debris

Any spilled load or broken parts from the accident vehicles have to be swept away after the vehicles are towed away.

(g) Removal of Barricades

Once the vehicles are removed and pavement cleared of obstacles, barricades are removed starting from the rear of the barricade.

(h) Reporting to TCC

After the barricade has been removed and traffic returned to normal, the patrol officer is to report back to TCC to lift off the traffic control regulation and CMS displays.

(i) Accident report

After returning from the scene to Kajang Maintenance Office the patrol personnel are to fill in the Highway Accident Sheet and Verification Forms.

Accident Investigation Sheet

1) Name of Road | 2) Regional Office | 3) Maintenance Office

5) Accident Date: Day Month Year

6) Accident Time: Hour Min

4) Name of Entering Officer

7) Day	8) Holiday	9) Location On Mainline	10) Location off Mainline	11) Direction
1. Sun. 5. Thur. 2. Mon. 6. Fri. 3. Tues. 7. Sat. 4. Wed.	1. Normal 2. Holiday	K.P.	1. Exit ramp to SA, PA 2. Entrance ramp from SA, PA 3. Acceleration Lane 4. Deceleration Lane 5. Toll Gate 6. PA, SA 7. Petrol Station 8. Others 9. Unknown	1. Northbound 2. Southbound 3. Eastbound 4. Westbound 9. Unknown

12) Weather	13) Wind	14) Period of Day	15) Lighting	16) Visibility Distance	17) Surface Condition
1. Fine 2. Cloudy 3. Foggy 4. Rainy 5. Others 9. Unknown	1. Strong 8. Others 9. Unknown	1. Dawn 2. Day 3. Dusk 4. Night 9. Unknown	1. On 2. Off 9. Unknown 0. No Lighting	1. Less than 50m 2. 50 to 100m 3. 100 to 200m 4. Over 200m 9. Unknown	1. Dry 2. Wet 8. Others 9. Unknown

18) Vehicle Type

Bus	Trucks	Passenger Car	Motorcycle	Pedestrian
11. Route Bus 13. Other Bus	21. Truck with 2 axles & 4 wheels 22. Truck with 2 axle & 6 wheels 23. Truck with 3 axles 24. Truck with 4 axles 25. Truck with 5 or more axles	31. Side car 32. Passenger Car 33. Taxi	41. 100cc or less 42. Over 100cc	51. Pedestrian (worker) 52. Pedestrian (others) 88. Others 99. Unknown 00. None

19) Maximum Carrying Capacity of truck	20) Overloading of truck	21) Vehicle Ownership	22) Road Line Structure		
.t 999 Unknown 000 None	.t 999 Unknown 000 None	1. Private usage 2. Commercial usage 8. Others 9. Unknown	Road Classification: 11. 6 or more lane dual carriageway 12. 4-lane dual carriageway 13. 2-lane single carriageway	Road Form: 21. Straight 22. Curve	Other Structure: 31. Tunnel 32. Toll Barrier on Mainline 33. Bridge 34. Junction 99. Unknown 00. None

23) Location of Traffic Regulation		24) Reason for Regulation	25) Traffic Jam
01. First Lane 02. Second Lane 03. Overtaking Lane 04. Climbing Lane 05. Acceleration/ Deceleration Lane 06. Shoulder 07. Median 08. Ramp	11. Facing Traffic 12. Coordinating Traffic 88. Others 89. Unknown 00. No Regulation	1. Accident 2. Breakdown 3. Construction 4. Working on Road 5. Weather Condition 6. Traffic Control 8. Others 9. Unknown 0. No Regulation	1. Yes 2. No 9. Unknown

I. Condition Before Accident

26) Lane Classification	27) Movement
01. First Lane 02. Second Lane 03. Overtaking Lane 04. Climbing Lane 05. Acceleration (Entrance) 06. Deceleration (Exit) 07. Shoulder 08. Median 09. Emergency Parking Space 10. Opposing Lane 88. Others 99. Unknown 00. None	01. Running 02. Braking 03. Stopping 04. Accelerating 05. Decelerating 06. Changing to Right Lane 07. Changing to Left Lane 08. Retreating 88. Others 99. Unknown 00. None

II. Movement Just Before Accident

28) Reason of Movement	29) Unusual Operation	30) Imminent Factor
01. Changing Lane before Overtaking 02. Changing Lane after Overtaking 03. Changing Lane for Entrance or Exit 04. Changing Lane for Other Reason 05. Evasion of Rear-end Collision 06. Evasion of Head-on Collision 88. Others 99. Unknown 00. None	01. Improper Steering 02. Improper Overtaking 03. Improper Steering and Braking 04. Other Steering/braking 05. Right-side Moving 06. Left-side Moving 07. Rear Missing (Too short safety gap) 88. Others 99. Unknown 00. None	1. Sleeping (Over fatigue) 2. No Looking Ahead 3. Random Glancing 4. Drunk 5. Drug 6. Fear Feeling 8. Others 9. Unknown 0. None

1 Name of Road | 2 Regional Office | 3 Maintenance Office — 1 2 3 4 5 6 7 8 9

4 File No. — A 1 — 10 11 12 13 14 15

5 Accident Date: Day Month Year — 16 17 18 19 20 21 22 23

6 Time Min 7 Day & Holiday — 24 25 26 27 28 29

9 Location On Mainline — 30 31 32 33

10 Location Off Mainline — 34

11 Direction — 35

12 Weather — 36

13 Wind — 37

14 Period of Day — 38

15 Lighting — 39

16 Visibility Distance — 40

17 Surface Condition — 41

18 Vehicle Type (1st) (2nd) — 42 43 44 45

19 Maximum Carrying Capacity of Truck — 46 47 48

20 Total Carrying Capacity of Truck — 49 50 51

21 Vehicle Ownership — 52

22 Road Line Structure — 53 54 55 56

23 Location of Traffic Regulation — 57 58

24 Reason for Regulation — 59

25 Traffic Jam — 60

A 2 — 14 15

26 Lane Classification — 16 17

27 Movement — 18 19

28 Reason of Movement — 20 21

29 Unusual Operation — 22 23

30 Imminent Factor — 24

III. Obstruction and Accident Type

31) Detail of Movement	32) Detail of Happenings	33) Objects of Obstruction			
1. Slip 2. Spin 3. Meander 4. Out of Control 8. Others 9. Unknown 0. None	01. Broken Front Glass 02. Loss of Wheel 03. Rush onto road by person 04. Rush onto road by animal 05. Flying Stone 06. Slope Slip 07. Water Splash 08. Fallen Gravel 99. Unknown 00. None	01. 1st Party 02. 2nd Party 03. 3rd Party 11. Guard Fence 12. Tunnel Wall 13. Bridge 14. Island 15. Slope 16. Sign 17. Light Pole 18. Others	21. Guard Fence 22. Tunnel Wall 23. Bridge 24. Island 25. Slope 26. Sign 27. Light Pole 28. Others	31. Guard Fence 32. Separation 33. Curb 34. Sign 35. Open Space 36. Others	41. Diverging End 42. Toll Plaza 51. Fallen Goods 88. Others 99. Unknown 00. None

*11-18 Left-side of Road (shoulder)
21-28 Right-side of Road (Divided without Median)
31-36 Median

34) Accident Type	35) Final Stopping Position		36) Stopping Condition	37) Reason of Item 29) - 02 & 03 Only
01. Head-on Collision 02. Rear-end Collision 03. Contact Collision 04. Running Off 05. Overturning 06. Personal Damage 88. Others 99. Unknown 00. None	01. First Lane 02. Second Lane 03. Overtaking Lane 04. Climbing Lane 05. Acceleration (Entrance Lane) 06. Deceleration (Exit Lane) 07. Shoulder 08. Parking Space 09. Median	10. Opposing Lane 88. Others 99. Unknown 00. None	1. Normal Stopping 2. Roll Over Stopping 3. Overthrown Stopping 4. Normal Stopping after Roll Over 5. Fell Down 6. Stopping after Fire 8. Others 9. Unknown 0. None	01. Talking with Passenger 02. Looking at Other Vehicle 03. Side Viewing 04. Looking at Accident Site 05. Operating Radio/Stereo 06. Smoking 07. Toll (Money or payment) 88. Others 99. Unknown 00. None

IV. Detail of Casualties

38) Casualties	39) Number	40) Classification of People Involved	41) Classification of Casualty	42) Seat Belt/Helmet
1. Non-casualty 2. Injury Accident 3. Fatal Accident 9. Unknown	1. 1st Party 2. 2nd Party 3. Total Number	1. Driver 2. Front-seated Passenger 3. Back-seated Passenger 4. Motorcycle 5. Pedestrian 8. Others 9. Unknown 0. None	1. Fatal 2. Serious Injury 3. Slight Injury 0. None	1. Fasten Seat Belt 2. Unfasten Seat Belt 3. No seat belt 4. Wear Helmet 5. Do not wear Helmet 9. Unknown 0. None

V. Detail of Driver

43) Age	44) Sex	45) Year of Driving Experience	46) Purpose of Driving	47) Usage	48) Accident Cause
	1. Male 2. Female 9. Unknown	1. Less than 1 year 2. 1 to 2 years 3. 2 to 3 years 4. 3 to 5 years 5. 5 to 10 years 6. More than 10 years 8. Others 9. Unknown	01. Commute 02. Business 03. Sight seeing 04. Private 05. Patrol 88. Others 99. Unknown	1. First Time 2. Several/year 3. Several/month 4. Often/week 5. Patrolling 8. Others 9. Unknown	From the Police Code

Accident Situation Drawing

N

31 Detail of Movement — 25

32 Detail of Happenings — 26 27

33 Objects of Obstruction — 28 29

34 Accident Type — 30 31

35 Final Stopping Position — 32 33

36 Stopping Condition — 34

37 Reason of Item 29) - 02 & 03 Only — 35 36

A 3 — 14 15

38 Casualty — 16

39 Total Number: Fatal Serious Slight — 17 18 19 20 21 22

1st Party — 23 24 25 26 27 28

2nd Party — 29 30 31 32 33 34

40 Classification of People Involved — 35

41 Classification of Casualty — 36

42 Seat Belt/Helmet — 37

43 Age — 38

44 Sex — 39

45 Year of Driving Experience: 1st Party — 40 — 41

2nd Party — 42 43 44 — 45

46 Purpose of Driving: 1st Party — 46 47; 2nd Party — 48 49

47 Usage — 50

48 Cause — 51 52

Accident Verification Form

Head	Deputy		Chief		

		Ref. No :	
Maintenance Office		Form Filler:	

Date		State	District	Left Right	Ramp	Median	
Time		Kilopost	km	Shoulder	IC	P.A	S.A
Weather		Northbound	Southbound	LB	Bridge	Slope	Viaduct
Injury	Light	1st Party	Driver Passenger pp	Hospital	2nd Party	Driver Passenger pp	Hospital
	Serious	1st Party	Driver Passenger pp	Hospital	2nd Party	Driver Passenger pp	Hospital
	Death	1st Party	Driver Passenger pp	Hospital	2nd Party	Driver Passenger pp	Hospital

First Party	Driver	Name:	Male Female	Age:	Occupation:
		Address:			Tel:
		Permanent Add:			Tel:
	Vehicle Owner/ Company	Name:			Tel:
		Address:		Relation to Driver:	
	Vehicle Type :	Make:	Reg. No :	Colour	Private Commercial
	Vehicle Damage:	No Damage Minor Damage	Major Damage Towed Away	Towing Company:	(Tel:)
	Entry Time:	Trip Purpose:		Load:	
	Entry IC:				

Second Party	Driver	Name:	Male Female	Age:	Occupation:
		Address:			Tel:
		Permanent Add:			Tel:
	Vehicle Owner/ Company	Name:			Tel:
		Address:		Relation to Driver:	
	Vehicle Type :	Make:	Reg. No :	Colour:	Private Commercial
	Vehicle Damage	No Damage Minor Damage	Major Damage Towed Away	Towing Company:	(Tel:)

Extent of Damage to Road or Facility	Person Involved	First Party Second Party
	Affidavit	Yes No Ref. No:
	Estimate Cost	MS
	Insurance	First Party Third Party
	Insurance Company	(Tel:)

Despatch	MHA	car	pp	Fire	car	pp	
	PLUS	car	pp	Tow	car	pp	
	Other Office	car	pp	Others:			
	Police	car	pp				

Traffic Regulation	Hr. Min. - Hr. Min.	Congestion	km
	Hr. Min. - Hr. Min.	Road Closed	I/C - I/C
	Total: Hr. Min. -	Time	Hr. Min.
Traffic Offence		Accident Type	

Accident Brief:

Accident Sketch:

4.6 Highway Police Patrol Unit

(1) General

When the emergency call is received at Ayer Keroh TCC, the highway police traffic control officer at the center is aware of the incident and he would immediately telephone Kajang Maintenance Office to dispatch the highway police patrol unit stationed at the Maintenance Office.

The police patrol unit chief, knowing of any police patrol units carrying out the patrolling duty nearby the accident site, will contact them via wireless and order them to speed to the accident site.

(2) Task Manual

(a) Approach to Accident Site

Generally, all police patrol units should approach any accident site from upstream on the same carriageway.

In case that there is a police patrol car nearby but travelling on the other carriageway, this patrol car must first stop near the accident site. The police officer should then get down to cross over to the accident scene while the patrol car makes its 'U' turn at the next interchange. The disembarked police officer should quickly take action to prevent any further accident by the use of smoking candles to warn on-coming vehicles (see Figure 4.6.1).

(b) Highway Traffic Control Measures

* On arriving at the scene, if it is obvious that closure of the road is necessary one police patrol officer must first contact and inform the traffic control police officer at TCC while the other carries out initial traffic control upstream.

* When the patrol units have arrived, the police officers are to cooperate and assist them in setting up the barricades as described in the previous sub-section 4.5.

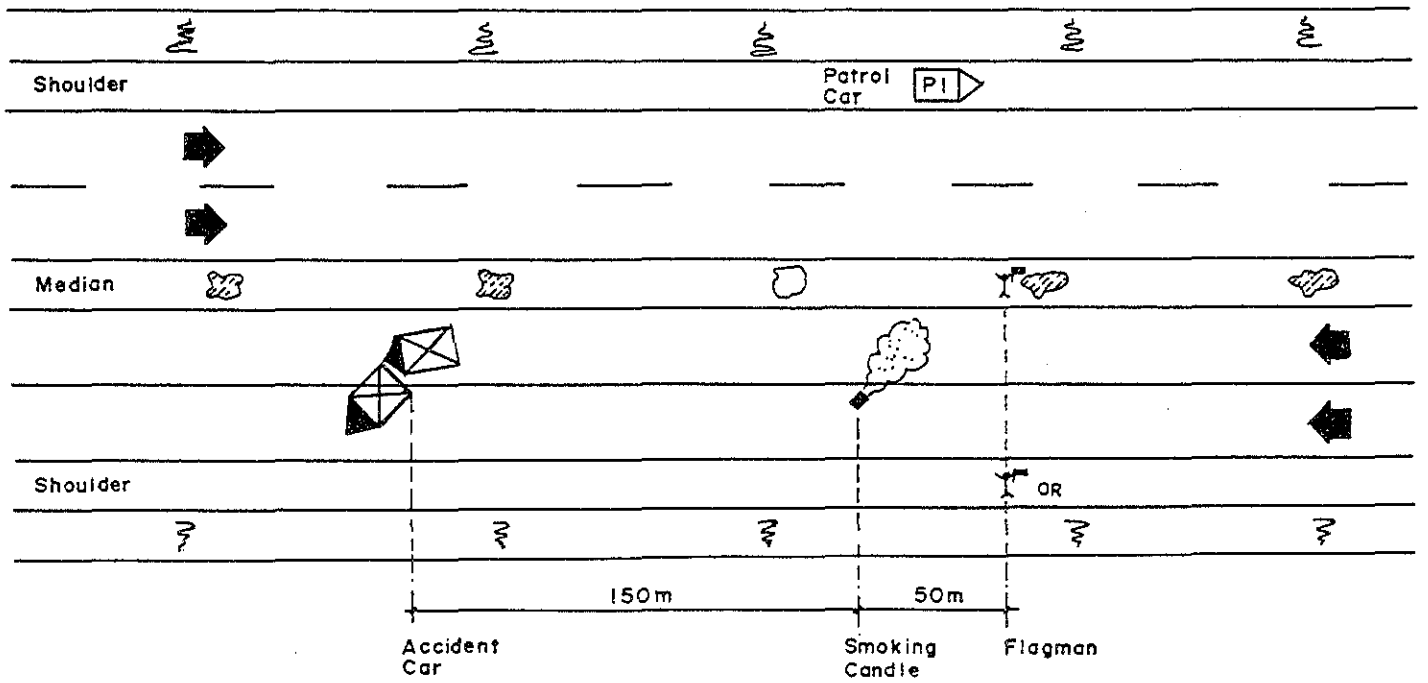


Figure 4.6.1: Traffic Control Measures to be Taken by Police Patrol if Approach from the Opposite Carriageway

(c) Accident Investigation

* Accident and crime investigation is the responsibility of the police. The investigation is essentially arrived at establishing the party who is responsible for the accident and the cause of the accident.

* For the purpose of investigation, the police has to ensure that the scene is preserved, i.e. vehicles are not moved and so on. Confirmation from witnesses are to be sought.

* Various essential facts must be established on the investigation, such as the location, the exact position of the accident vehicles, type and extent of damages (pictures to be taken as evidence), any broken parts, and so on. These are to be carefully recorded to assist in establishing the cause of accident.

  - Date and Time of Accident
  - Weather Condition
  - Parties Involved (names, sex, age, address, occupation, drivers physical state eg. under influence of alcohol, fatigue, etc.)
  - Type of Accident (rear collision, side swipe, etc.)
  - Damages
  - Cause of Accident
  - Happening Sequence (hearing from witness, establish by assessing location of vehicles, point of collision, damages, etc.)
  - Evidence (tire marks, broken glass, spilled load, blood mark, spilled oil, loss of vehicle parts, etc.)

(d) Lifting of Traffic Control Measures

* After the accident investigation has been satisfactorily completed and all other tasks required of the traffic patrol personnel (as in 4.5) have been fully completed, the patrol police is to ascertain that it is safe to lift off any warning or measures and report back to TCC.

(e) Accident Reporting

* The patrol police officer has to record all the investigated facts in the Road Accident Report (prepared by the Royal Malaysian Police) and assist the highway patrol officer in filling up the highway accident investigation sheet.

NO. BATCH 1 ☐☐☐☐☐☐☐

NO. SIRI 8 ☐☐☐☐☐

POLIS DI RAJA MALAYSIA
LAPORAN KEMALANGAN JALAN RAYA

POL. 27
(Pin. 1987)

(Borang ini mestilah diisi dalam 3 salinan)

A BUTIR LAPORAN

1	No. Laporan	13 ☐☐☐☐☐☐
2	Jenis	19 ☐
3	Tahun	20 ☐☐☐☐

B MASA

1	Bulan (01 – 12)	24 ☐☐
2	Tarikh (01 – 31)	26 ☐☐
3	Hari(1–Ahad,7–Sabtu)	28 ☐
4	Jam (0001 – 2400)	29 ☐☐☐☐

C LOKASI

1	Kod Balai	33 ☐☐☐☐☐☐
2	Jenis Jalan	39 ☐
3a	Kod Jalan	40 ☐☐☐☐☐
3b	Nama Jalan	
4	Pos Km/Simpang	45 ☐☐☐
5	Jarak (m)	48 ☐☐☐
6	Jenis Tempat	51 ☐
7	Jenis Kawasan	52 ☐☐

D BUTIR–BUTIR JALAN RAYA

1	Jenis Jalan Raya	54 ☐
2	Bentuk Jalan Raya	55 ☐
3	Had Laju Kawasan (km/j)	56 ☐☐☐
4	Jenis Garisan Tengah	59 ☐
5	Jenis Kawalan	60 ☐☐
6	Jenis Permukaan	62 ☐
7	Kualiti Permukaan	63 ☐
8	Keadaan Permukaan	64 ☐
9	Keadaan Sekitar	65 ☐

E SUASANA PERSEKITARAN

1	Cuaca	66 ☐
2	Cahaya	67 ☐

ULASAN

F BUTIR–BUTIR KENDERAAN YANG TERLIBAT

1 Jumlah Kenderaan Terlibat 68 ☐☐

2 Bilangan	3 Nombor Pendaftaran	4 Jenis Kenderaan	5 Jenis Muatan	6 Pemilik Kenderaan	7 Jantina Pemandu	8 Pergerakan Kenderaan	9 Kenderaan Diubahsuaikan
1 70	☐☐☐☐☐☐☐☐	☐☐	☐	☐	☐	☐☐	☐
2 86	☐☐☐☐☐☐☐☐	☐☐	☐	☐	☐	☐☐	☐
3 102	☐☐☐☐☐☐☐☐	☐☐	☐	☐	☐	☐☐	☐
4 118	☐☐☐☐☐☐☐☐	☐☐	☐	☐	☐	☐☐	☐
5 134	☐☐☐☐☐☐☐☐	☐☐	☐	☐	☐	☐☐	☐
6 150	☐☐☐☐☐☐☐☐	☐☐	☐	☐	☐	☐☐	☐
7 166	☐☐☐☐☐☐☐☐	☐☐	☐	☐	☐	☐☐	☐
8 182	☐☐☐☐☐☐☐☐	☐☐	☐	☐	☐	☐☐	☐

G BUTIR–BUTIR KECEDERAAN

1 Bilangan	2 Pengguna Jalan	3 Umur	4 Bangsa	5 Jantina	6 Jenis Kecederaan	7 Pemakaian Keledar	8 Kedudukan Penumpang	9 Bilangan Kenderaan
1 198	☐☐	☐☐	☐	☐	☐	☐	☐	☐
2 208	☐☐	☐☐	☐	☐	☐	☐	☐	☐
3 218	☐☐	☐☐	☐	☐	☐	☐	☐	☐
4 228	☐☐	☐☐	☐	☐	☐	☐	☐	☐
5 238	☐☐	☐☐	☐	☐	☐	☐	☐	☐
6 248	☐☐	☐☐	☐	☐	☐	☐	☐	☐
7 258	☐☐	☐☐	☐	☐	☐	☐	☐	☐
8 268	☐☐	☐☐	☐	☐	☐	☐	☐	☐
9 278	☐☐	☐☐	☐	☐	☐	☐	☐	☐
10 288	☐☐	☐☐	☐	☐	☐	☐	☐	☐
11 298	☐☐	☐☐	☐	☐	☐	☐	☐	☐
12 308	☐☐	☐☐	☐	☐	☐	☐	☐	☐
13 318	☐☐	☐☐	☐	☐	☐	☐	☐	☐
14 328	☐☐	☐☐	☐	☐	☐	☐	☐	☐
15 338	☐☐	☐☐	☐	☐	☐	☐	☐	☐

H ORANG YANG TERUTAMA SEKALI DISALAHKAN / TERLIBAT

1	Sebutkan samada : 1 –Disalahkan 2 –Terlibat	348 ☐
2	Bil. Kenderaannya di F–2	349 ☐
3	Pengguna Jalan Raya	350 ☐☐
4	Bangsa	352 ☐
5	Jantina	353 ☐
6	Umur	354 ☐☐
7	Kelayakan	356 ☐
8	Kedudukan Lesen	357 ☐
9	Cara Mendapat Lesen	358 ☐

J JENIS KEMALANGAN

1	Jenis Pelanggaran	359 ☐☐
2	Rumusan Siasatan	361 ☐
3	Sebab Utama Kemalangan	362 ☐☐
4	Sebab-Sebab Lain	

364 ☐☐ 366 ☐☐ 368 ☐☐

J ANGGARAN KEROSAKAN

1	Kenderaan	370 ☐☐☐☐☐☐
2	Harta	376 ☐☐☐☐☐☐

PEGAWAI YANG MENGISI LAPORAN

Tandatangan: _____

Nama: _____

Nombor: _____

Pangkat: _____

DISEMAK OLEH

Tandatangan: _____

Nama: _____

Nombor: _____

Pangkat: _____

5.0 REFERENCE

5.1 Basic Standards for Road Inspection, Repair and Improvement

5.2 Terminology

5.3 Related Laws and Regulations

5.0 REFERENCE

5.1 Basic Standards on Road Inspection, Repair and Improvement

5.1.1 Inspection

Road inspection constitutes one of the basic maintenance tasks in keeping the road and related facilities in good condition. Road inspection is thus aimed at spotting any defect on the road and facilities quickly so that countermeasures can be taken right away before such defects become dangerous to the road users.

(1) Type of Inspection

There are three types of inspection depending on the objects of inspection:

* Daily Inspection
* Periodical Inspection
* Incidental Inspection

The content, frequency and coverage differ among these three different inspections. Table 5.1.1 shows the contents and frequency of daily and periodical inspection.

The extent of damages discovered during inspection are recorded and ranked according to an assessment of their effects on traffic safety and thus their urgency in restoration (see Table 5.1.2 below). Figure 5.1.1 shows the work flow for highway inspection.

Table 5.1.1: Items and Frequency of Daily and Periodical Inspection

Inspection Category and Item		Type of Inspection	
		Daily	Periodical Inspection (once/day)	Inspection (once/year)
Road Surface	* Pavement		●	●
	* Expansion Joint		o	●
Slope	* Turf Slope		o	●
	* Special Slope		o	●
	* Concrete Embankment		o	●
Drainage Facility	* Surface Drainage * Shoulder		o	●
	* Median		o	●
	* Slope Drainage		o	●
	* Bridge Drainage		o	●
	* Slip Road Drainage		-	●
Bridge	* Concrete Structures		-	●
	* Steel Structure		-	●
	* Floor Plates		-	●
	* Painting		-	●
	* Beams		-	●
	* Railing		o	●
Tunnel	* Ceiling		o	●
	* Wall Bridge		o	●
	* Drainage Facility		o	●
Culvert	-		-	●
Traffic Safety Facility	Guardrail Delineators, Others		o	●
Traffic Management Facility	Signs		o	-
	Kiloposts and others		●	-
Vegetation	-		o	-
Traffic Condition	-		●	-

Legend: o Partial Inspection
● Overall Inspection

Table 5.1.2:Ranking of Damages during Inspection for Urgency in Restoration

Rank	Effects on Traffic and Safety	Restoration Urgency
1	Damage is profound which clearly affects or may affect traffic safety	Immediate repairs needed
2	Damage is substantial but post little or no danger to third party	Repairs is needed
3	Damage is small and pose little or no danger to third party	Deliberation on whether to repair
4	No damage or unusual condition is detected	-

(2) Daily Inspection

Daily inspection is carried out using patrol cars with visual observation of road surface, slope, drainage, bridge, tunnel, culvert, traffic safety and management facilities and traffic conditions.

Daily inspection has to be carried out at least once a day.

(a) Road Surface

Look out for surface obstacles or road surface damages which may pose danger to road users. Fallen objects or fallen rocks are dangerous obstacles to road users. Pavement damages such as faulting, rutting and damages at bridge expansion joints can cause vehicles to loose control.

Daily inspection is thus to spot such damages and report them for repairs. If they are found to be serious, rank them accordingly in the inspection report and alert maintenance personnel for immediate repair.

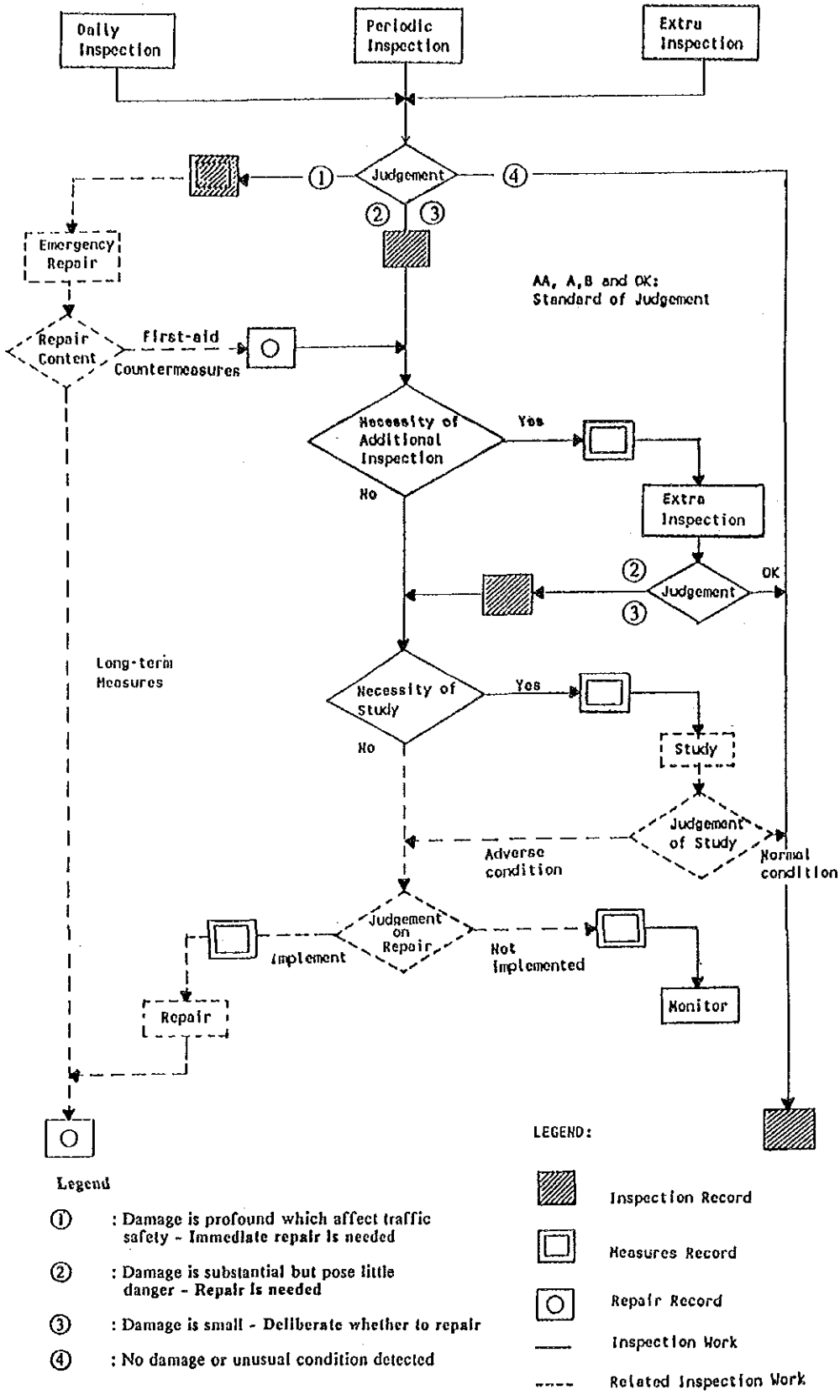


Figure 5.1.1: Work Flow for Highway Inspection

(b) Slopes

If cracking or bulging are spotted on the turfed or other slopes, the scale of cracking, number of cracks and their surrounding condition have to be carefully observed and recorded. Furthermore, the potential danger of such cracking to traffic safety has to be assessed and rank them accordingly for maintenance personnel to follow-up with repair work.

Failure of cut slope often pose direct danger to traffic. Inspect the road shoulder of a cut slope section for any fallen concrete chips or cracks after a heavy downpour. If such fallen objects are found whereby indicating possible damages on the slopes, a careful slope inspection work must be carried out.

(c) Drainage Facility

Damages to drainage facility have the most significant effect on its functions. When inspecting the drainage facility during raining condition, look out for any water stagnation on road surface, clogged drains, blockages by accumulated sand, earth or dried vegetation.

(d) Bridge

Railings and the joints are the main items of bridge inspection. If any damages to concrete structures are found, the extent of damages must be carefully inspected.

(e) Tunnel

Damages to tunnel ceiling (concrete or ceiling board) have grave effect on traffic safety in the tunnel. Early detection of such damages is one of the major task of daily tunnel inspection. As certain portions of the tunnel ceiling are not well lit and making visual observation difficult, look out for any concrete chippings or bolts that may have fallen on the road surface.

(f) Traffic Safety and Management Facility

Damages to traffic safety and management facility are frequently caused by traffic accidents, especially those listed under "unknown reasons". Guardrails, delineators and others have to be routinely inspected. Other facilities such as streamer, road signs also have to be inspected.

(g) Vegetation

Daily inspection also includes the observation of vegetation (turf and shrubs) within the scope of viewing from the patrol car. The inspection has to look out for fallen branches or trees, overgrown branches which may affect drivers' vision, traffic flow and safety. Others items for inspection include the general vegetation growth, foliage or trunk damages by insects, etc.

(h) Traffic Conditions

Daily inspection also includes the observation of general traffic conditions on the highway. Traffic volume, travel speed, traffic congestion, accident; traffic safety measures implemented for road maintenance and repair works and so forth are the main items for inspection.

Table 5.1.3 shows the checklist of daily inspection items by category.

(3) Periodic Inspection

Periodic inspection is to inspect structures and facilities not covered by the daily inspection. Periodic inspection is carried out on fixed time period on foot as compared to using the patrol car for the daily inspection. Periodic inspection is therefore able to assess the structural well being of road surface, civil structures and other facilities. Periodic inspection is carried out using both visual observation as well as equipment if needed.

In principle, periodic inspection is carried out once a year based on the inventories on civil structures and the inspection must cover from the largest element to the smallest element.

Table 5.1.3: Checklist of Daily Inspection Items by Category

HIGHWAY INSPECTION CHECKLIST

Countermeasures to be Taken
*Immediate Repairs *Emergency Repairs *Further Inspection *Survey *Observation

Category	Sub-Category	Components	Items
Road Surface	Pavement	*Asphalt Pavement	*surface obstacles (fallen objects, rock, spills) *Pothole, sinkage *faulting *rutting *cracking *corrugating *surface peel-off
		*Concrete Pavement	*surface obstacles(fallen objects,rocks,spills) *pothole *sinkage *faulting *rutting *cracking *corrugating *warping *bulging
	Expansion Joint	*Grooves	*joint damage *toe damage *leakage *faulting *unusual sound
		*Rubber Joint *Metal Joint	*joint damage *toe damange *leakage *faulting *unusual sound
	Curb	-	*curb damage
Slope	Sodded Slope	-	*slip *crack,bulge,sinkage *gully erosion *soil accumulation on berm *spring water *fallen tree,overgrown weeds *dying vegetation *falling rock
	Special Slopes	*Concrete Block Crib *Concrete/mortar Spraying *Concrete Block Pitching	*cracking *bulging, sinkage *loosening *spring water *erosion *hollowing
		*Netting/fence against fallen rocks	*rock accumulation *broken netting/fencing
	Masonry	*Concrete Block Masonry *Concrete Block Pitching *Stone Masonry *Gabion	*cracking *sinkage, fallen parts *hollowing *erosion *spring water
	Concrete Retaining Wall	*R.C *Non R.C.	*cracking *exposure of reinforcement *sinkage *erosion *spring water *fallen parts
Drainage	Road Surface Drainage	*Shoulder Drainage *Median Drainage *Catchpit *Cascade Drains *Manhole	*damages to main *poor joints *blockage by sand,earth
	Slope Drainage	*Top of Slope Drains *Berm Drains *Toe Drains *Catchpit	*damages to main *poor joints *blockage by earth,sand *blockage by dried grass
	Bridge Drainage	*Catchpit *Drainage pipe	*damages to main *blockages *poor joints
	Slip Road Drainage	*Drains *Catchpit *Manhole	*damages *poor joints *blockages by sand *blockages by dead plants

Category	Sub-Category	Components	Items
Bridge	Superstructures	*RC Girder *PC Girder *RC Slab/PC Slab	*cracking *peel-off *hollowing *leakage *exposure/erosion of reinforcement *sinkage *falling parts
	Substructures	*Abutment *Piers	*cracking *peel-off *hollowing *leakage *exposure/erosion of reinforcement *sinkage *falling parts
		*Footing Protection *Revetment	*sinkage *shifting *washed-off
	Steel Structures	*Girder *Steel Plate Floor *Piers *Cross Beam	*leakage *crack *loosening/falling HT bolts *Loosening/falling revets *warping
	Painting	-	*crack *peel *leak
	Bearing	*Metal Bearing *Elastometric Bearing	*damages *erosion
	Railing & Curb	-	*damages *crack *erosion *broken corners
Tunnel	Lining and Portal		*leakage *crack *spring water *peel-off *exposure of reinforcement
	Drainage	-	*damages *blockages by sand/earth
Culvert	*RC Box Culvert *RC Pipe Culvert *Corrugate Pipe	-	*broken corners *damages *cracks *leaks *sinkage *exposure of reinforcement *blockage by sand,earth
Traffic Safety Devices	Guardrail	*Guardrail *Concrete Block	*damages *damage to foundation *damage to parts
	Delineator	-	*damages *broken *missing *peel-off
Traffic Control Facility	*Signs *Markings *Cateyes *Chatter Bars *Kilopost	-	*damages *missing *foundation damage *broken parts *peel-off
Others	Weather Observatory Devices	-	*damages *missing parts *malfunction
Vegetation	-	-	*pest damage *overgrown foliage *fallen branches *dying plants
Traffic Conditions	-	-	*accident *congestion *on-going repairs *traffic regulation measures

The proper recording and updating of road and structure inventories is therefore very important for effective inspection. The previous yearly inspection record must be used to ensure minor damages detected before being remedied or not being worse. If such damages have been left out or worsened, their prompt repairs must be called for.

(4) Incidental Inspection

Incidental inspection is inspection carried out at disaster-prone sections when adverse weather conditions are anticipated. These sections are to be identified using weather data collected and analyzed along the highway in relation to the stability and type of slopes. An "Anti-disaster Management Map" must be prepared indicating where the dangerous spots are and the degree of danger in relation to the level of weather conditions.

When adverse weather conditions occur, incidental inspections are to be carried out at these locations. If any slope is found to be unstable, report to the traffic control center.

(5) Slope Stability Evaluation

The stability of cut slopes are chiefly dependant on the geological features of the slope itself as well as the type of slope protection work used. Slope failure can pose serious danger to road users. A standardized procedure in slope evaluation is essential, covering wide areas of the cut slopes (Figure 5.1.2).

Slope evaluation is recommended to be carried out according to the following procedure:

(a) Evaluation and Ranking of Earthwork, Topography and Geological Features

(i) Earthwork

* Location of slope (Plateau, Hilly area)
* Slope gradient
* Slope height
* Slope protection work
* Slope drainage

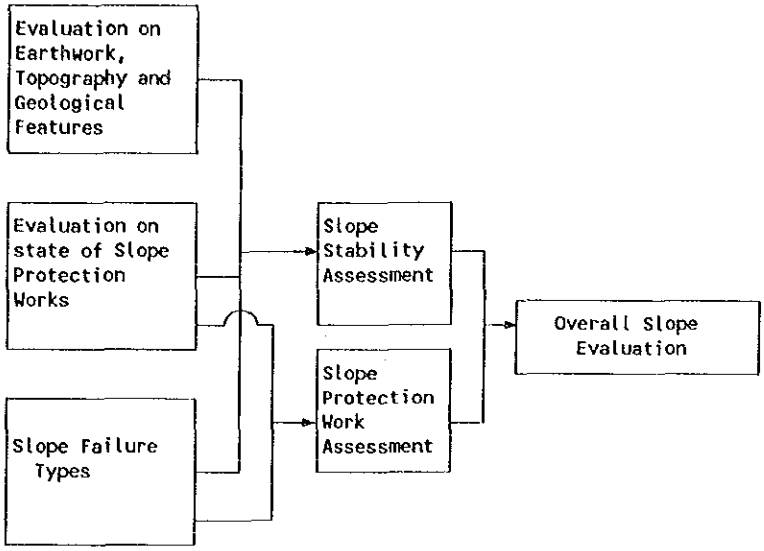


Figure 5.1.2: Procedure in Slope Evaluation

(ii) Topography

* Disaster prone/Unstable topography (Landslide, Cliff area)
* Water clogged area

(iii) Geology

* Degree of weathering of base rocks
* Present of any water spring
* Porosity of soil

Using these three features, an evaluation of the slope topographic and geological features is first carried out. The slopes are ranked accordingly as:

Rank "a" - Slopes having high failure prone features
Rank "b" - Slopes having fair amount of failure prone features
Rank "c" - Slopes having little failure prone features

(b) Evaluation and Ranking of Slope Protection Works

Evaluate and mark the type and state of slope protection works as follows:

Rank "aa" - Protection work is old and relatively unstable

Rank "bb" - * Protection work suffers deformation and in need of repairs (cracking, bulging, damage)
* Effect of protection work is diminishing (signs of initial cracking)

Rank "cc" - No deformation of slope protection works

(c) Characteristics of Likely Slope Failure

The slopes are classified here into five different likely failure characteristics under adverse weather conditions based on human judgement.

Type "a" - Erosion of slope forming gullies will occur
Type "b" - Surface peeling will occur
Type "c" - Failure with less than 1 m deep slips
Type "d" - Failure with over 1 m deep slips
Type "e" - Failure in large scale involving the entire slope and slipping of hinterland

Using the ranking and types in the three factors above, the slopes are assessed for their level of stability.
Level "1" - Unstable slope
Level "2" - Fairly unstable slope
Level "3" - Stable slope

Next, using the results of the last two factors, the slopes are assessed in terms of whether the existing slope protection works can withstand adverse weather conditions without serious slope failures.

Assessment "A" - Slope protection works offer no confidence to chances of failure

Assessment "B" - Slope protection works offer little confidence to chances of failure

Assessment "C" Slope protection works offer substantial confidence in chances of failure

(d) Overall Slope Evaluation

The slopes are thus evaluated using the matrix with the level of stability and slope protection assessment and categorized into I, II and III.

Slope Protection Assessment \ Stability Level	1	2	3
A	A1	A2	A3
B	B1	B2	B3
C	C1	C2	C3

Category

I — Dangerous Slope (Thorough slope checking is needed)

II — Fairly Dangerous Slope (Reinspection and survey of slope is needed)

III — Stable and Safe Slope

Slopes being categorized as "I" (dangerous slopes) or "II" or "III" are then listed up in respective lists (eg. Table 5.1.4) together with their locations marked on route map of 1:2500 scale. These maps and listing therefore would provide the necessary reference materials for emergency or incidental inspection.

km/ Direction	Left/ Right of Slope	Type of Slope Protection Work	Topographic, Geological Features			State of Slope Protection Works			Slope Failure Types					Slope Stability			Slope Protection Confidence			Overall Slope Evaluation		
			a	b	c	aa	bb	cc	a	b	c	d	e	1	2	3	A	B	C	I	II	III
			Slope with high failure prone feature	Slope with fair amount of failure prone features	Slope with little failure prone features	Protection work is old and unstable	Damages to protection work	No deformation	Gully erosion	Surface peeling	Failure with less than 3m deep	Failure with more than 3m deep	Large scale failure	Unstable slope	Fairly stable slope	Stable slope	No protection	Little protection	Sufficient protection	Dangerous slope	Fairly dangerous slope	Safe slope
45.5 (N)	R	Turf	o				o					o		o				o		I		
46.0 (N)	L	Turf	o				o				o				o		o			I		
48.0 (N)	R	Exposed	o				o					o		o			o			I		

Table 5.1.4: Example of Slope Assessment of a List of Slopes in Category ' I '

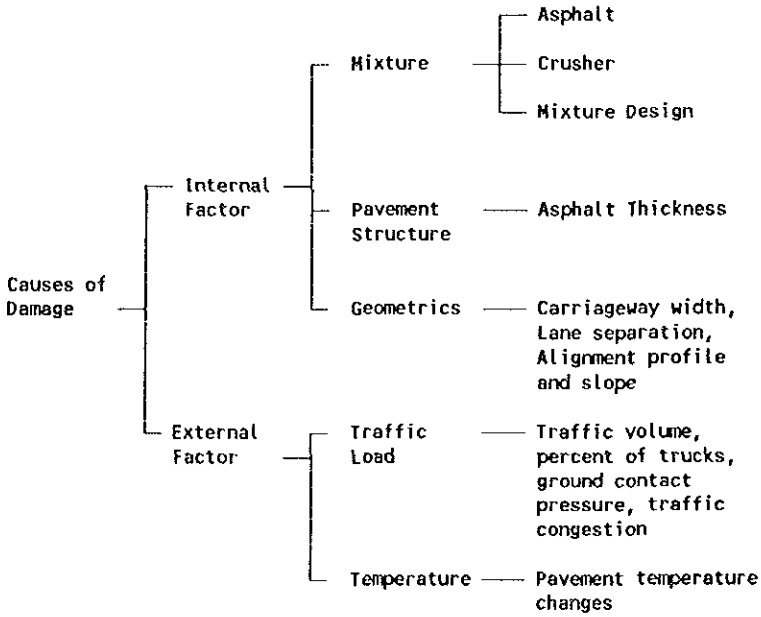
5.1.2 Pavement Repairs

(1) Damage to Asphalt Pavement

Asphalt pavement is generally made up of a surface course, a binder course and the base course or sub-base course. The bearing strength of pavement depends on how well the strength of each of these layers is maintained.

Water seepage through the surface course may penetrate the binder course and further down to the base course, softening or loosening these layers and thus weakening their bearing strength. When load is applied to these unstable structures, crack will appear on the surface which will soon deteriorate into adverse depression, grooves and other damages. In addition, if the proportion of bituminous material in the asphalt or surface course is insufficient, rutting, corrugating can easily occur.

Causes for pavement damages can be categorized into external and internal factors.



Internal factors are those pertaining to design material quality and structure of the pavement itself while external factors are those relating to loading on pavement (traffic volume, axle load of trucks) and temperature.

Table 5.1.5 gives the category of common asphalt pavement damages and their main causes.

Table 5.1.5: Category of Common Asphalt Pavement Damages and Their Main Causes

Category	Features	Causes
1 Crack	Longitudinal or traverse cracks	. Uneven subsidence at cut and fill boundary . Poor construction joint . Defective tack coating . Uneven bearing capacity of subbase
	Hair line cracks	. Inadequate asphalt content . Poor mix quality . Uneven bearing capacity of subbase . Insufficient pavement thickness
2 Faulting	Subsidence of pavement level at edges to building or structures	. Sinkage due to inadequate initial compaction . Subsidence of embankment subbase
3 Rutting	Traverse bulging of asphalt mix creating uneven surface	. Excessive bituminous content . Poor mix quality . Large number of heavy trucks . Vehicles passing consistently at one location
4 Linear Deformation	Longitudipal wave-like deformation	. Excessive asphalt content . Poor mix quality . Insufficient voids for binders . Uneven bearing capacity of subbase and subgrade . Uneven spread of tact coat or prime coat
5 Corrugation	A series of wave like deformation resembling that of a washing board	. Excessive asphalt content . Poor mix quality . Insufficient voids . Uneven bearing capacity of subbase and subgrade
6 Loss of Skid Resistance	Smoothening of surface	. Inadequate asphalt content . Poor mix quality . Aging of asphalt
7 Pot Hole	Holes appear on surface after abrasion of mix	. Inadequate asphalt content . Overheating of asphalt . Uneven mix . Inadequate compaction

(2) Repairs of Asphalt Pavement

Repairs of damages to asphalt pavement are generally done using the following methods:

(a) Patching
(b) Surface Treatment
(c) Overlay
(d) Replacement
(e) Scarifying and Overlay
(f) Crack Repair

(a) Patching

Damages to asphalt pavement can be temporarily repaired once they are spotted using a method called "patching". This is to check the damage immediately and prevent any further deterioration of damage.

For example, once a pot hole is spotted after heavy rain, it must be quickly patched up to prevent further deepening or widening of the hole.

(b) Surface Treatment

Surface treatment is to evenly spread a thin layer of bituminous material as seal coat, then top with a thin layer of asphalt mixture to strengthen the surface. The thickness is less than 3 cm (over 3 cm would be called overlay). Compared to overlay or replacement, this is a more economic method in pavement repair.

(c) Overlay

Overlay is recommended for surface that has many cracks or to areas where rutting and pot holes have occurred which are likely to affect a large area. In overlaying the pavement, a heated asphalt mix is evenly spread over the surface for a thickness of 3 cm or more before compaction is applied.

(d) Replacement

This is by far the most costly method of pavement repair because it involves the removal of the damaged pavement and then replaces it with a new course. This method is used only for areas where other methods are deemed unable to restore the pavement to a satisfactory condition.

In carrying out replacement work, care must be taken to investigate the drainage system, ground water level, subgrade materials, thickness of subbase or subgrade, etc.

Table 5.1.6 gives the various repair methods for each category of damage.

Table 5.1.6: Type of Pavement Damage and Their Repair Methods

Damage	Repair Methods
1. Crack	. Sealing of cracks . Surface treatment . Scarifying and overlay
2. Faulting	. Overlay . Patching . Replacement . Scarify and overlay
3. Rutting	. Overlay . Scarifying and overlay . Replacement
4. Linear Deformation	. Patching . Overlay
5. Congestion	. Overlay . Scarify and replacement
6. Loss of Skid Resistance	. Carpet coat . Surface treatment . Scarifying
7. Pothole	. Patching . Replacement

5.2 Terminology

(1) Organization

(a) Headquarters

The headquarters is responsible for the overall planning and programming, carrying out studies, research, development and formulation of standards on expressway facility design, traffic engineering, traffic operation, traffic safety and maintenance.

The headquarters is to be solely responsible for inter-urgency cooperation, liaison at the national level.

(b) Regional Office

The regional office is to carry out the planning of maintenance works, improvement and repair works on the highway under the headquarters management. The regional office is to be fully responsible for the daily operation, control and management via its lower level offices.

(c) The Maintenance Office

The maintenance office is mainly responsible for carrying out daily field activities as planned by the regional office, such as patrolling, routine maintenance and repair works of the highway.

(d) Traffic Control Center

The traffic control center is equipped with various terminal equipment for the surveillance of traffic and road conditions, conveyance of information to drivers, incident response and traffic management on the expressways. TCC is the "nucleus" to which patrolling personnel on site will report the actual road or incident conditions; and from which instructions are given to patrolling personnel for various actions or measures to take during an emergency or incident.

(2) Traffic Control and Management

Traffic control and management has three goals; traffic safety, smooth traffic flow and comfort on expressways and highways. In order to achieve these goals, traffic control and management has two basic functions; traffic operation and maintenance.

(a) Traffic Management

Traffic management means to maintain safety and convenience of expressway and highway through the activities of the management body and other agencies concerned, and through the operation of various facilities installed on the expressway and highway.

(b) Traffic Operation

Traffic operation has four components; traffic control, traffic surveillance, toll collection and traffic regulation.

(c) Traffic Control

Traffic control on the expressway includes not only the general daily traffic control under normal conditions carried out by highway or police patrol units along the expressway but also those measures taken under unusual conditions. Such unusual conditions include traffic accident, adverse weather phenomena and conditions generated as a result of executing various improvement works to the expressway.

The traffic control component also performs information dissemination. Road conditions, traffic conditions or weather information are conveyed to the drivers via such media as radio broadcasting and changeable message signs.

(d) Traffic Surveillance

Traffic surveillance is aimed at collecting road conditions and traffic information through various means such as vehicle detectors, closed-circuit television, aerial surveillance, emergency telephone, cooperative motorist, mobile telephone, patrol vehicle, etc.

Traffic information collected and processed are interpreted by traffic engineers and passed on to police or patrol personnel for traffic control.

(e) Toll Collection

At toll collection plazas or gates, equipment are also installed for the collection of data. Toll ticketing itself provides traffic data such as traffic volume data and traffic composition.

(f) Traffic Regulation

Traffic regulation which is the jurisdiction of the police, legitimates the various traffic control measures as provided by the governing traffic laws and regulations; such as speed limit control, closure of a lane or even a section of the highway.

(g) Maintenance

The function of maintenance of an expressway or highway can be distinctively divided into three categories. These are carried out by the maintenance offices on their respective managed sections or routes.

* Routine maintenance
* Periodical maintenance
* Incidental maintenance

(h) Patrolling

Highway patrolling is done by means of riding in patrol cars and travelling along the highways. During the patrol, fallen objects, if spotted, have to be removed. Breakdown vehicles stranded on the highway have to be towed away to prevent traffic accidents. Highway patrolling has to report the road surface conditions back to the traffic control center or maintenance office.

(i) Roadside Assistance

It is the duty of the patrolling officer to offer assistance to disabled vehicles by towing them to a safe location and summoning mechanics to repair the vehicles. If large trucks are stranded, assistance in the form of summoning the nearest private towing company has to be offered to such vehicles so that they may be removed as soon as possible.

(3) Traffic Management Equipment

(a) Vehicle Detector

Vehicle detectors are equipment installed along highways but at selected locations to capture directional traffic volume data, speed, density, occupancy and queue length of the traffic stream. Vehicle detector is the basic yet most commonly employed data gathering equipment on highways and roads in collecting quantitative traffic related data.

Many different types of detectors are available:-

* Pressure
* Magnetic
* Loop
* Radar
* Sonic
* Radio Frequency
* Light Emission

The latter two types are used for the detection of priority vehicles such as buses, police cars and fire trucks.

Vehicle detectors may be used either solely or in combination to measure variables of volume, presence, speed and occupancy.

The commonly used type of vehicle detectors are the ultrasonic-sensor or radar type installed above traffic lanes and the loop-coil type installed beneath the road surface.

Information collected by the detector are directly conveyed via communication cable to the computer in the traffic control center. The information is then automatically processed by the computer and printed out in easy-to-read formats.

(b) Closed Circuit Television System

CCTV system in a traffic control and management system is used mainly for the following applications:

* Traffic flow monitoring
* Disaster prevention in tunnel
* Weather observation
* Others

CCTV system is one of the information collection tools and used to confirm the occurrence of congestion and other incidents in conjunction with the quantitative data obtained by detectors. It provides visual information which is more intuitive and comprehensive than figures and has proved to be an essential component in the traffic surveillance system.

As one of the disaster prevention facilities, CCTV system in tunnel provides information on site situation and facilitates the effective execution of adequate countermeasures should an incident occur in the tunnel.

In connection with weather observatory equipment, CCTV system is also used to evaluate the data sent from these equipment and to formulate the countermeasures. It can also be installed at toll gate to monitor the toll gate operation.

These four applications are not mutually exclusive and in many cases a camera is installed for multiple purposes.

CCTV system consists of central equipment including receiver/controller, an operator console and monitor TVs at the control center, cameras and controllers at the site and cable connecting between the center and the site. From the control center, command signals such as power ON/OFF, pan, tilt, zoom, telescope, etc. are sent to the controller, while video signal is transmitted to the center. Video tape recorder with a time signal

generator will be included in the central equipment for recording and playing the image data.

The camera is provided with a zoom lens which is capable of automatic iris control and focussing. It is incorporated in a rain-proof housing and mounted on the universal head. The head will be provided with pan and tilt functions.

(c) Emergency Telephone

Emergency telephones are exclusive telephones installed at regular intervals at curbside along highways and linked to traffic control center or room. Emergency telephone is the important communication tool for users to traffic control personnel seeking assistance such as during accident or breakdown and informing the traffic control room of such incidents on the highway as fire, disaster, fallen obstacles on highways, etc. In the United States of America, emergency telephones are commonly called "Call Boxes".

Emergency telephones are largely divided into two types:

Centralized Call Receiving System
Calls from all emergency telephones are received collectively at a center from which they are transferred to other locations when required.

Independent Call Receiving System
Emergency telephone is provided with selection buttons by which users of emergency telephones are capable of selecting their contact point (freeway administration agency, repair shop, etc.).

Basically, there are two types of emergency telephone sets, one with a built-in speaker, a microphone and one or more push buttons to initiate a call and another with a handset. In the latter case, call is initiated by lifting up the handset from the cradle. Functionally, these two types are the same. In Malaysia, the former type is already in use but number of buttons differ from one to four as reported in Chapter 2.

(d) Weather Observatory Equipment

Weather observatory equipment, capable of measuring conditions of rain, fog, wind and others are often installed at selected locations (locations prone to inclement weather conditions) to constantly monitor these weather changes. These equipment are often directly linked to the traffic control centers whereby data are transmitted and processed by computers. Since these equipment can only measure weather conditions at one particular spot, the selection of their locations is very important.

Element	Features	Equipment
Rain	Rainfall Rain Intensity Precipitation	Rain Sensor
Wind	Wind Velocity Wind Direction	Anemometer Wind Rose Streamer
Fog	Visibility	Visibility Indicator

The rain sensor is capable of immediate detection of the presence of rain and is characterized by the non-detection of fog and dew. To detect rain, this sensor employs an electro-conductive method utilizing such material as platinum, etc.

In the rainfall sensor, a water faucet measuring 200 mm in diameter is employed. To measure the quantity of precipitation, a turn-over liquid measure system is used in many instances. When liquid measure turns over once with a rainfall of 0.5 mm to 2 mm, one pulse is generated. From the number of pulses, the quantity of precipitation can be found. Normally, through use of the rainfall sensor, the following data are computed to monitor rainfall:

* Precipitation for 10 minutes
* Precipitation for 1 hour
* Precipitation for 3 hours
* Cumulative precipitation
* Effective precipitation (during a given time)

Several kinds of anemometer are available and propeller type anemometer is commonly used for the freeway applications. For meteorological height where the wind is not affected by buildings nearby. While to measure the influence of the wind on moving vehicles at the spot along the freeway and provide wind information to drivers, anemometer is positioned at the height two to three meters above the ground.

Range of measurement is usually 0 to 60 meters per second and 0 to 540 degrees for velocity and direction respectively. While the wind resistance of the meter itself is necessary to be more than 70 meters per second.

(e) Changeable Message Sign

Changeable message signs (CMS) or sometimes called variable message signs are visual communication facilities which are installed at strategic points on the freeway to give the drivers such information as congestion, occurrence of accident, road condition and detour recommendation. The information (message) displayed at the terminal is set automatically by a computer or manually by operators.

Changeable message signs can come in many different types and forms:

1. Fixed Message Signs with Flashing Beacons
2. Scroll Type
3. Fiber Optics
4. Lamp Matrix
5. Light Emitting Diode (LED) Matrix
6. Electro-magnetic Matrix

Fixed-message signs with flashing beacons are used by many agencies to warn drivers of hazards due to adverse environmental, roadway or traffic conditions. The flashing beacons generally are mounted on each side of the sign panel and are actuated when the hazard exists.

This type of sign can be applicable to the sections with limited sight distance, for example, due to vertical curve or winding alignment, the location where there exists consistent congestion, or the toll gate which often forms queues downstream.

In the scroll type of CMS, the viewing face of the scroll sign is formed by a continuous belt of flexible cloth or plastic material containing a number of message. The belt is stretched between two storage drums that are rolled until the desired message is displayed. In many cases the message belt is made of translucent material permitting back illumination. Scroll sign may be applicable to the location on streets and roads approaching on-ramps and displays traffic, road and environmental conditions on the freeway and the ramp-closure. This type is susceptible to mechanical troubles compared with electronic ones.

A fibre optics basically display disperses light energy from a point light source through fiber bundles that form messages and symbols on the sign's face, signs capable of displaying up to 14 messages have been developed in Europe. Any kind of graphic design and message are possible but its number is limited and they are fixed and difficult to change. Visibility is good as the elements emit the light but brightness is generally lower than lamp matrix type.

Lamp matrix display is formed by an array of incandescent bulbs for each message line. The array can either be a continuous field of bulbs or a fixed number of matrix modules. Typically, the number of message lines varies from one to four. By independently controlling on or off state of each bulb, any messages or graphic symbols can be displayed. Messages can be displayed statistically or flashed on and off. Messages change almost instantaneously when a new message is selected. Because of the use of incandescent bulbs, this type has enough visibility under the bright daylight.

LED matrix sign is identical to the lamp matrix type except LED matrix is used in place of incandescent bulb. Matrix of LED arranged four columns by four rows replaces one incandescent bulb. Normally LEDs of two different colors, red and yellow, are used so that messages and symbols can be displayed in red, yellow or orange color. Because of high density of LEDs, the sign can display minute image than lamp matrix type. Use of LED also provide longer life and lower power consumption compared with lamp matrix type.

Disk matrix signs are similar to the lamp matrix with the exception that electro-magnetic elements rather than lamps are used to form the legend characters. The elements are made of plastic and take the form of disk, sphere or cube. A portion of the element is permanently magnetized. One side or face of the element is flat back to match the sign face background. Other sides, which is used to form the message characters, are colored, usually in greenish yellow if disk or sphere is used and red, white and blue if the element is cube. Messages are displayed by electro-magnetically flipping appropriate elements from one side to the other.

This type of sign consumes power only when the display is changed and no power is consumed to maintain the displayed. But during night time, light is necessary.

Depending on whether it is a single message display CMS or multiple message CMS, and the length of messages, the signboards will have to be designed to suit these needs and thus come in different sizes. Depending on its size, CMS may be gantry mounted or overhanged.

(f) Changeable Speed Limit Sign

Changeable speed limit sign is installed along the freeway and used to inform drivers of the speed limit being enforced. The sign is capable of displaying two or three different speed limits in accordance with the command from the control center. Reduction of speed limit is required when the original speed limit is hazardous under the inclement weather condition.

Changeable speed limit signs also come in different forms or makes. The three common types are:

* Lamp matrix type
* Rotating disk type
* Fiber optics type

Lamp matrix type displays the figure by dots of lamps. This type has high visibility and easily recognized by drivers even under fog or heavy rain.

For the rotating disk type, two or three disks with different speed limit painted on them are concentrically placed and speed limit in effect is shown by rotating by a motor the disk with the corresponding figure to the top of other disks.

Fiber optics type is a variation of the sign described in the preceding section on changeable message sign. Fiber bundles are formed into figures and light from a source is guided to the sign surface to express two or three speed limits.

(g) Highway Radio

Highway radio is one of the information dissemination devices on the freeway. It utilizes the conventional car radio as the information receiving device thus eliminating the necessity of additional equipment on the vehicle side. It uses near-end of the AM band frequency not used by commercial radio station but can be received by car radio. It provides information, usually more in detail compared with message shown on changeable message sign, in the form of voice so that drivers' sight is not disrupted to obtain information.

Another advantage of the highway radio over changeable message sign is that more than one message can be conveyed to the drivers at a time.

Highway radio system consists of message preparation device, antenna on the freeway and car radio. Message preparation device includes voice synthesizer, interactive message editing, video terminal and tape recorder. Antenna is selected among directional antennas using slit cable or parallel cable, or non-directional antennas based on the area covered, ambient noise level, antenna location.

Information on road, traffic and weather obtained by information collection function of traffic control and management system is edited and arranged in the order of priority and then input to the highway radio system. Automatic preparation of information by computer and voice synthesizer is possible and effective for the

information on recurrent congestion. As a voice source, microphone and tape recorders are also used in the system. Different information is prepared for the different section of freeway according to the relevance and priority of all information collected.

(h) Axle Load Weighing Bridge

It is important to prohibit large trucks with axle load of more than 10 ton from using the highway so as to preserve the pavement conditions. Besides, overloaded trucks often face brake failure, slow travelling speed may pose danger to other road users.

Axle load weighing bridges installed on the truck lane at entry booths are to screen off overloaded trucks from entry into the highway