Traffic Engineering Course e-Book

1st Edition (2020)

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Traffic Engineering Course

e-Book

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Preface

This e-book is intended to offer the students with a clear and precise understanding the basic of traffic engineering. The content of each chapter are divide into a few sections with related topics according to the real situation. This e-book will prefer students to understand the basic of traffic engineering easily.

The chapter on this book are include an enlarge section on the knowledge regarding the method and design involved in traffic engineering. It also emphasizes on introduction to traffic, transportation planning, junction design, and traffic management.

Authors of this e-book were extremely grateful that the first edition of Traffic Engineering Course e-Book has been more useful at any level. The authors of this e-book were significantly involved in Traffic Engineering Course throughout the years and put their ideas and knowledge together in writing up this e-book. We hope this book will prove valuable for students and it as part of their reference to help them in basic of Traffic Engineering.

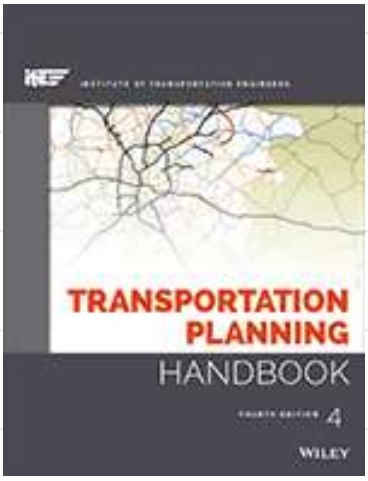
Topic 1

TRANSPORTATION PLANNING

1.1 THE CONCEPTS OF TRANSPORTATION ENGINEERING

1.1.1 Introduction of transport and road engineering

Transport Engineering



(Source: Institute of Transportation Engineers, ITE (1987))
Transportation engineering is the application of technology and scientific principles to the planning, functional design, operation and management of facilities for any mode of transportation in order to provide for the safe, rapid, comfortable, convenient, economical and environmentally compatible movement of people and goods.

Transport or transportation is the movement of people, animals and goods from one location to another. Transportation allows people and things to go places, whether it is across a room or across an ocean. There are many forms of transportation, like walking, bicycles, cars, trains, aircraft, boats, and in fact, anything that allows a person or item to move. Therefore, transportation facilities, such as opening of new roads and public transport system should be provide sufficiently for the development of a country's society.

Highway engineering

A branch of civil engineering that includes planning, design, construction, operation, and maintenance of roads, bridges, and related infra-structure to ensure effective movement of people and goods

Traffic engineering

A branch of transportation engineering "that phase of transportation engineering which deals with planning, geometric design and traffic operations of roads, streets and highways, their networks, terminals, abutting lands and relationships with **other modes of transportation**. *(Source: Institute of Transportation Engineers (ITE) of the U.S)*.
However, traffic engineers also consider traffic safety by investigating locations with high crash rates and developing counter measures to reduce crashes.

Relationship between transport, human and goods

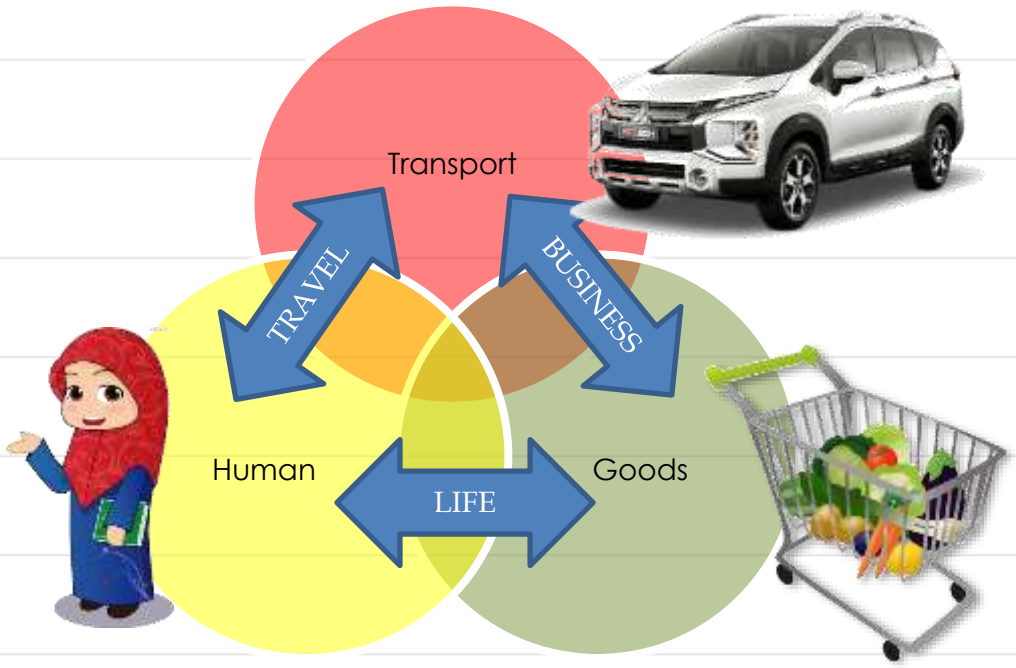


Figure 1-1: Relationship between transport, human and goods

The relationship between transport, people and goods

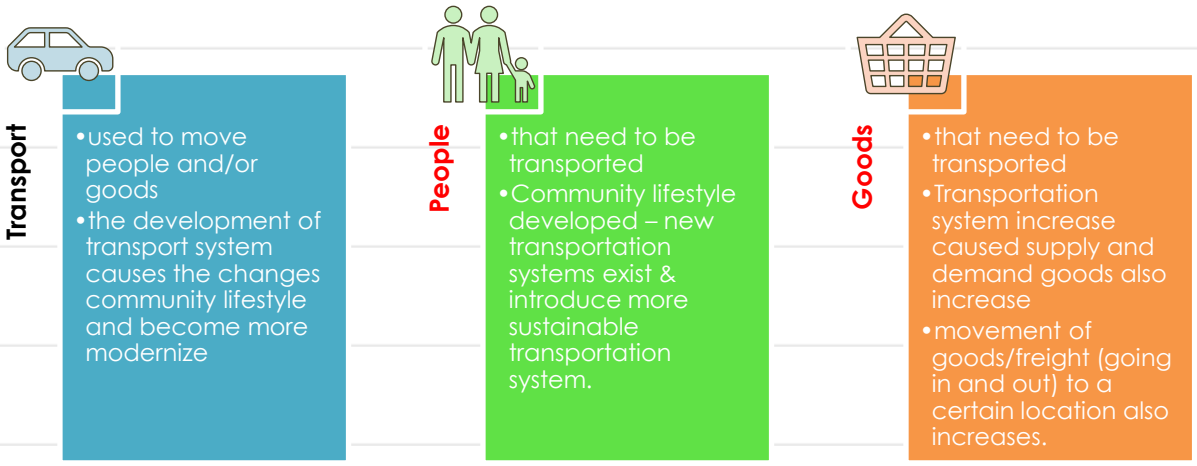


Figure 1-2: Relationship between transport, human and goods

1.1.2 The duration of transportation planning

Transportation planning is a field involved with the evaluation, assessment, design and sitting of transportation facilities (generally streets, highway, footpaths, bike lanes and public transport lines) which is process to look ahead for provides service in terms of movement of goods and people from a place of origin to a place of destination in future. Transportation planning is usually focus on specific problems or on broad transport concerns at a local level. Both plans are synchronize for compatibility

i. SHORT TERM (Action Plan)

- Review matters that can be completed within three years and involve high costs.
- Example: Installing various traffic control devices such as signs and signals to improve a traffic congested zone due to sudden increase of traffic demands

ii. MEDIUM/LONG TERM (more than 5 years)

- This type of planning is more structured and complicated and it must be designed better than short term planning
- For example; An urban transportation planning process involves planning the next 20 to 25 year

1.1.3 The function of:

a. Transportation

- Transport not only for people, but also for liquid, gas, power and messages.
- Data collection, plan, design and structure of facilities that have been designated for transport purposes, including for highway and rail, canals, pipelines for the transport of water, sewage, oil, gas and also belt for power transmission, telephone and telegram.
- Managing existing systems to ensure efficiency and safety of all aspects of use.
- There are many forms of transportation, like walking, bicycles, cars, trains, aircraft, boats, and in fact anything that allows a person or item to move.

b. Transportation planning

Characteristic of a good transportation planning

- Determine the transportation needs
- Make/built a transportation formulas
- Study the profitability
- Traffic/travel pattern is clear, stable and can be control
- Relationship between the various modes of transport.
- The transportation system can influence the development for that area and ready to serve it.

1.1.4 The types of transportation

- **Road networking** - A road network is a system of interconnecting lines and points that represent a system of streets or roads for a given area. A road network provides the foundation for network analysis; for example, finding the best route or creating service areas. Example, Rails and Highways

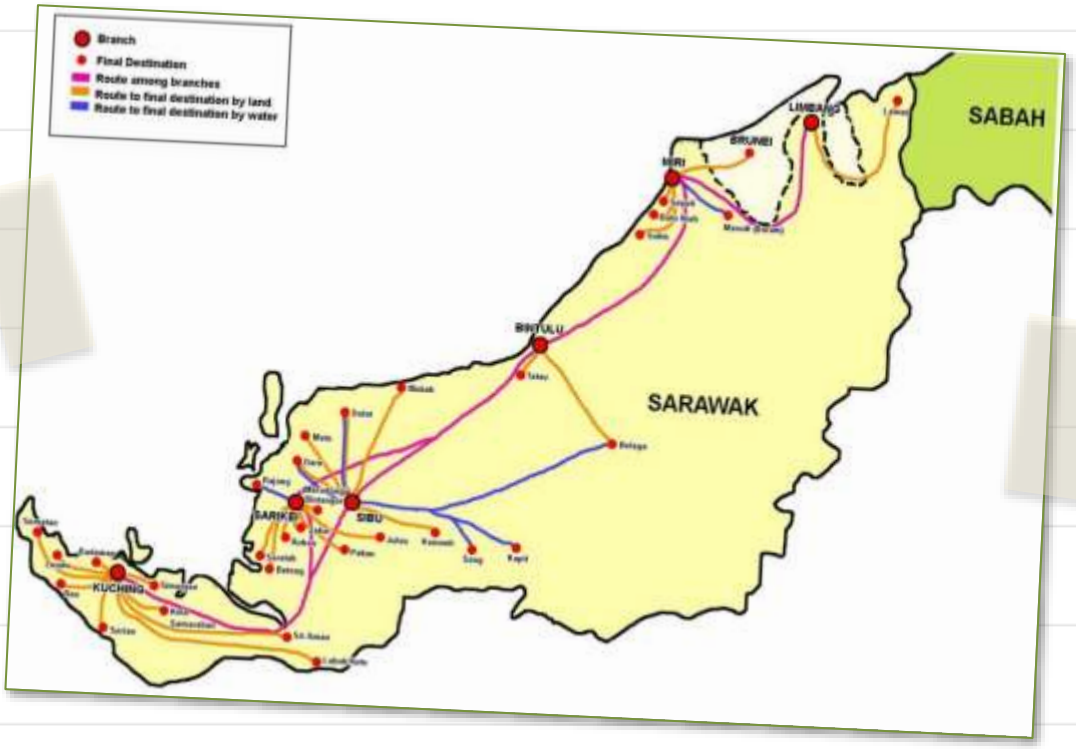


Figure 1-3: Road networking in Sarawak

- **Private Transport** - for personal use only, such as using cars, vans, bikes on roads.
- **Public Transport** - for public use, such as buses, taxi, LRT, commuter, boats, planes by the land, air and water.
- **Commercial and Trade Transport** - For business use, such as lorries, boats and aeroplanes for shipping goods by land, air and water

Table 1-1: Mode of transportation

TRANSPORTATION MODES	TYPES
Land transport	Roadways • Private vehicle (motorcar, motorcycle, bicycle) • Recreation vehicle • Heavy vehicle (truck, lorry, bus, etc) Railways • Railroads (mostly < 300 miles & suburban commuters; KTM, ETS – Electric Train Service) • Rail transit (LRT – Light Rail Transit, Monorail, ERL – Express Rail Transit)
Waterways transport	• Hovercraft (ferry services) • Ships (cruise traffic, ferry service) • Barges (cargos, containers)
Airways transport	• Air carriers (mostly > 300 miles & across bodies of water) • General aviation
Pipeline transport	• Constitute a highly specialized freight transportation system • Their market is almost entirely crude oil, petroleum products and natural gas
Other modes – cable & belt system	• Cable and belt system–used extensively for transportation of freight within industrial complexes. • These are used for specialized passenger transportation system such as ski lifts and moving belts in airports

1.1.5 The purpose of transportation planning

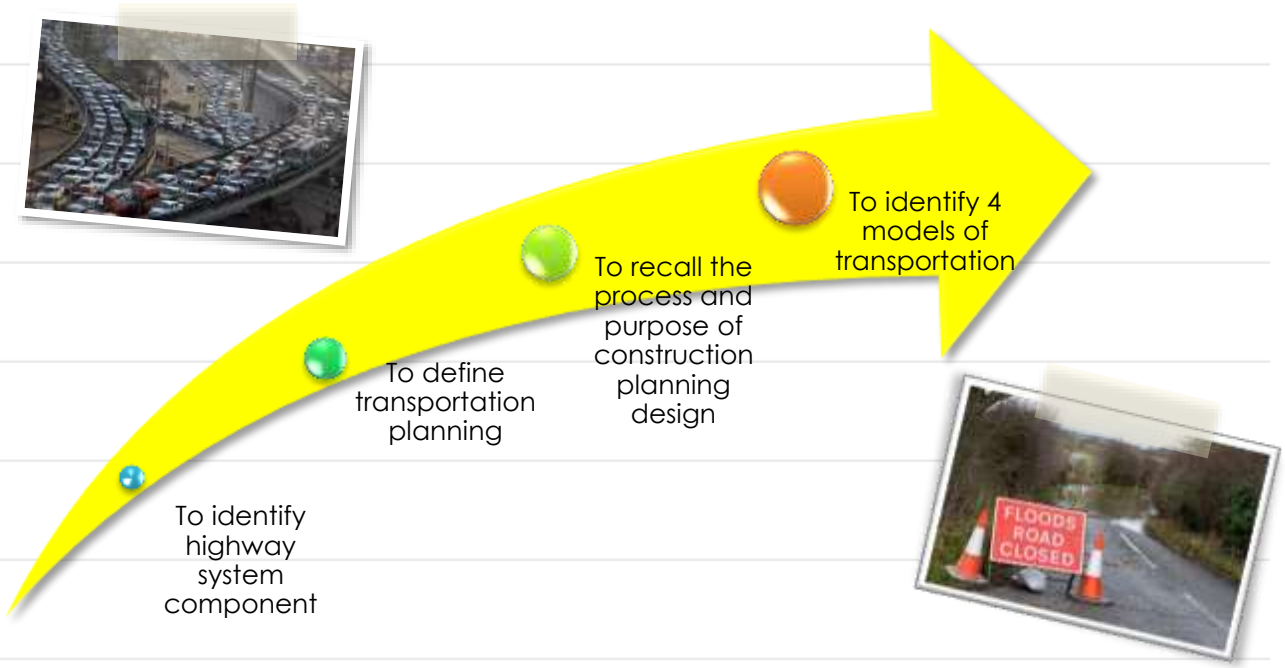


Figure 1-4: The purpose of transportation planning

1.2 THE PLANNING ASPECTS OF TRANSPORTATION

1.2.1 The importance on transportation planning

- Comfort and Convenience
- Ease and Speed
- Creation of employment
- Production and consumption of products to occur at different locations
- Help increase economic development

Comfort and Convenience

The world that we live in now will most likely be impossible had it not been for innovations in transportation. There would not have been any great infrastructure, industrialisation, or massive production, if transportation were incompetent. Life would not have kept up with the fast changing times if there were no huge trucks, bulldozers, trailers, cargo ships, or large aircrafts to carry them to different places. Today, humanity has technology to thank for all the wonderful things that it currently enjoys now.

Ease and Speed

Makes available goods to customers: Transport makes possible movement of goods from one place to another with great ease and speed. Thus, consumers spread in different parts of the country have the benefit of consuming goods produced at distant places

Creation of employment

Helps in creation of employment: Transport provides employment opportunity to individuals as drivers, conductors, pilots, cabin crew, captain of the ship, etc. who are directly engaged in transport business. It also provides employment to people indirectly in the industries producing various means of transport and other transport equipment.

Production and consumption of products to occur at different locations

Transport is a key necessity for specialization—allowing production and consumption of products to occur at different locations. Transport has throughout history been a spur to expansion; better transport allows more trade and a greater spread of people. Economic growth has always been dependent on increasing the capacity and rationality of transport.

Help increase economic development

Transport improvements are not always the best way to improve productivity or increase economic development. In general, such improvements only increase economic development where inadequate transport is a significant constraint on economic activity. An area that lacks paved roads may experience significant economic growth from a new highway or bridge that significantly reduces travel costs, but once an area has basic highway access, each increase in highway capacity tends to provide less overall benefit.

Efficiency

- To achieve efficient management and better management of existing resources
- Effective use of transportation system
- Uses of technology
- Land use and resource controlling

Quality

To reduce a negative impact to the traffic that produce a pollution

Equity

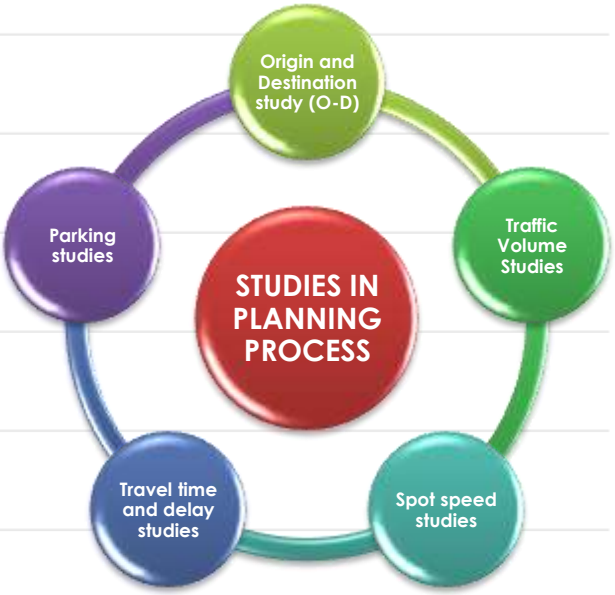
To meet travel demand and response for all communities

1.2.2 The general criteria in selecting the transportation plan

- **Social aspect** - improve the social aspects as can be done safely and comfortably
- **Community association**
- **Services and facilities** provided
- **Occupant transfer**

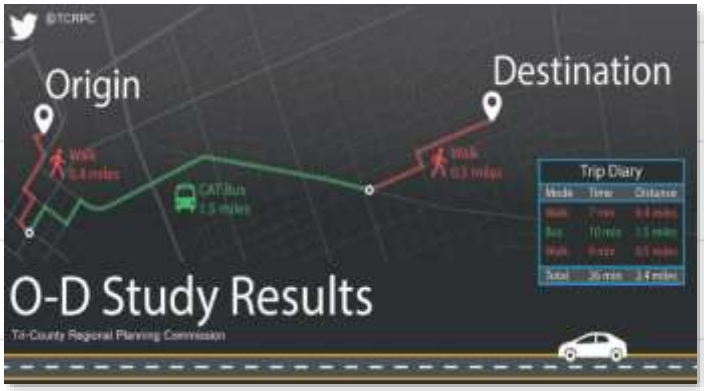
The transportation study conducted in the planning process:

a. **Origin destination studies (O-D)**
b. **Traffic Volume studies**
c. **Spot speed studies**
d. **Travel time and delay studies**
e. **Parking studies**



a. Origin-destination/direction studies (O-D)

- To show the pattern and nature of daily trips made by the residents
- The main purpose of O-D study is to plan the transportation in urban city especially the type of land use, road/traffic network and public transportation system.
- Determine the traffic flow – if traffic congestion occurs, a short cut must be plan to give a comfortable travel to road user.
- Determine whether the existing road system is adequate or not
- Determine the suitable/best position of a bridge or new transport terminal to be constructed.
- Built a transportation models to make sure the transportation planning will be easier and make a prediction about the traffic pattern in the future.
- Method of Origin-Destination (O-D) Study : **Road side interviews, License Plate, Return Post Card Method, Tag on car Method and Home Interview**



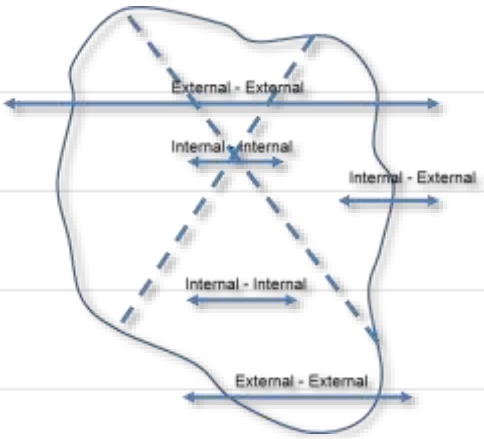


Figure 1-5: Origin-destination/direction (OD)

The work involved in the origin-destination studies

i. Defining the study area
ii. Traffic zone
iii. Data collection
iv. Data analysis

Data gathering or collection

A complete database in transportation planning is very important because all data can become base in understanding the interaction between the transportation movement along the study area. Data collection is very important in transportation planning because the occurrence of error and mistake in this stage can cause incorrect model determination. In addition, a larger error may occur when making prediction for the future.

Important components in a database:

1. Current data related to the transportation system such as roadways, highways, public transport services, traffic management, and etc
2. Current usage of public transport , such as the traffic flow on the main road, bus services, etc
3. Travel pattern & demand
   - This involves O - D study and travel time, transportation pattern in traveling, and the reason for the related traveling.
4. Land use
   - Development and changes of land used can change the travel demand. To gather all data related to the land used for housing & types of house. Commercial and the used of the development, industrial area and the types of factory.
5. Socioeconomic such as the total of population or number of family, income and
   - vehicle's own

Data collection method

Data analysis

The method to get data analysis are using CODING and PUNCHING method. Data will be code in one serial number pre - determine form. The information will be code and punch into one paper tape for separating the data using mechanically and processing method. Data will separate into origin and destination only, and the other will code into travel mode and etc.

Later after coding process has finish then it will be transfer into punch card or paper tape by an expertise, and this will be use as input in the computer. The categories of data analyse are:

i. Trip generation - The first model of travel demand used in transportation planning process. Used to predict which zone the traffic will flow.

ii. Trip distribution - The second model travel demand used in transportation planning process and to get a travel/traffic pattern (in/out) in a zone. Also shows the total traffic in certain time, distance and cost.

iii. Modal split - To estimate the number of trips by different types of transport and limited to public and private transport only

iv. Trip assignment - Intended to give a traffic direction to which road in road/transport network.

b. Volume study

- To collect data on the number of vehicles / pedestrians that pass a point during a specified time period
- To know whether the existing road can accommodate the vehicles that using a road.
- To ensure the smooth movement of vehicles and traffic safety
- Design for road rehabilitation
- Study the traffic at intersection
- Study of traffic control systems
- Forecast/predict traffic volumes
- Study of traffic accidents
- Analysis of costs - benefits for highway projects
- 2 methods of data collected:
  - **i) Manually Method -** record data manually in a special form
  - **ii) Mechanic/Automatic Method -** Detect by special detector e.g Magnetic Detector

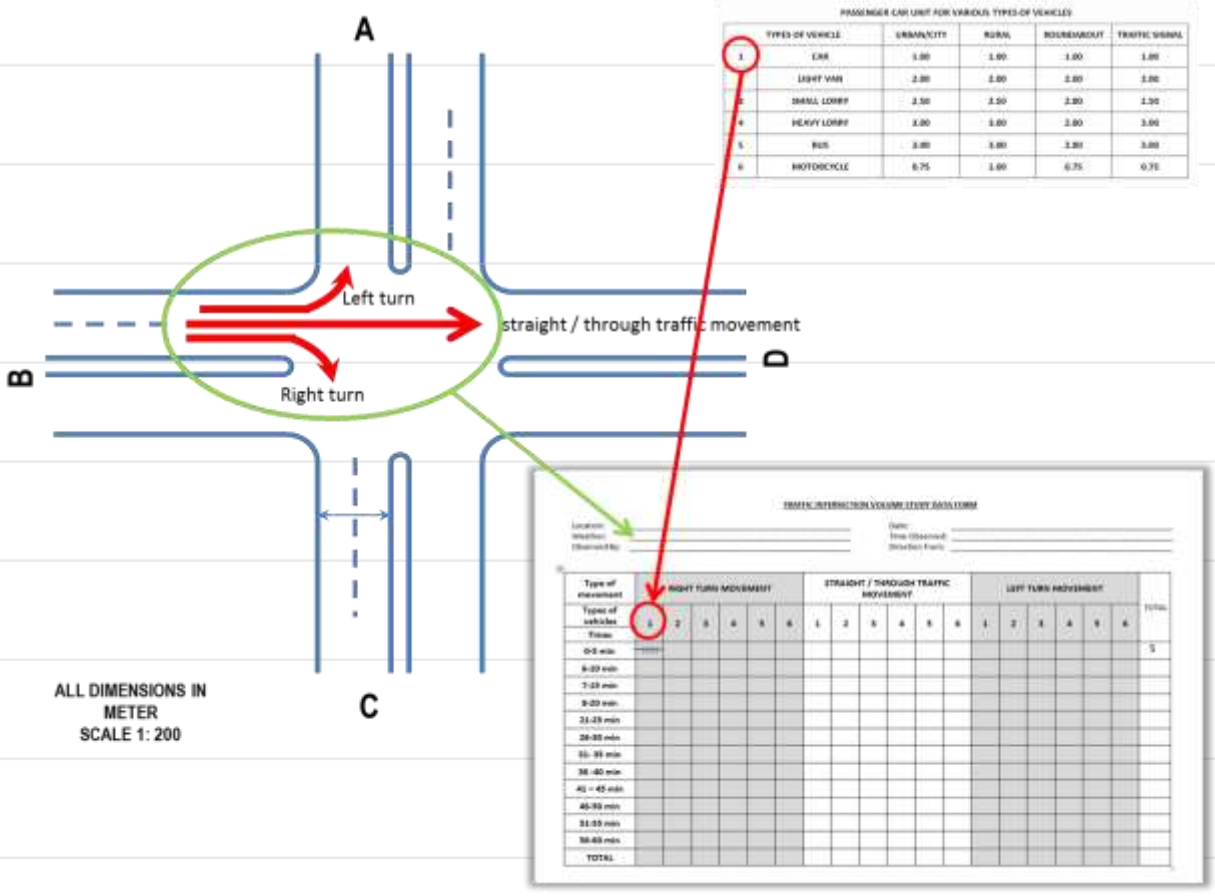


Figure 1-6: Manually Method

c. Spot speed study

Definition of spot speed
If S ≤ 100 meters, then the speed measure is known as Spot Speed.

- Conducted to estimate the distribution of speeds of vehicles in a stream of traffic at a particular location or spot on a highway
- Carried out by recording the speed of a sample of vehicles at specific location
- Will be valid only for the traffic and environmental conditions that exist at the time of study.
- Establish parameter for traffic operation such as speed zones, speed limits, and passing restriction
- Evaluate the effectiveness of traffic control devices such as variable message sign at work zone.
- Evaluate/determine the adequacy of highway geometric characteristic
- Evaluate the effect of speed on highway and determine speed trends.

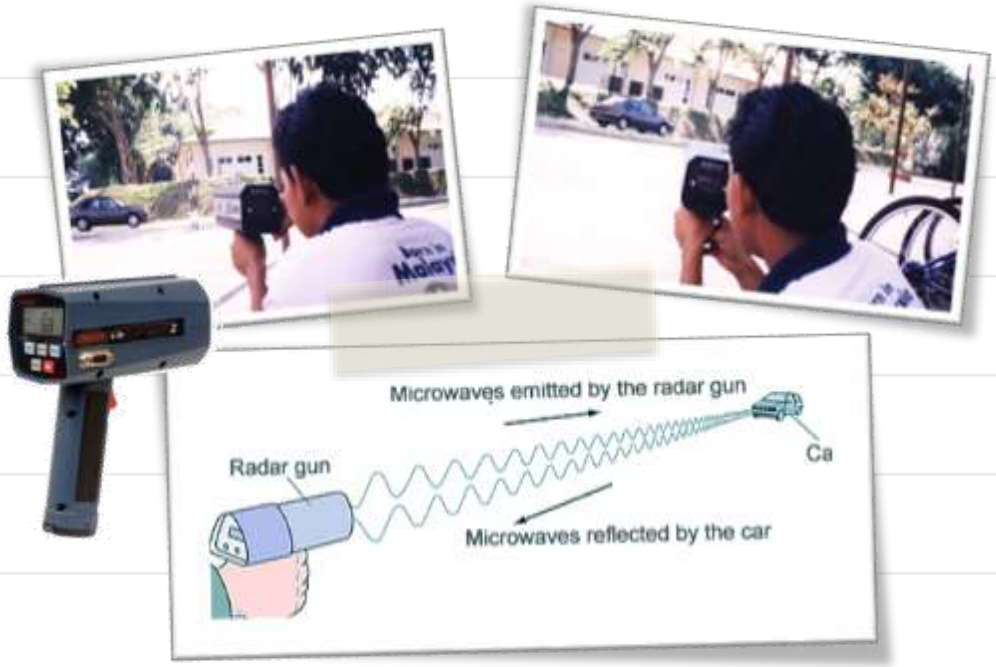


Figure 1-7: Spot speed study using radar meter

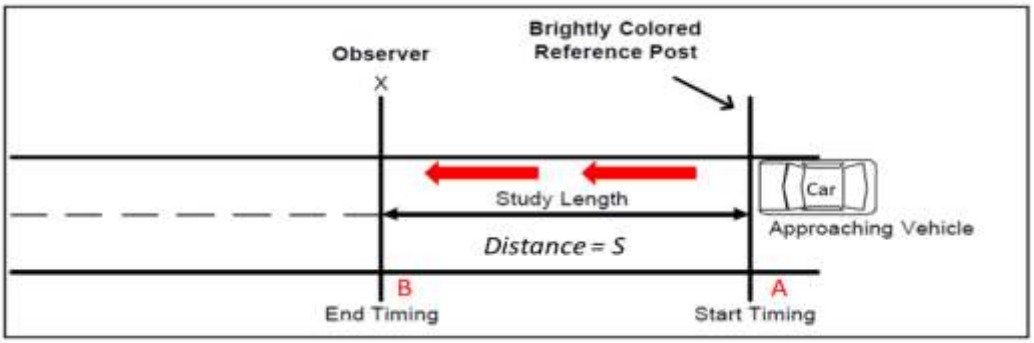
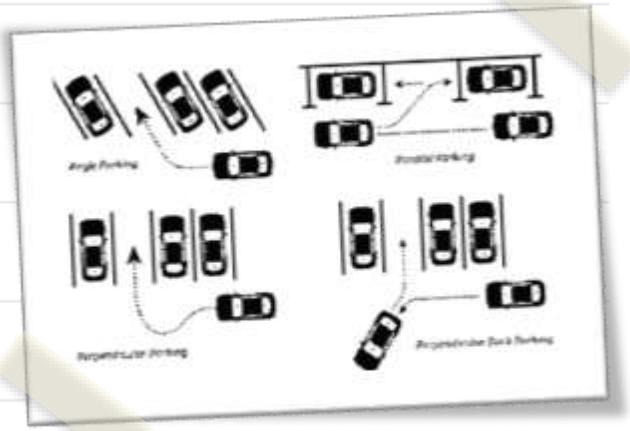


Figure 1-8: Spot speed study using manual method

d. Delay speed study

- A travel time study determines the amount of time required to travel from one point to another on a given route.
- Information may also collected on the location, duration, and causes of delays.
- Data also aid the traffic engineer in identifying problems at the location.
- Determine the efficiency of a route with respect to its ability to carry traffic.
- Identification of locations with relatively high delay and the causes for those delays.
- Determine the traffic times on specific link for use in trip assignment models
- Performance of economic studied in the evaluation of traffic operation alternative that reduce travel time.
- To evaluate the change in efficiency and level of service with time.
- A travel time study determines the amount of time required to travel from one point to another on a given route.
- Information may also collected on the location, duration, and causes of delays.
- Data also aid the traffic engineer in identifying problems at the location.

e. Vehicle parking study



- The need of parking spaces is usually very great in the areas where land uses including business, residential and commercial activities
- Providing adequate parking space to meet the demand for parking in central parking district may affect the level of service.
- To get the valid information (before and latest)
- To know whether it is adequate parking or not
- To provide information needed to enable the implementation of payment by the parties involved.

1.3 THE TRANSPORTATION PLANNING PROCESS

As an engineer, responsibility to planning a new public transportation need to propose transportation planning process involved with the evaluation, assessment, design and sitting of transport facilities. So in that process, you can explain:

Evaluation

- Transport planning aims to evaluate for ensure that is suitable, safe and interconnected transport infrastructure for different transport mode such as bus, rail, LRT, Monorail and taxi services.
- It also consider for pedestrian for walking and cycling, which results in improving the community's accessibility to jobs, services, recreation and other daily activities.
- To provide for and improve the safety and security of transportation customers and the transportation system.
- Collect the data population from survey data to evaluate the size, capacity, location facilities, land, public transport, material and etc.
- Evaluate the duration time for preliminary process, construction process and maintenance process.

Assessment

- Quality assessment especially for quality plan, material quality, workers quality, machinery quality and investments in transportation systems and services.
- Provide a good contractor and developer to organize the quality improvement.
- All components related must be systematic, ongoing cycle of collecting and analysing.
- The information collected is used to evaluate how the progress to assess the design and functionality.
- To support quality of planning to improvement efforts.

Design

- To make sure the design was follow the standard in all aspects covered with transport design, facilities design, geometry design and infrastructure design.
- Environmental consideration to minimize pollution.
- The design must be economical to reduce cost of operation and maintenance.
- Comfortable design to give users comfortable facilities, convenient and efficient.
- To provide safety design and compatible movement of people and goods.

Sitting transport facilities

- Provide proper signage and road marking for helping users as guidance to warning and regulations.
- ITS (Intelligent transportation system) was apply to transport facilities.
- Advanced traffic control system such as ramp meter also recommend on this proposal.
- Vehicle infrastructure integration in order to improve road safety.
- Designing equipment and devices to fit human body and cognitive abilities.

The elements of transportation planning:

Inventory
- include the establishment of the data for the evaluation of the existing travel demand and existing travel capacity
- Will involve two main task that is collecting and processing data.

Land uses
- Required a detailed assessment and forecasting in terms of distribution of area, population, employment, economic, social and land use activities.

Trip generation
- The first model of travel demand used in transportation planning process.
- Used to predict which zone the traffic will flow.

Trip Distribution
- The second model travel demand used in transportation planning process.
- To get a travel/traffic pattern (in/out) in a zone
- Shows the total traffic in certain time, distance and cost

Modal Split
- To estimate the number of trips by different types of transport
- Limited to public and private transport only

Traffic Assignment
- Intended to give a traffic direction to which road in road/transport network.

Assessment
- Contains the testing and evaluation of the alternatives selected before.
- emphasis on the ability of the traffic and environmental impact of each alternative strategy
- to choose and determine the best transportation system for future needs

ASSESSMENT 1

1. List FOUR (4) types of transportation system

(4 marks)

2. Explain ONE (1) example between short term and medium/long term in duration of transportation planning

(4 marks)

3. Explain briefly FIVE (5) characteristics of a good transportation planning

(4 marks)

FEEDBACK ON ASSESSMENT 1

1. State FOUR (4) types of transportation system

(4 marks)

- Road networking
- Private transport
- Public transport
- Commercial and trade transport

2. Explain ONE (1) example between short term and medium/long term in duration of transportation planning

(4 marks)

SHORT TERM (Action Plan) : Example: Installing various traffic control devices such as signs and signals to improve a traffic congested zone due to sudden increase of traffic demands

MEDIUM/LONG TERM (more than 5 years) : For example; An urban transportation planning process involves planning the next 20 to 25 year

3. Explain briefly FIVE (5) characteristics of a good transportation planning

(4 marks)

- Determine the transportation needs
- Make/built a transportation formulas
- Study the profitability
- Traffic/travel pattern is clear, stable and can be control
- Relationship between the various modes of transport.
- The transportation system can influence the development for that area and ready to serve it.

Topic 2

TRAFFIC CONTROL EQUIPMENT AND ROAD FURNITURE

2.1 THE TRAFFIC CONTROL EQUIPMENT AND ROAD FURNITURE IN HIGHWAY ENGINEERING

Traffic control devices are need to control the traffic flow to effective system. The purpose of traffic control, devices and warrants for their use is to help ensure highway safety by providing for the orderly and predict able movement of all traffic, motorised and non-motorised, and to provide the necessary guidance and warnings to ensure the safe and informed operation of every road user on the highway.

The functions of the traffic control device

Road users depend upon traffic control devices to be advise of the requirements or conditions affecting road use at specific places and times so that appropriate action can be taken to avoid accidents, delays etc. Functionally, the traffic control devices in use are divide into the following three groups:

i. Regulatory devices have the authority to impose precise requirements upon the actions of road users.
ii. Warning devices call attention to potentially hazardous roadway conditions or unusual traffic movements that are not readily apparent to on-coming traffic. They impose the responsibility upon the individual road user to employ added caution.
iii. Guiding devices show route designations, destinations, directions, distances, points of interest, and other geographical or cultural information.

The purposes of traffic control devices

i. To promote highway safety and efficiency by providing for the orderly movement of all road users
ii. Traffic control devices notify road users of regulations and provide warning and guidance needed for the reasonably safe, uniform, and efficient operation of all elements of the traffic stream

2.1.1 Traffic control devices and signboards

A sign, signal, marking or other device used to regulate, warn or guide traffic, placed on, over or adjacent to a street, highway, pedestrian facility or shared-use path by authority of a public agency having jurisdiction. (MUTCD, 2003). Types of devices:

i. **Road Marking**
ii. **Road studs**
iii. **Delineators**
iv. **Traffic signboards**
v. **Lighting Devices**
vi. **Traffic Signal/Traffic Light**

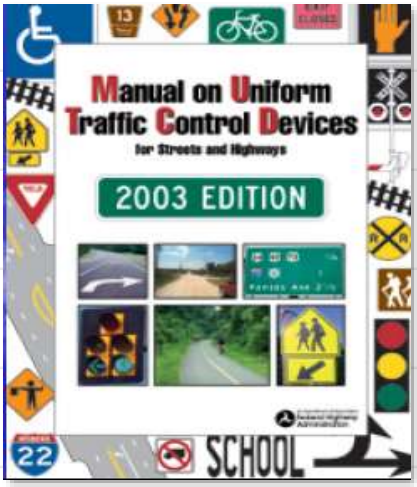


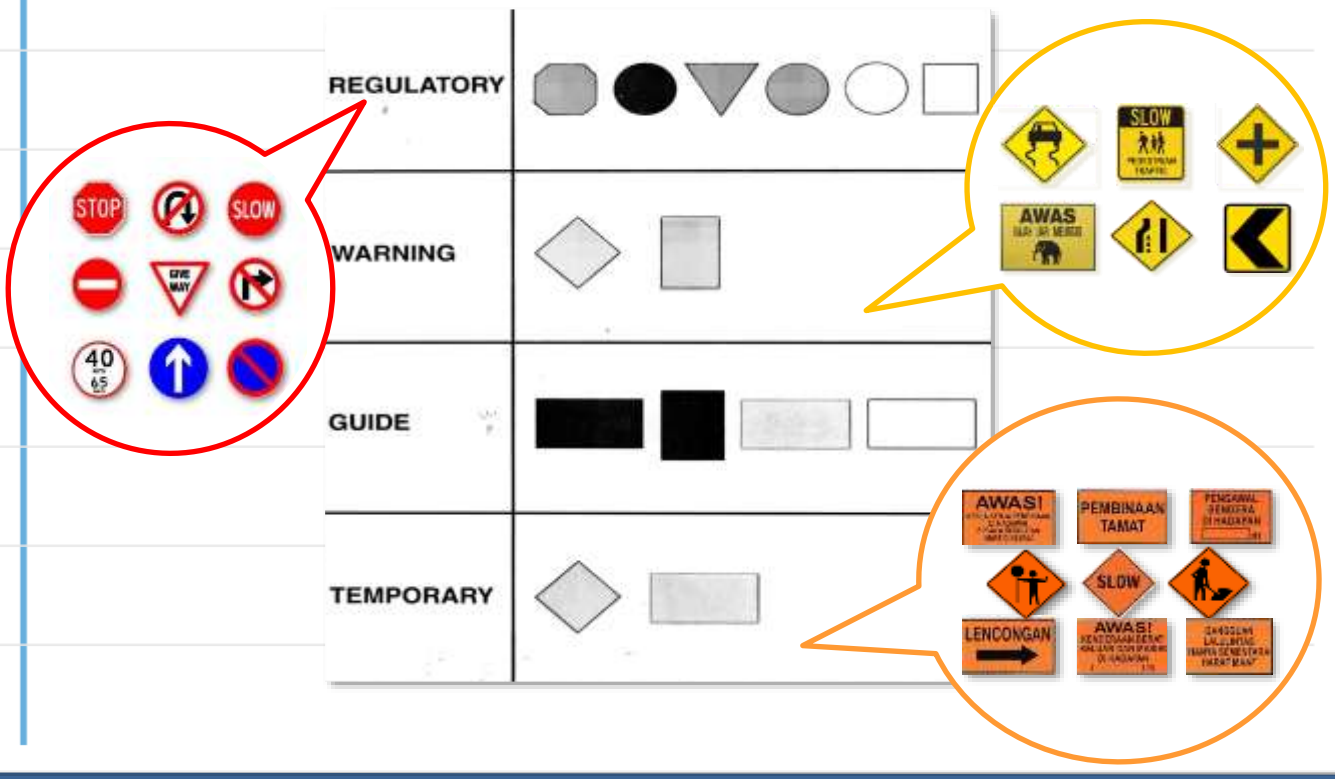
Figure 2-1: Manual on Uniform Traffic Control Devices

Traffic signs devices design principles

i. High visibility by day and night
ii. High legibility - adequately sized letters or symbols, and a short legend for quick comprehension
iii. Uniformity in design - include shape, color, dimensions, legends, borders, and illumination or retro-reflectivity
iv. Material

2.1.2 The category of devices according to their functions

Table 2-1: Devices according to their functions



The geometrical shapes for signboards

Shapes and Sizes of Traffic Sign

a. Circular
   i) Size when used with traffic signal: Diameter = 300 mm
   ii) Minimum size: Diameter = 600mm
   iii) Normal size: Diameter = 750 mm

b. Octagonal
   i) Minimum size: Width = 600 mm.
   ii) Other size: Width = 900 mm

c. Triangular (Equilateral)
   i) Minimum size: Width = 600 mm
   ii) Normal size: Width = 750 mm

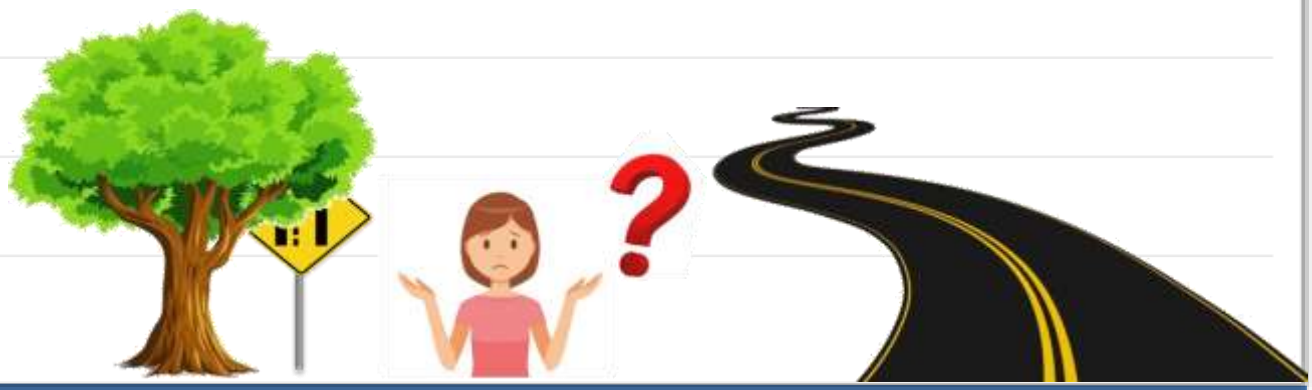
d. Diamond (square with vertical diagonal)
   i) Minimum size: Width 400 mm
   ii) Normal size: Width = 600 mm
   iii) Other size: Width = 750 mm & 900 mm.

e. Rectangular
   Size varies according to legend (word message/symbol) on sign.

2.1.3 The basic characteristics of traffic control device

The characteristics of traffic control devices used.

i. Fulfill a need.
ii. Command attention.
iii. Convey a clear, simple meaning.
iv. Command respect of drivers and pedestrians.
v. Be place so as to give users time for proper response



2.1.4 The importance and functions of traffic control device

The importance of traffic control device

The following factors need to be consider for the Traffic Control Plans:

a) Economic and community

- Commercial business districts
- Residential locations
- Recreation areas
- Shopping centres
- Railroad crossings
- Rural areas
- Other work planned adjacent to: or within the area of the project

b) Traffic

- Volumes
- Bicycle
- Large vehicles such as trucks and buses
- Speed of traffic
- Capacity of roadway
- Traffic signal operation (effect on existing vehicle detectors)

c) Seasonal changes and weather

- Maintaining traffic control during seasonal shutdowns
- loss of visibility and damage to devices during rain
- maintenance of traffic control devices (cleaning, cutting vegetation away from signs)

2.1.5 The types of material and color used in preparing road sign/marking

Road markings and delineations are used to regulate traffic or to warn or guide road users. They may be used either alone or to supplement other traffic control devices. All road markings and delineation, as other traffic control devices should be uniform in design, position and application so that they may be recognise and understood immediately by all road users. Markings and delineators no longer applicable which may create confusion in the mind of the motorist shall be removed or obliterated as soon as practicable. All markings on highways shall be reflectorise. Even on well-lighted town and streets, it is generally desirable markings which must be visible at night be reflectorise.

Road pavements may be mark by one or more of the following materials:

i. Paint (reflectorised and nonreflectorised)

Only road line paints conforming to M.S. 164:1973, tested and approved by SIRIM shall be used. Paint is best used in situations and on roads where the markings are not subjected to heavy traffic wear.

ii. Thermoplastics (reflectorised and non-reflectorised)

Thermoplastics used shall be of the hot-applied thermoplastics material conforming to B.S 3262 or the equivalence. This material is apply hot and sets on laying. It has good durability and is recommend being use in heavily travel urban areas and in main highways with high traffic densities. All road centre lines shall be in thermoplastics.

Figure 2-3: Thermoplastics

iii. Preformed tapes

Markings in this material take the form of plastic sheet attached to the carriageway surface by means of an adhesive. The markings must be pattern or embossed in order secure satisfactory resistance to skidding. It can be used as temporary markings because it can be removed easily even after an extended time.

Figure 2-4: Preformed tapes

2.2 THE TYPES OF ROAD FURNITURE IN HIGHWAY ENGINEERING

2.2.1 The objectives of road signs

- To regulate traffic or to warn or guide road users.

2.2.2 The basic principles of:

a. Road signs/marking

- Should be uniform in design, position and application so that they may be recognise and understood immediately by all road users.
- No longer applicable which may create confusion in the mind of the motorist shall be removed or obliterated as soon as practicable. Other markings and delineations required by road conditions or restrictions should be remove or obliterated when those conditions cease to exist or the restrictions are withdrawn.
- Must be visible at night shall be reflectorized unless ambient illumination assures adequate visibility. All markings on highways shall be reflectorize Even on well-lighted town and streets, it is generally desirable markings, which must be visible at night, and reflectorize.
- In addition to reflectorized lines, the use of road studs may be consider for roads with poor alignment or at dangerous situations, for eg, at important junctions and intersections.
- Road markings have definite limitations. They may not be clearly visible when wet, and may not be very durable when subjected to heavy traffic. Therefore, they require frequent maintenance. Their effect on skid resistance requires care in the choice of materials to be use. Finally, they cannot be apply to unsealed roads.

b. Traffic signboards

The FOUR (4) basic principles of traffic signboard

i. Colour
ii. Shape
iii. Size, Wording, and symbol
iv. Material

2.2.3 The color of material, types and specification of:

a. Road studs

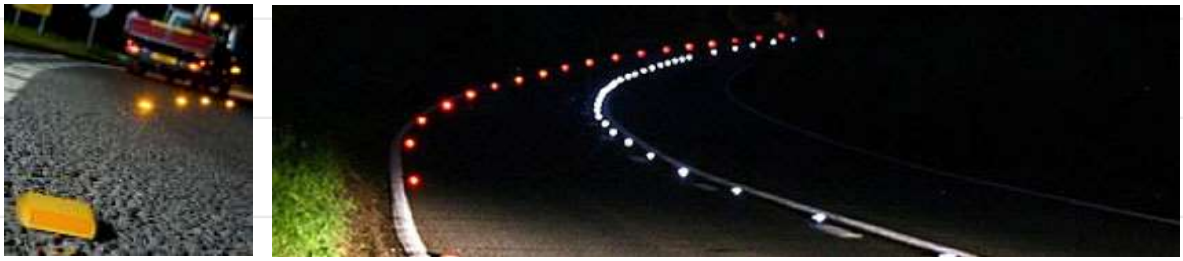


Figure 2-5: Road studs

Road studs are integral to traffic safety at night. It consists of a metal base that must be embed in the road surface, and separate rubber pad insert into each side of which (for two-way roads) two longitudinal biconvex reflectors are fitted. Road studs can be temporary or permanent, but both require high levels of long-term retro-reflectivity and excellent adhesion to the road surface.

Permanent Road Studs divide into two types:

i. **Snow-ploughable Raised Road Studs**

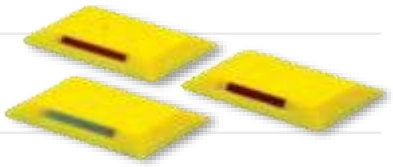
These road studs have prisms set in metal castings and installed in a cut made by a drop saw using 51 cm radius blades surrounding a number of 46 cm radius blades. The castings are installed using a 2-part epoxy and are designed to protect prisms from vehicular traffic and snowplough damage.

Figure 2-6: Road studs

ii. Recessed Reflective Road Studs

These road studs are install in grooves cut in the road by a specially designed cutting head. The grooves are approximately 1.2 m long for one-way markers and 2.1 m long for two-way markers. The stud is install with a 2-part epoxy and sits in the low point of the groove approximately 1.6 cm below the road surface.

Temporary Road Studs



These road studs are traditionally used in work zones, spaced from 1.5 m to 24 m apart and installed with a 2-part epoxy or bitumen. When the work zone needs to be alter, the temporary studs are remove with little or no damage to the existing surface.

The advantages and disadvantages of road studs

In nighttime, car drivers could not see where the road ends and where the alignment of road changes in direction.

The advantages of road studs over conventional line markings are:

- Greater effectiveness in wet weather
- Greater durability
- The vibration and audible noise created by vehicle tyres crossing road studs act as a secondary warning to the driver
- The use of differently coloured reflex lenses permits the imposition of directional control upon the motorist, e.g. to convey a 'wrong way' message

Disadvantages include:

- Their high initial cost
- Their susceptibility to damage during snow-clearing
- They must be attach to a high-quality surfacing that does not require an early over-lay surface dressing.

b. Posts delineator

Posts Delineator are effective aids for nighttime driving. They are considered to be guide, markings rather than warning devices and should never be substituted for a proper warning sign. The purpose of delineators is to outline the edge of the roadway and to indicate the roadway alignment. Post delineators usually consist of reflector units (glass, plastic, or reflective sheets) mounted on suitable supports.

Figure 2-7: Post Delineators

Post mounted delineators are beneficial for horizontal curves over 5°. It should be point out that whilst installation of such delineators or markers will assist night driving, it may also encourage drivers to increase speed. Unless other safety features are correspondingly increased, such installation can give drivers a false sense of security.

Post delineators are simply reflector units mounted on suitable supports. Both the reflector units and the supports should be of types approved by J.K.R. The reflector units may be of the circular corner-cube prismatic lens type and shall be not less than 75 mm diameter. They can also be made of glass, plastic, or reflective sheeting. Reflective sheeting should be of rectangular shape 180mm x 50mm and should be of the high intensity retro-reflective material.

These reflector units must be capable of clearly reflecting light under normal atmospheric conditions from a distance of 300 meters when illuminated by the upper beam of standard automobile lights. Timber posts should be of hardwood timber painted with stripes of black and orange.

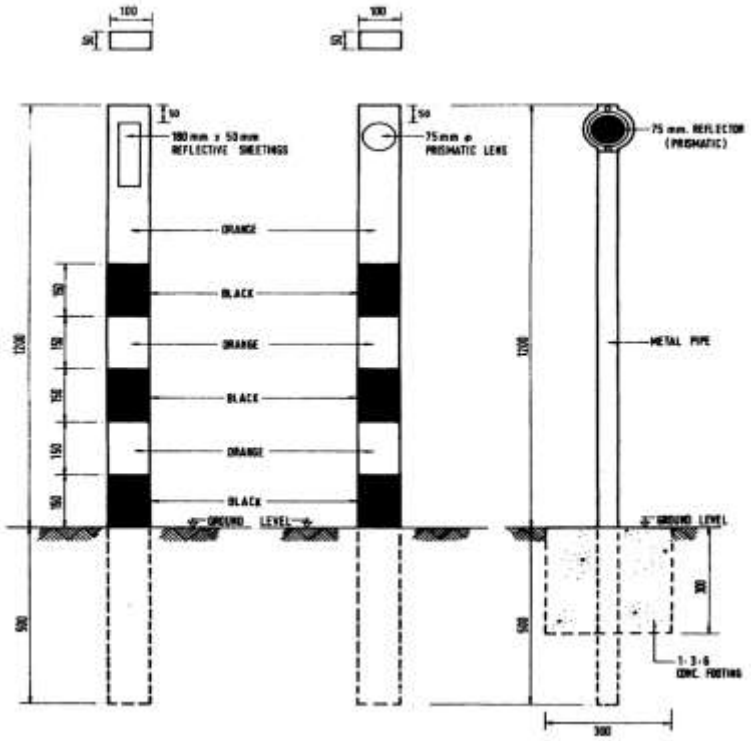


Figure 2-8: Details of Post Delineators
(Dimension Are In Milimetres)

c. Traffic signboards

Functions of traffic signboard

Functionally, the traffic signboard in use are divided into three major category.

Types of Traffic Sign

a. Regulatory Signs
   i) Prohibitive Signs
   ii) Mandatory Signs
b. Warning Signs
c. Guide Signs
   i) Destination Signs
   ii) Distance Signs
   iii) Information Signs
      - General Service Signs
      - Historical & Cultural
      - Interest Area Signs
      - Recreational Area Signs
      - Town Name Signs
      - River Name Signs
d. Route Markers
e. Temporary Signs


Warning Sign

Guiding Sign


Regulatory Sign


Regulatory Sign


Temporary Sign

The types and specifications of materials used on traffic signboards

i. High intensity retro-reflective sheeting
ii. Standard traffic signboards
iii. Guidance signboards
iv. Non-illuminated types of signboards at gentry

The colour used in signboards

Figure 2-9: The colour used in signboard according to their functions

The functions of Colours on Traffic Sign

a. Red on White background or vice versa
   i) Prohibitive
   ii) Warning for extreme danger
b. White on Blue background
   i) Mandatory
   ii) Directive (destination and distance)
   iii) Inform on general services.
c. White on Green background
   i) Inform on river names
   ii) Inform on historical and cultural interest areas.
d. Yellow on Dark Green background
   i) Inform on recreational areas
e. Black on White background
   i) Prohibitive for some cases
   ii) Inform on town names
f. Black on Yellow background
   i) Warning
g. Black on Orange background
   i) Temporary
h. Red on Blue background
   i) Prohibitive for some cases

2.3 THE CONCEPT OF TRAFFIC SIGNBOARD

2.3.1 The traffic signboard based on their functions

a. Regulation signboards
b. Warning signboards
c. Information Signboards

An example of traffic control equipment for the following category:

i. **Prohibition Sign:** Overtake prohibition, U-Turn Prohibition, Turning Prohibition and etc.

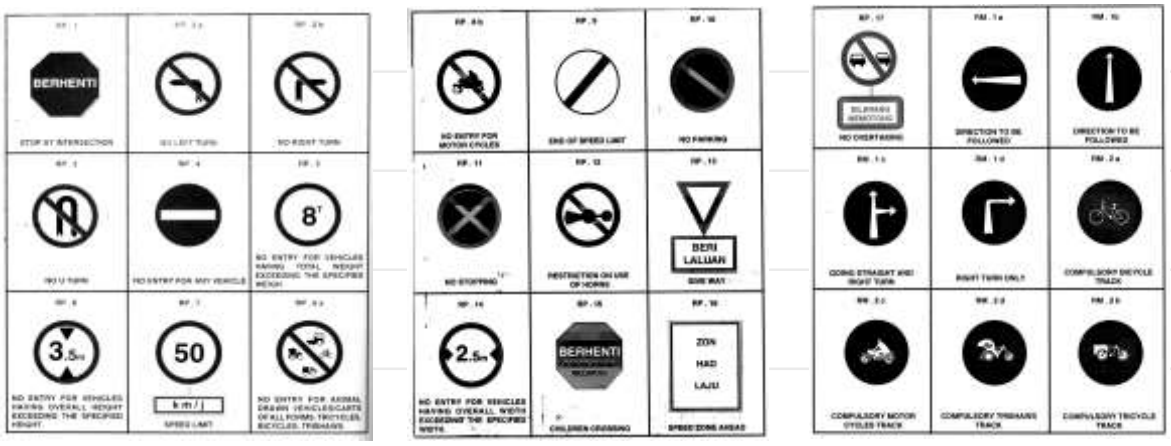


Figure 2-10: Prohibition Sign *(Source: Jabatan Kerja Raya, MANUAL ON TRAFFIC CONTROL DEVICES STANDARD TRAFFIC SIGNS, JKR/J(Rb) 0001/80)*

ii. **Warning Sign:** Land Slide Warning, Accident Area Warning and etc.

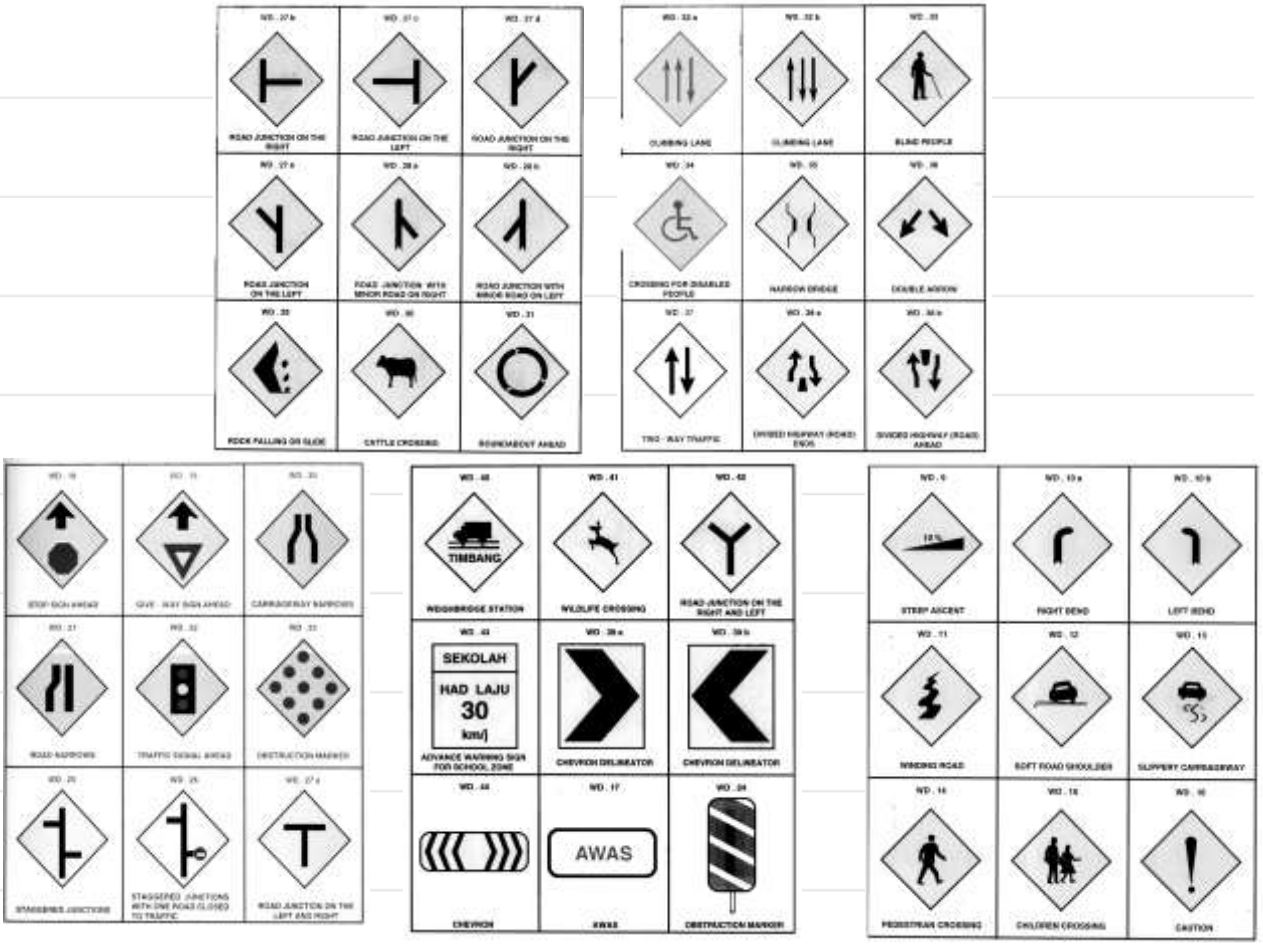


Figure 2-11: Warning Sign
(Source: Jabatan Kerja Raya, MANUAL ON TRAFFIC CONTROL DEVICES STANDARD TRAFFIC SIGNS, JKR/J(Rb) 0001/80)

iii. **Guidance Sign :** Hospital Sign, Kilometer Post, Places Sign and etc

Figure 2-12: Guide Information Signs *(Source: Jabatan Kerja Raya, MANUAL ON TRAFFIC CONTROL DEVICES STANDARD TRAFFIC SIGNS, JKR/J(Rb) 0001/80)*

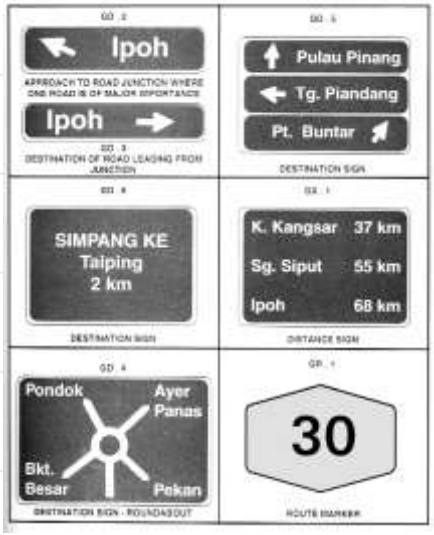


Figure 2-13: Guide Destination/ Guide Distance Signs and guide route marker
(Source: Jabatan Kerja Raya, MANUAL ON TRAFFIC CONTROL DEVICES STANDARD TRAFFIC SIGNS, JKR/J(Rb) 0001/80)

iv. **Road Marking:** Double line, Centre line, zebra crossing and etc

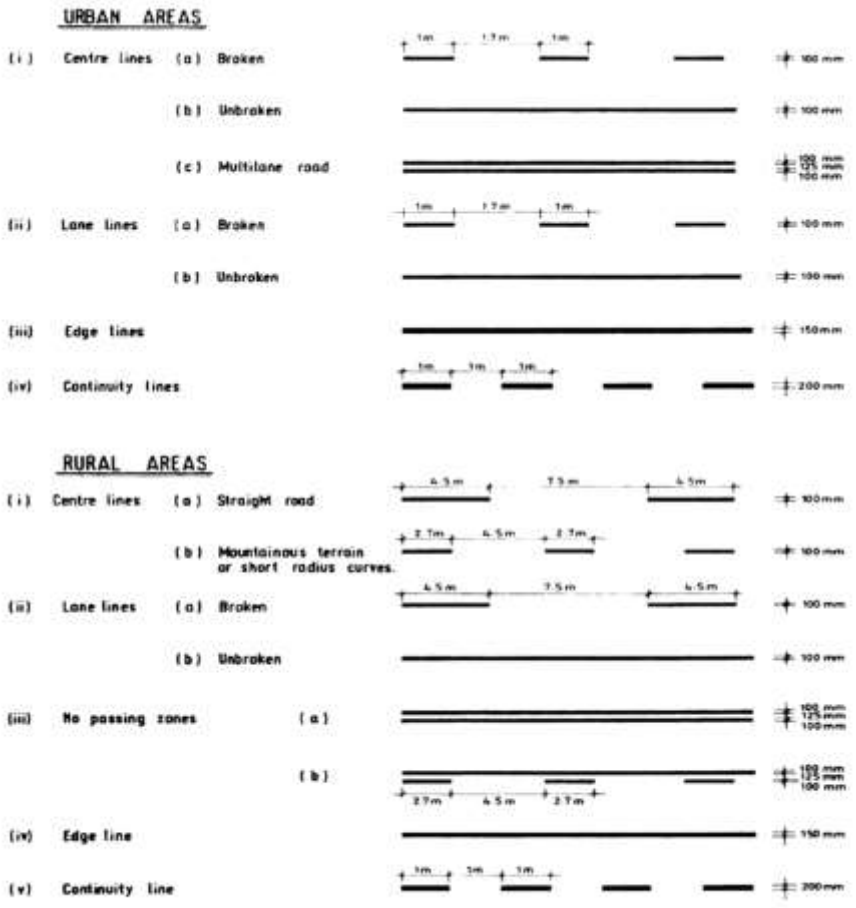


FIG. 1 LONGITUDINAL LINES

Figure 2-14: Longitudinal Lines
(Source: Jabatan Kerja Raya, MANUAL ON TRAFFIC CONTROL DEVICES STANDARD TRAFFIC SIGNS, JKR/J(Rb) 0001/80)

v. Temporary Signs

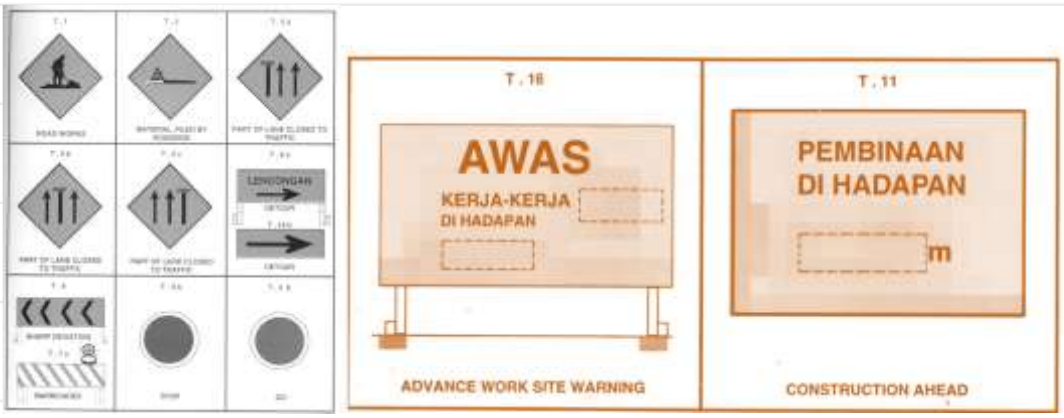


Figure 2-15: Temporary Signs
(Source: Jabatan Kerja Raya, MANUAL ON TRAFFIC CONTROL DEVICES STANDARD TRAFFIC SIGNS, JKR/J(Rb) 0001/80)

Symbol Templates

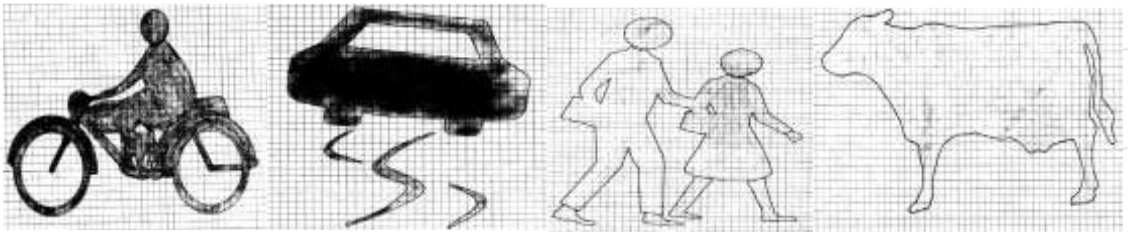


Figure 2-16: Symbol Templates *(Source: Jabatan Kerja Raya, MANUAL ON TRAFFIC CONTROL DEVICES STANDARD TRAFFIC SIGNS, JKR/J(Rb) 0001/80)*

2.4 THE CONCEPT OF TRAFFIC SIGNAL

Traffic signals are valuable devices to control traffic and assign right-of-way. The message in traffic signals is relay by colors, therefore, the meaning of the colors have been standardized all over the world.

GREEN SIGNAL
Permits traffic to proceed if it is safe to do so.

YELLOW SIGNAL
Always follows a circular green signal or green arrow and warns that the red signal is about come on. Driver must stop if it is possible to do so.

RED SIGNAL
It is means stop and remain stopped until a green signal is show and it is safe to proceed.

Traffic signals purposes

i. To ensure an orderly flow of traffic
ii. Provide an opportunity for pedestrians or vehicles to cross an intersection
iii. Reduce the number of conflicts between vehicles entering intersections from different directions.

ASSESSMENT 2

1. List THREE (3) types of material used in preparing road sign/marking

(3 marks)

_____

_____

_____

_____

2. Give ONE (1) the advantages of road studs application

(4 Marks)

_____

_____

_____

_____

3. Which of the followings are the types of material used in preparing road sign/marking

(4 Marks)

i. Paint
ii. Thermoplastics
iii. Performed tapes
iv. High intensity retro-reflective sheeting

A. i and ii
B. iii and iv
C. i, ii and iii
D. All of above

FEEDBACK ON ASSESSMENT 2

2. List THREE (3) types of material used in preparing road sign/marking

(3 marks)

- Paint
- Thermoplastics
- Performed tapes

2. Give ONE (1) the advantages of road studs application

(4 Marks)

- In night time, car drivers could not see where the road ends and where the alignment of road changes in direction.
- Without sufficient number of road lightings, it is necessary to provide some means to guide the drivers along dark roads.
- When a ray of light enters the eyes of a cat, the light shall be reflected back

3. Which of the followings are the types of material used in preparing road sign/marking

(4 Marks)

i. Paint
ii. Thermoplastics
iii. Performed tapes
iv. High intensity retro-reflective sheeting

A. i and ii
B. iii and iv
C. i,ii and iii
D. All of above

3.1 THE FUNDAMENTAL CONCEPT OF JUNCTION

3.1.1 Junction

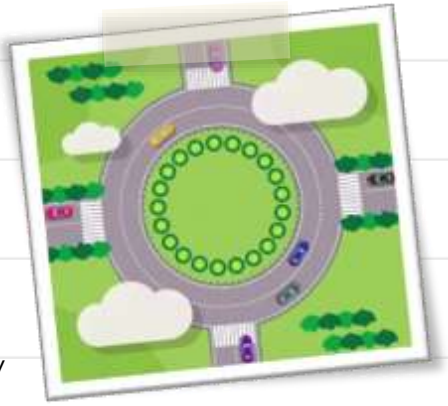
A road junction is where two or more roads either meet or cross at grade (they are at the same level) or different levels (interchange). Such a road junction may also name as a crossroads and is normally when a Major road meets a Minor road.

Figure 3-1: Junction

The Major road is defined as the one on which the Give Way line runs along the side of it, parallel to the left hand (nearside) kerb.

The Minor road is the one with the Give Way or Stop lin es at the end of it. Junctions can be open or closed, marked or unmarked, controlled or uncontrolled.

3.1.2 The factors that affect junction load



- **Road physical/Total or length wide** – road width, no. of lane, types of junction and etc.
- **Traffic flow** – An intersection should accommodate with comfort and safety a design peak traffic volume
- **Types of vehicles**
- **Traffic surrounding area** – pedestrian, parking space, zebra crossing, weather, topography and etc.
- **Topography and Environment** – the location and design of an intersection will be affect by many factors.
- **Economics** – should benefits to traffic.
- **Human factors** - driver characteristics
- **Distribution design**
- **Turning radius**

3.1.3 The factors must be taken in designing a junction

In designing a junction, these factors must be take into consideration:

- **Traffic flows**
- **Safety**
- **Allowable delay**
- **Ecstatic**
- **Cost efficiency**
- **Suitability of the intersection**

3.1.4 The types of junctions

TWO (2) general types of Junctions defined:

- **Intersections (At Grade Junction)** do not use grade separation (they are at-grade) and roads cross directly. Forms of these junction types include Roundabouts and traffic circles, priority junctions, and junctions controlled by traffic lights or signals.
- **Interchanges (Grade Separated)** are junctions where roads pass above or below one another, preventing a single point of conflict by utilizing grade separation and slip roads. The terms motorway junction and highway junction typically refer to this layout.

3.1.4 The types of movement at a junction

- **Junction without signage / control**
- **Priority junction**
- **Junction with channelization**
- **Roundabout with and without traffic light**
- **Signal Controlled Intersections**
- **Grade Separated Intersections (Interchanges)**
- **Tiered Junction**

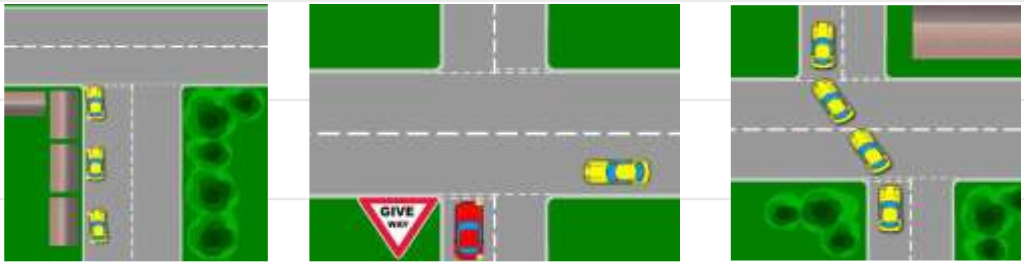
Junction without signage / control

- Only be used for the admission of minor traffic.
- Usually in residential areas and minor roads in rural areas where traffic volume is less than 100 pcu/hr

Figure 3-2: Junction without signage/control

Priority junction

- Manage the traffic at intersections where there are major routes and minor routes.
- Three forms of priority junction are simple T-junction, staggered T-junction and crossroad junction (not recommended)
- T- Junction or staggered junction without any ghost or physical island in the major road and without channelling islands in the minor road approach.



Simple T-junction Crossroads Staggered Junction

Figure 3-3: Priority Junction

Priority junction with routing/ junction with channelization

- Restricting the amount of widespread turning movements
- Taking into account the safety of pedestrians
- Prioritize the main routes

Figure 3-4: Junction with channelization

Roundabout with and without traffic light may be applicable for total traffic volume (sum of all directions) of up to 6000 vehicles/hour and may if the layout can be freely chosen, be designed to cater for any distribution of turning traffic.

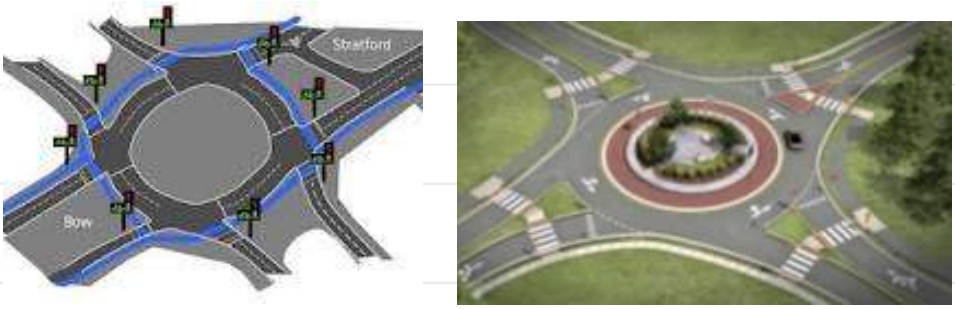
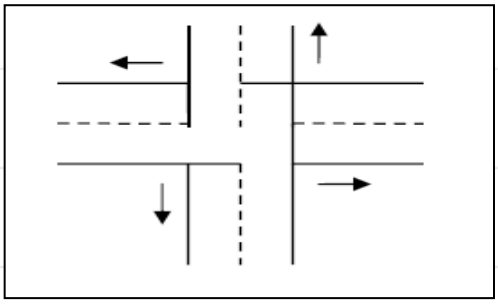


Figure 3-5: Roundabout with and without traffic light

Signal Controlled Intersections are applicable to very high traffic volume of 8,000 vehicle/hour or more provide that the necessary number of approach lanes are present and that there is no interference from other nearby intersections. Traffic lights, which may also be known as stoplights and traffic signals are signaling devices positioned at road intersections.



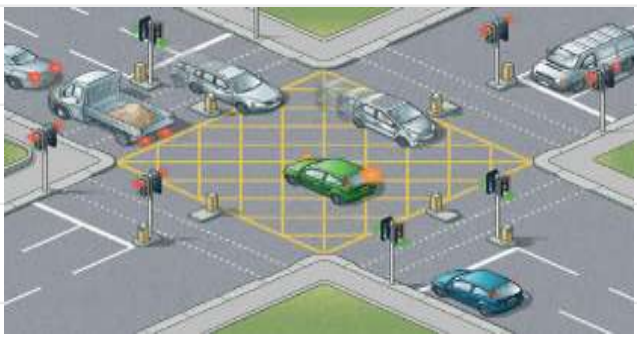


Figure 3-6: Signal Controlled Intersections

Tiered Junction

- Expensive construction costs are common on highways
- Examples: Flyover, Viaduct

Figure 3-7: Flyover

Grade Separated Intersections (Interchanges)

- Trumpet interchange is a popular form of three legs interchange. If one of the legs of the interchange meets a highway at some angle but not cross it, then the interchange called trumpet interchange.
- Diamond interchange
- Partial cloverleaf
  - Full cloverleaf
  - Modified cloverleaf

Trumpet interchange

Diamond interchange

Partial cloverleaf

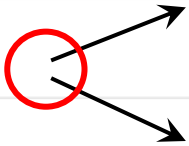
Figure 3-8: Grade Separated

Types of movement at a junction

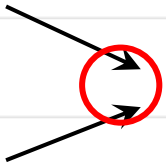
Conflict points at intersections - Conflicts occur when traffic streams moving in different directions interfere with each other.

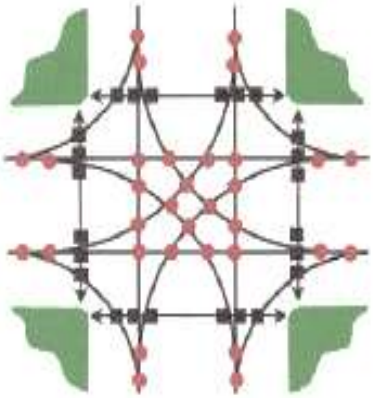
Three types of conflicts:

i. Diverging - Occurs when vehicles leave the traffic stream

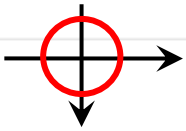


ii. Merging - Occurs when vehicles enter a traffic stream

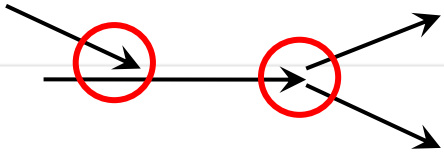




iii. Crossing - Occurs when they cross paths directly



iv. Conflict arises from the combination of conflict over /Weaving



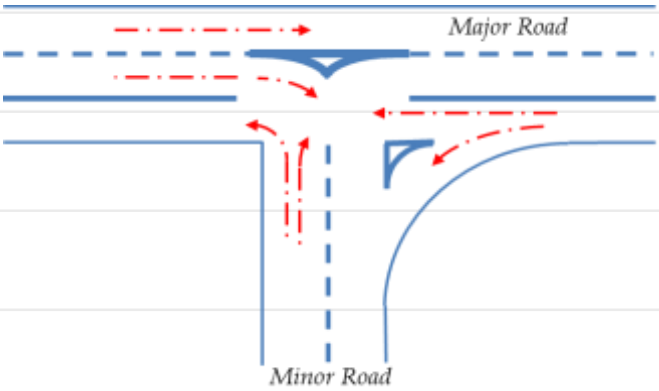
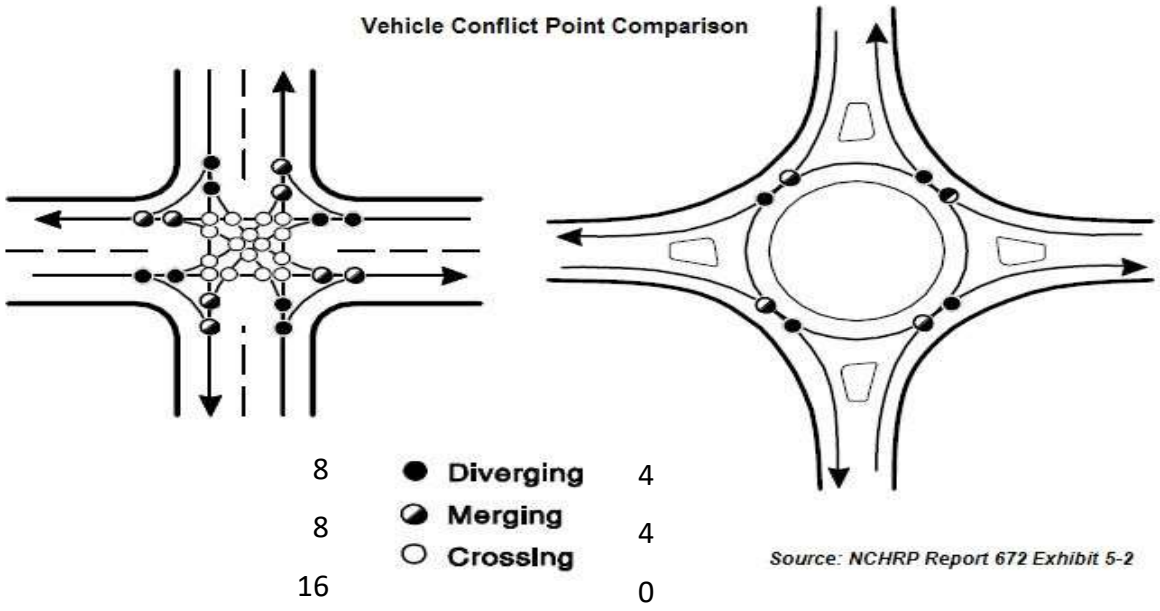


Figure 3-9: Movement at a junction



3.1.5 The conflict point and the conflict area at a junction

The number of potential conflict points at an intersection depends on the:

i. Number of approaches to the intersection
ii. Number of lanes on each approach
iii. Type of signal control
iv. Extent of channelization and
v. Movements permitted

Table 3-1: The relationship between the Total of conflicts with Junction

Total Junction	*Intersect Conflict*	*Link Conflict*	*Diverge Conflict*	*Total of Conflict*
3	***3***	***3***	***3***	***9***
4	***16***	***8***	***8***	***32***
5	***49***	***15***	***15***	***79***
6	***124***	***24***	***24***	***172***

(Sources : Arahan Teknik (J) 11/87)

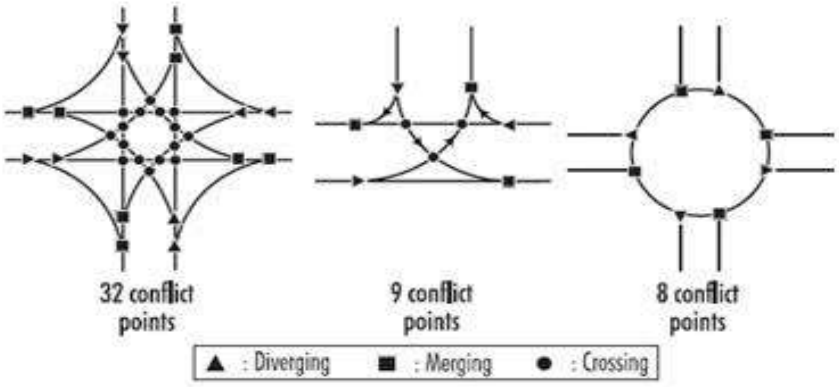


Figure 3-12: Conflict Points

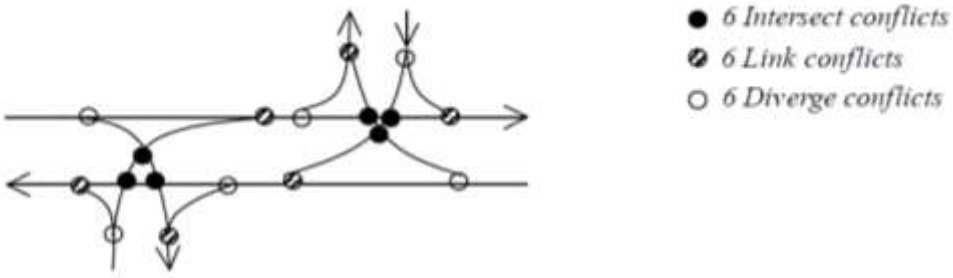


Figure 3-12: Conflict at staggered-junction

Ways to reduce conflict at a junction

- Prevent vehicles turning right from a road
- Make a one-way road
- Converts junction into a staggered intersection
- Through priority control to steer the vehicle in the road, to stop or give way to traffic on major road
- If the volume of traffic in the major road is very high, the delay need to reduce by providing roundabout and traffic lights

Figure 3-13: One-way road

Figure 3-14: Prevent vehicles turning right from a road

3.1.6 The selection factors of junction types;

The principal factors influencing the design of a junction are:

i. **Traffic volume and characteristics:** an intersection should accommodate with comfort and safety design peak traffic volume. The needs of commercial vehicles should be consider.

ii. **Topography and environment:** the location and design of an intersection will be affect by many factors including the alignment and grade of approach roads, the need to provide for drainage, the extent of interference with public utilities, proper access and the presence of local features, both fabricated natural.

iii. **Economics :** variation to existing intersections should be justified by commensurate benefits to traffic

iv. **Human factors** : in an intersection design, driver characteristics should be considered

3.1.7 Traffic light design and phases

Figure 3-15: Two Phase Cycle

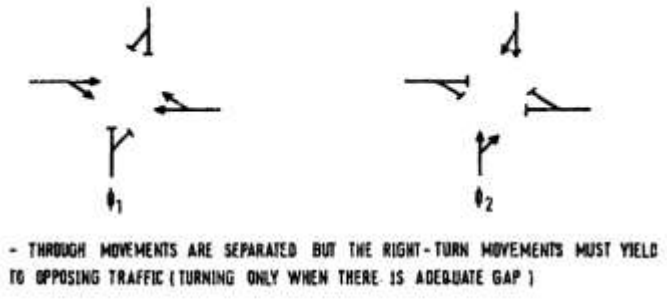


Figure 3-16: Three Phase Cycle

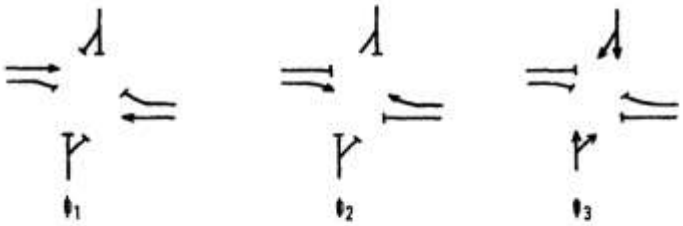
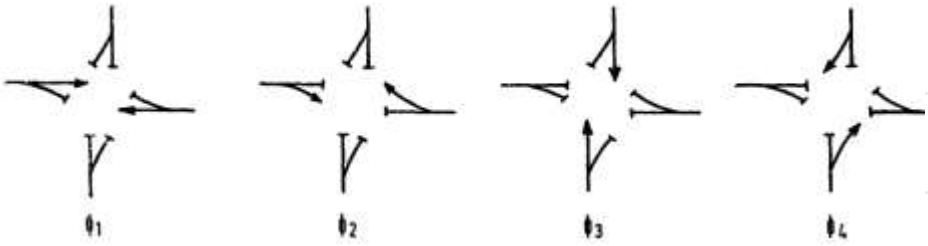


Figure 3-17: Four Phase Cycle



(Source: Jabatan Kerja Raya, Arahan teknik (Jalan) (2) 13/87 A Guide to the design of traffic signals)

3.2 THE CONCEPT OF JUNCTION DESIGN, CONFLICT AREA AND ROUNDABOUT

3.2.1 The term of traffic light circulation phase design:

a. **Lost time, l -** Time during which the intersection is not effectively used by any approach

b. **Actual green time** - The time within a cycle in which an approach has the green indication

c. **Effective green time -** The time that is effectively available to the permitted traffic movements. It is an equivalent time during which the actual flow can be maintain at the saturation level. Taken to be green time plus the change interval minus the lost time for approach.

d. **Red time -** The time during which a given traffic movement is effectively NOT PERMITTED to move. It is the cycle length minus the effective green time.

e. **Amber/yellow time, a** - The amber plus red intervals that provide for clearance of the intersection before conflicting traffic movements are released.

f. **Cycle length, Co -** One complete sequence (for all approaches) of signal indications (green amber red)

g. **Interval, *I* -** A period of time during which all signal indications remains constant

h. **Phase** – Part of a time cycle allocated to any traffic movement receiving the right way

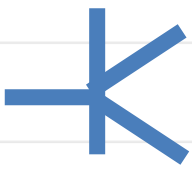
3.2.2 The types of junction:

a. Types of At grade junction

- Three-leg intersection (Consist of three approaches)
- Tee junction and Y junction

- Four-leg intersection (Consist of four approaches)
- Staggered junction, skewed junction, scissors junction, cross junction

- Multileg intersection (Consist of five of more approaches)
- Multiway junction



Selection factors of junction type

Selection factors of junction types depends on:

- Traffic delay - The significant phenomenon in the big city and it occurs during peak hours. Experienced by the driver due to the interaction of the vehicle.
- Geometry delay - It happens even when there is no vehicle in the intersection. The geometric delay are depends on geometric intersection and vehicles speed. Good intersection design will reduce the geometric delay
- Vehicle operation cost on the junction - The costs that should be taken into account is the cost of gasoline, tires, maintenance, depreciation caused by the intersection. Vehicle operating costs depending on the vehicle speed, distance travelled and the type of intersection.
- Acquisition of Land - Land acquisition in urban area is high. This is the important factor in types of junction selection.

3.2.3 The characteristics and the types of roundabout

Roundabouts

Figure 3-18: Roundabouts

A roundabout is a type of circular intersection or junction in which road traffic flows almost continuously in one direction around a central island

Characteristics of Roundabouts

- Suitable for 3 to 5 or more junction, have almost similar flow, no intersect flow
- Non-serious accident do occur, but less than two third compare to signalized junction
- Needed large area, non-warranty of pedestrian safety
- If has high volume, roundabout will be locked
- Not easily updated as traffic signal
- Require a lot of traffic sign, central island must be lighted during night time, can be landscape to reduce night

Table 3-2: The advantages and disadvantages of roundabout

Advantages of roundabout	Disadvantages of roundabout
• Safety • Improved traffic flow • Better solution for complex intersections • Fewer conflict points	• Circle requires a wide flat area • Pedestrian safety is not guaranteed • The circle will not easily be amended or modified • If traffic volume is too high, the circle will be "locked" and causes a long delay

Types of roundabouts

- **Conventional roundabout**, Dc > 25m , Di > 50

Figure 3-19: Conventional roundabout

- **Small roundabout**, 25 > Dc > 4m , 50m > Di > 20m

Figure 3-20: Small roundabout

- **Mini roundabout**, 4 > Dc, 20 > Di

Figure 3-21: Mini roundabout

- **Twin roundabout**

Figure 3-22: Twin roundabout

- **Grade separation roundabout**

Figure 3-23: Grade separation roundabout

- **Signalized roundabout**

Figure 3-24: Signalized roundabout

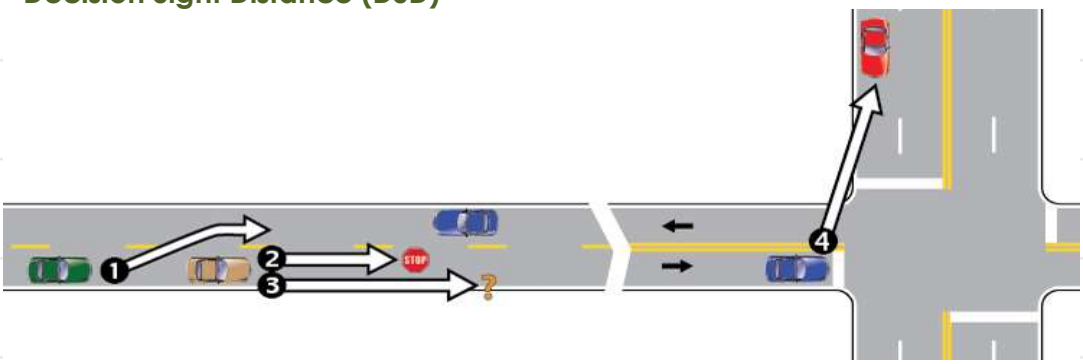
8.4.1 Sight distance, design speed and optimal circulation time for two-phase at a junction

Sight Distance

Sight Distance is a moving distance along the road that can be see clearly by the driver or the way in which drivers on an ongoing basis can see the distance of an object at a certain height. According to the American Association of State Highway and Transportation Officials (AASHTO), the ability of a driver to see ahead on the roadway is of paramount importance for the safe and efficient operation of a vehicle. In general, sight distance refers to the driver's line of sight. Insufficient sight distance is a significant factor in roadway crashes and many other near collisions.

THREE types of Sight Distance:

i. **Stopping Sight Distance (SSD)**
ii. **Passing Sight Distance (PSD)**
iii. **Decision Sight Distance (DSD)**



Stopping sight distance (db)

Distance required by the ordinary driver traveling at design speed to stop his vehicle did not violate the object on an average of driver is of unexpected trouble wet surface. The total distance travelled by the driver at the three time intervals, namely:

i. Response time is the time required when the driver saw the object and then makes a decision.
ii. Reaction time is the time taken to respond.
iii. Braking time is the time taken after the brake is pressed until the vehicle stops.

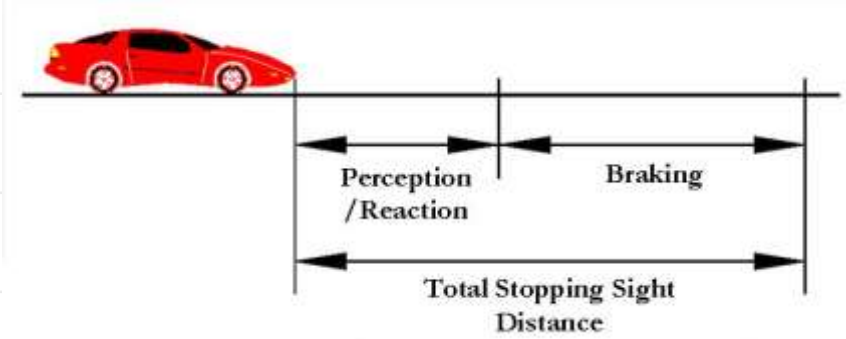


Figure 3-25: Stopping sight distance

Stopping Sight Distance,

$$db = 0.28t\ V + V2/254f$$

Where,
V = design speed (km/h)
t = times (seconds)
f = coefficient of friction between tire and road surface

EXAMPLE

Design value by Arahan Teknik Jalan (8 / 86), response time – reaction time = 2.5s, speed = 120 km / h, f = 0.282. Determine the stopping sight distance.

Solution

db = 0.28t V + V2/254f
db = 0.28 (2.5) (120) + (120)2 / 254 (0.282)
db = 285 m

Passing sight distance

The shortest distance needed to get out of the original lane. Then accelerates to pass the vehicle in front and then go back into the original lane safely and not interfere with oncoming traffic.

Decision sight distance

Distance required by the driver to make decisions and take action, as it deems proper.

STEP 1: Determination of Saturation Flow, S

i. No On-Street Parking
a. Effective approach width, W = 5.5m → ***S = 525 W***
b. ***W < 5.5m***, Refer Table 8-2

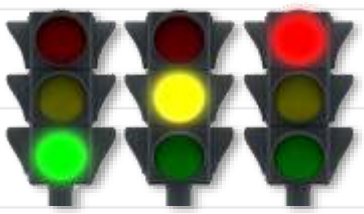
Table 3-3: Relationship between effective lane width and saturation flow

W (m)	3.0	3.25	3.5	3.75	4.0	4.25	4.5	4.75	5.0	5.25
S (pcu/hr)	1845	1860	1885	1915	1965	2075	2210	2375	2560	1760

i. ON-STREET PARKING, W is reduced where
Z = clear distance of the nearest parked car from the stop line (> 7.6m)
K = green time in seconds

If LW is negative, take LW as 0. For parked lorry and wide van, LLW should be increase by 50%.

$$LW = 1.7 - 0.9\frac{(Z - 7.6)}{k}$$



STEP 2: Determination Of *y* Value

$$y = \frac{q}{s}$$

Where,
y = Ratio of flow to saturation flow
q = Actual flow on traffic-signal approach in pcu/hr (refer table 2 for conversion to pcu)
S = Saturation flow for the approach in pcu/hr

The Y value for a phase is the highest y value from the approaches within that phase. For the whole junction, Y = Σyi

Where,
n = number of phases
yi = highest y value from the approach within phase I

The Y value is a measure for the occupancy of the intersection

Preferably, Y ≤ 0.85

If Y > 0.85, it is recommended that, the geometrics of the intersection be upgraded to increase capacity

Table 3-4 : Conversion factors to pcu

Vehicle type	Equivalent pcu value
Passenger cars	1.00
Motorcycles	0.33
Light Vans	1.75
Medium Lorries	1.75
Heavy Lorries	2.25
Busses	2.25

STEP 3 : Determination Of Total Lost Time Per Cycle, L

Total lost time per cycle is given as $L = \Sigma (l-a)+\Sigma \ell$

Where,

l = Intergreen time between phases = R+ a → R = all red interval

a = amber time (assumed 3 seconds)

ℓ = drivers reaction time at the beginning of green per phase (in practice, it is set as 2 seconds but 0-7 seconds can also be used)

STEP 4 : Determination Of Optimum Cycle Time, Co

Co = is the average delay for intersection, but this delay is not increased if the cycle time varies within the range of 0.75 to 1.5 of the calculated Co (in seconds)

$$C_0 = \frac{1.5L+5}{1-Y}$$

For practical purposes, 45s < Co <120s, although an absolute minimum of 25s can be used

STEP 5 : Determination Of Signal Settings

Effective green time plus the change interval minus the lost for a designated phase.

The total effective green time = cycle time- total lost time

$g_1+g_2+\ldots+g_n$ = Co - L

When n denotes the number of phases and gn is the effective green time for phase n.
For optimum conditions, (2 phase cycle) g_1/g_2 = yi

With the above ratio, the following formulas apply to each individual phase (in seconds)

$$g_n = \frac{Y_n}{Y}(C_0 - L)$$

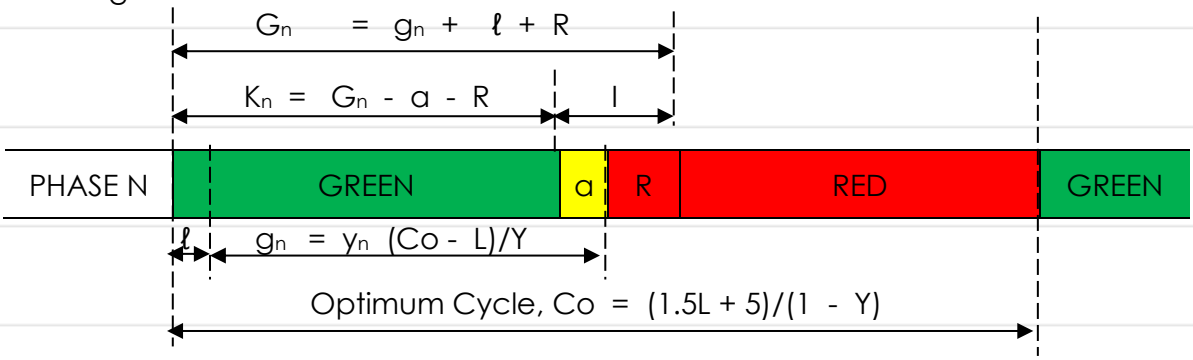
Where,
g_n = effective green time of the nth single phase
Y_n = calculated Y-value of the same signal; phase

$$G = g + \ell + R$$

$$K = G - a - R$$
$$= g + \ell - a$$

Where,
G = actual green time
K = Controller Setting time

Phase Diagram



Example 3.1

Table 3-5 shows peak-hour volumes and saturation flow for a major intersection on an expressway.

Table 3-5 : Saturation Flow Table

Unit	Lane Group	North/Utara	South/Selatan	East/Timur	West/Barat
Flow (pcu/hr)	Car	300	264	580	557
	Motorbike	150	118	158	124
	Bus	47	46	43	35
	Heavy Vehicle	58	62	40	45
Width (mm)		6.0	6.0	7.0	7.0
Fg		1.00	1.00	0.88	1.12
Fr		0.95	0.99	0.95	0.98
Fl		0.98	0.99	1	1

Given :
Car = 1.00 pcu
Bus = 2.25 pcu
Heavy Vehicle = 1.75 pcu
Motorbike = 0.33 pcu

Assume :
Amber time, a = 3 sec
Lost Time, ℓ = 2 sec
All red interval, R = 2 sec

From the data given, determine :
i. Optimum cycle time both phases
ii. The actual green time for each phase
iii. The time diagram for each phase

Solution:

Unit	Lane Group	North/Utara	South/Selatan	East/Timur	West/Barat
Q, Flow (pcu/hr)	Car	300	264	580	557
	Motorbike	150	118	158	124
	Bus	47	46	43	35
	Heavy Vehicle	58	62	40	45
Flow, q (pcu/hr)		300 x 1 + 150 x 0.33 + 47 x 2.25 + 58 x 1.75 = 556.75	514.94	798.89	755.42
Width (mm)		6.0	6.0	7.0	7.0
Fg		1.00	1.00	0.88	1.12
Fr		0.95	0.99	0.95	0.98
Fl		0.98	0.99	1	1
S = 525x Width, (pcu/hr)		525 x 6 = 3150	525 x 6 = 3150	525 x 7= 3675	525 x 7= 3675
S' actual		3150 x 1 x 0.95 x 0.98 = 2933	3150 x 1 x 0.99 x 0.99 = 3087	3675 x 0.88 x 0.95 x 1 = 3072	3675 x 1.12 x 0.98 x 1 = 4033
y = q / S'		0.19	0.17	0.26	0.19
y max		0.19		0.26	

Y = $y_1 + y_2$

= 0.19 + 0.26

= 0.45 ≤ **0.85 (OK)**

Time between green, **I** = **R + a**

= 2 + 3

= 5 sec

Total lost time, **L** = $(I_{phase1} - a_{phase1}) + (I_{phase2} - a_{phase2}) + (\ell_{phase1} + \ell_{phase2})$

= (5 - 3) + (5 - 3) + 2 + 2

= 8 sec

i. Optimum Cycle, C_o = $\dfrac{(1.5L + 5)}{1 - Y}$

= $\dfrac{(1.5(8) + 5)}{1 - 0.45}$

= 30.9 ≈ 31 sec ≤ **120 sec (OK)**

Effective green , g_n = $\dfrac{y_n (C_o - L)}{Y}$

g for each phase, :

Phase 1 N/S : g_1 = $\dfrac{0.19\ (31 - 8)}{0.45}$ = 9.71 sec ≈ 10 sec

Phase 2 E/W : g_2 = $\dfrac{0.26\ (31 - 8)}{0.45}$ = 13.29 sec ≈ 14 sec

ii. Therefore, Actual Green Time /*Masa hijau sebenar*, G_n = $g_n + \ell + R$

Phase 1 N/S : G_1 = $g_1 + \ell + R$ = 10 + 2 + 2 = 14 sec

Phase 2 E/W : G_2 = $g_2 + \ell + R$ = 14 + 2 + 2 = 18 sec

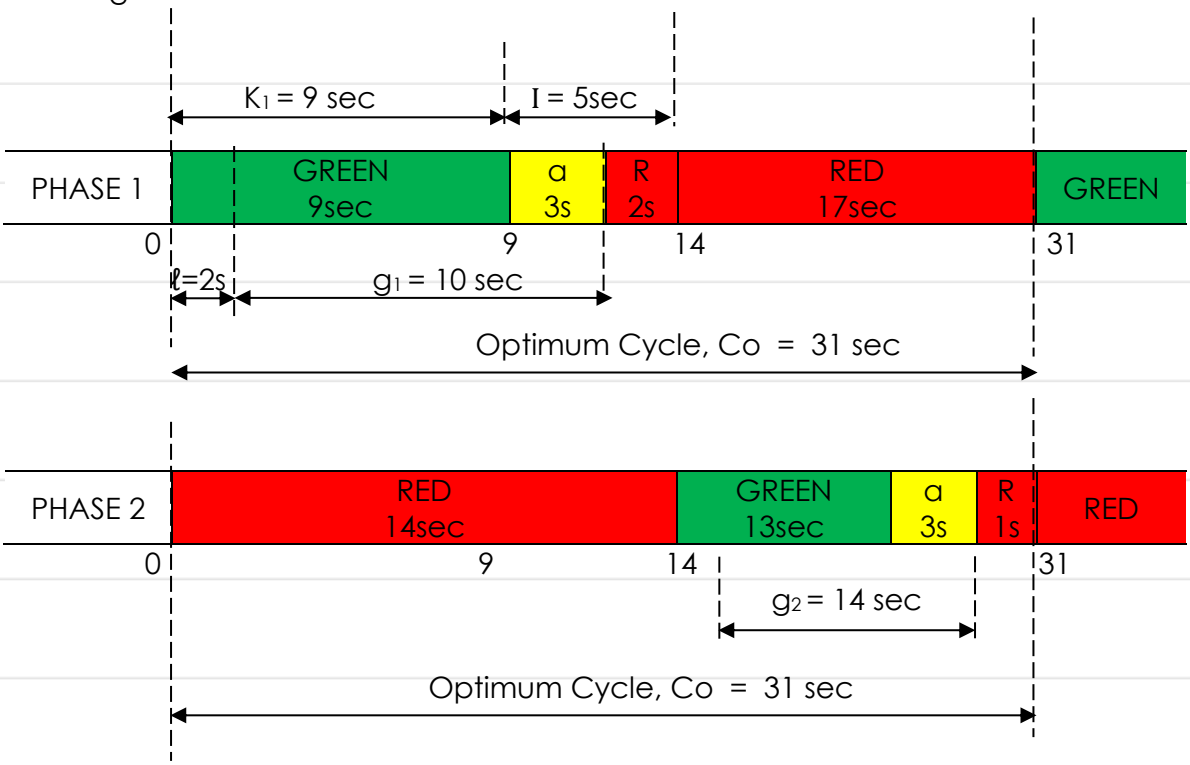
Controller Setting time, K_n = $G_n - a - R$

K_1 = $G_1 - a - R$ = 14 – 3 – 2 = 9 sec

K_2 = $G_2 - a - R$ = 18 – 3 – 2 = 13 sec

ii. The time diagram ;

Phase Diagram



Example 3.2

A 2-phase signal is to be install at the following junction. Q flow is shown in the figure and Saturation flow is shown in the following table 3-6.

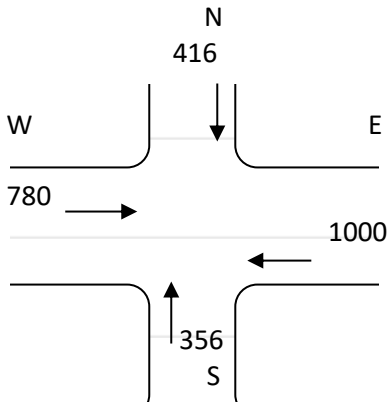


Table 3-6: Saturation Flow Table

Direction/Cabang	North/Utara	South/Selatan	East/Timur	West/Barat
Saturation Flow/*Aliran Tepu*, S (pcu/hr)	1950	1950	2250	2250

Intergreen/ *Masa antara hijau* = 4 sec
Amber/ *Masa kuning* = 3 sec
Lost time /*Masa terhilang* = 2 sec

a) Determine the total lost time, L
b) Determine the optimum cycle time, C_O
c) Determine the actual green time for each phase.
d) Sketch the traffic signal diagram

Solution:

Direction/*Cabang*	North/Utara	South/Selatan	East/Timur	West/Barat
Actual flow/*Aliran Sebenar* (q) pcu/h	416	356	1000	780
Saturation Flow/*Aliran Tepu*, S (pcu/hr)	1950	1950	2250	2250
y = q/s	**>0.21<**	0.18	**>0.44<**	0.35

a. Select maximum value,
y_1 (E/W) = 0.44
y_2 (N/S) = 0.21

Y = ∑ y maximum
= y_1 + y_2
= 0.44 + 0.21
= 0.65 **≤ 0.85 (OK)**

Total lost time per cycle /*Jumlah masa terhilang*, **L = ∑ ℓ + ∑(I – a)**

Where, *there is no different between phase 1 and 2 for the value of I, a and ℓ,*
Intergreen time between phases /*Masa antara hijau*, (I) = 4 s
Amber time /*Masa kuning*, (a) = 3 s
Drivers reaction time at the beginning of green per phase /*Masa terhilang*, (ℓ) = 2 s
Determine L,

L = [ℓ1 + ℓ2] + [(I1 – a1) + (I2 - a2)]
= [(2 + 2)] + [(4 – 3) + (4 – 3)]
= 6 sec

b. Optimum cycle time / *Masa Pusingan Optima*, **Co** $= \frac{1.5\,L + 5}{1 - Y}$
$= \frac{1.5\,(6) + 5}{1 - 0.65}$
= 40 s

c. Effective Green Time, **g = Co - L**
= 40 - 6
= 34 s

Effective Green Time for each phase, :

Phase 1 N/S : $g(i) = \frac{y\,(N/S)}{Y} \times g = \frac{0.21}{0.65} \times 34 = 11\ s$

Phase 2 E/W : $g(ii) = \frac{y\,(E/W)}{Y} \times g = \frac{0.44}{0.65} \times 34 = 23\ s$

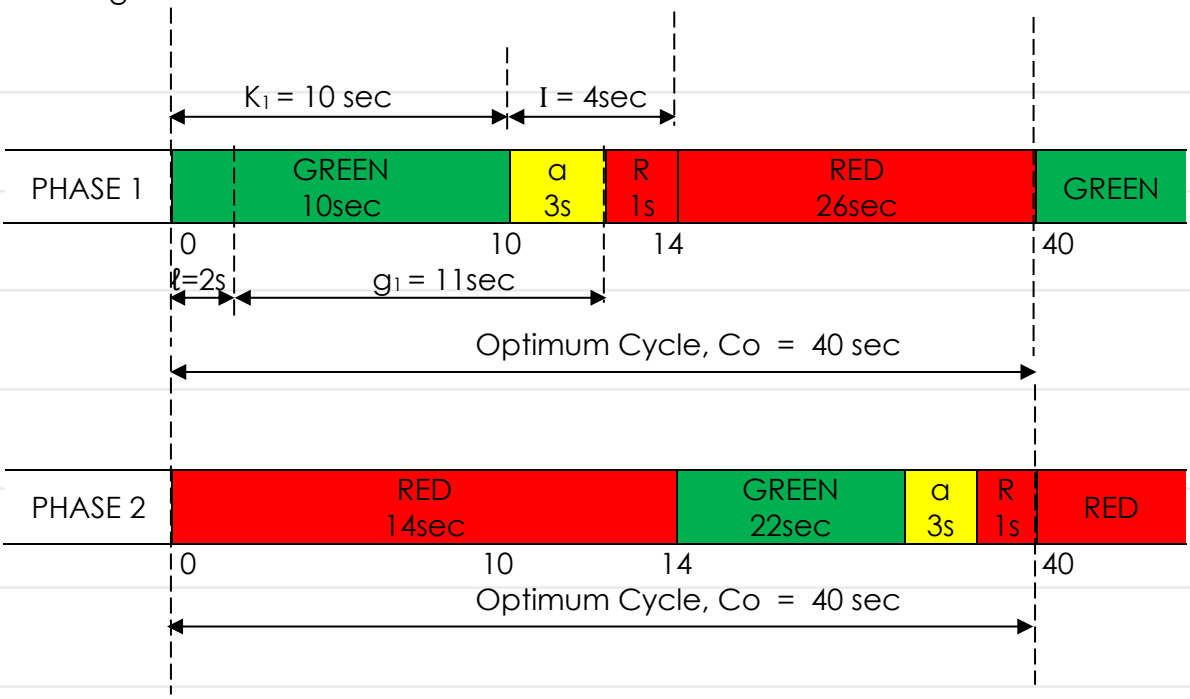
Therefore, Actual Green Time /*Masa hijau sebenar* :

$$K = g(i) + (\ell - a)$$

Phase 1 N/S : $K_1 = 11 + 2 - 3 = 10\ s$
Phase 2 E/W : $K_2 = 23 + 2 - 3 = 22\ s$

d. Traffic signal diagram:

Phase Diagram



ASSESSMENT 3

1. State FOUR (4) types of grade-junction

(4 marks)

2. Describe briefly TWO (2) advantages and TWO (2) disadvantages of roundabout

(4 marks)

_____

_____

_____

_____

3. Two phase traffic light is suggested for a junction. Based on Table, determine
   i. Total of loss time, L
   ii. Optimum Cycle Length, Co
   iii. Effective green time for each phase
   iv. Actual green time for each phase
   v. Sketch the time phase diagram

Table 3-7: Saturation Flow Table

Direction/*Cabang*	**North/Utara**	**South/Selatan**	**East/Timur**	**West/Barat**
Actual flow/*Aliran Sebenar* (q) pcu/h	550	700	500	880
Saturation Flow/*Aliran Tepu*, S (pcu/hr)	1975	1975	1875	1875

Given: Intergreen time = 5 seconds
Amber period = 3 seconds
Lost time = 2 seconds

(15 marks)

FEEDBACK ON ASSESSMENT 3

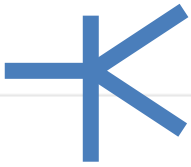
1. State FOUR (4) types of grade-junction

(4 marks)

- *Three-leg intersection (Consist of three approaches)*
- *Tee junction and Y junction*

- *Four-leg intersection (Consist of four approaches)*
- *Staggered junction, skewed junction, scissors junction, cross junction*

- *Multileg intersection (Consist of five of more approaches)*
- *Multiway junction*



2. Describe briefly TWO (2) advantages and TWO (2) disadvantages of roundabout

(4 marks)

Advantages:	*Dis advantages:*
• *Safety*	• *Circle requires a wide flat area*
• *Improved traffic flow*	• *Pedestrian safety is not guaranteed*
• *Better solution for complex intersections*	• *The circle will not easily be amended or modified*
	• *If traffic volume is too high, the circle will be "locked" and causes a long delay*
• *Fewer conflict points*	

3. Two phase traffic light is suggested for a junction. Based on Table, determine

i. Total of loss time, L
ii. Optimum Cycle Length, Co
iii. Effective green time for each phase
iv. Actual green time for each phase
v. Sketch the time phase diagram

Table 3-7: Saturation Flow Table

Direction/*Cabang*	North/Utara	South/Selatan	East/Timur	West/Barat
Actual flow/*Aliran Sebenar* (q) pcu/h	550	700	500	880
Saturation Flow/*Aliran Tepu*, S (pcu/hr)	1975	1975	1875	1875

Given: Intergreen time = 5 seconds
Amber period = 3 seconds
Lost time = 2 seconds

(15 marks)

Answer:

i. Total Lost Time, L

$L = \sum \ell + \sum (I - a)$
$= [2 + 2] + [(5 - 3) + (5 - 3)]$
$= 8$ sec

ii. Optimum cycle, Co

Determine Y and ∑Y

Direction/*Cabang*	North/Utara	South/Selatan	East/Timur	West/Barat
Actual flow/*Aliran Sebenar* (q) pcu/h	550	700	500	880
Saturation Flow/*Aliran Tepu*, S (pcu/hr)	1975	1975	1875	1875
y = q/S	0.28	0.35	0.27	0.47
y_{max}	0.35		0.47	

$Y = \sum Y_{max}$
$= (0.35 + 0.47) = 0.82 \leq 0.85$ (OK)

Determine the optimum cycle time, Co

$Co = \frac{1.5L + 5}{1 - Y}$
$= \frac{1.5(8) + 5}{1 - 0.82}$
$= 94$ sec

iii. Effective Green Time for Phase 1 and 2, g

$g = Co - L = 94 - 8 = 86$ sec

G for each phase,

Phase 1 : $g(i) = \frac{y(1)}{Y} \times g = \frac{0.35}{0.82} \times 86 =$ 37 sec

Phase 2 : $g(ii) = \frac{y(2)}{Y} \times g = \frac{0.47}{0.82} \times 86 =$ 49 sec

iv. Therefore, Actual Green Time /Masa hijau sebenar :

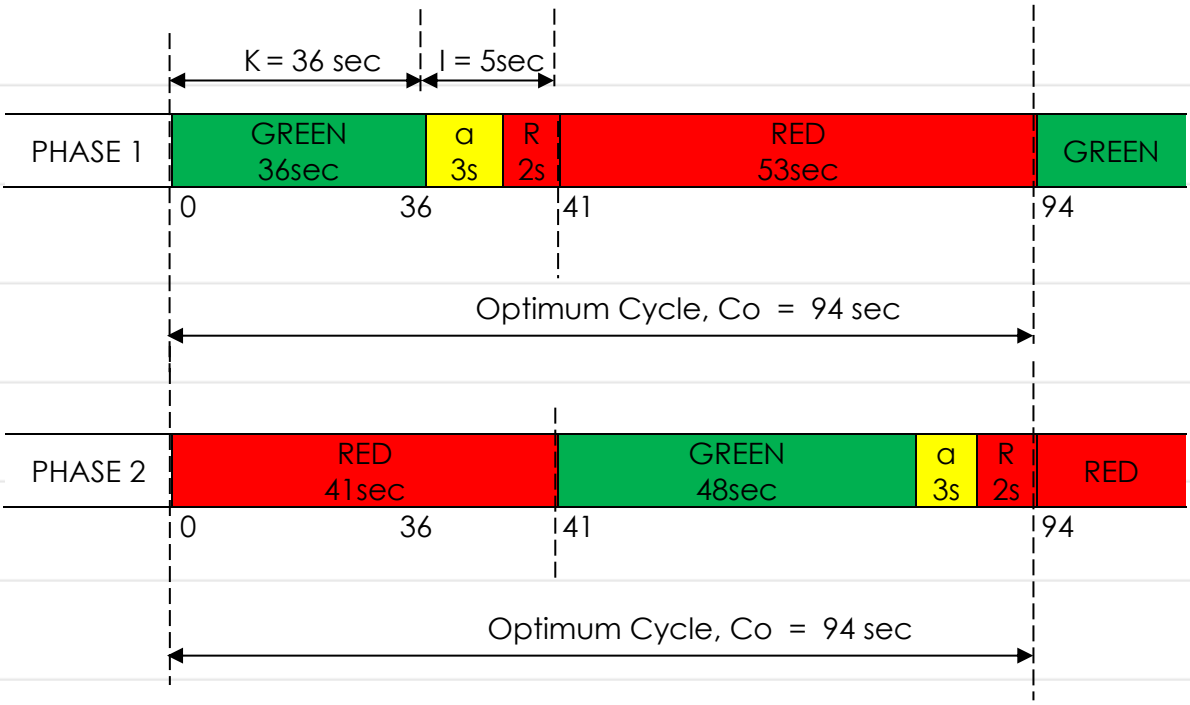
$$K = g(i) + (l - a)$$

Phase 1 : K = 37 + (2 - 3) = 36 sec

Phase 2 : K = 49 + (2 - 3) = 48 sec

v. Traffic signal diagram:

Phase Diagram



4.1 THE CONCEPT OF ROAD ACCIDENT AND TRAFFIC MANAGEMENT

Traffic management is the management and controlling of transportation modes, carriers and services. It is often use to describe the adjustment process of the usage of road system and transportation, to fulfil the specific objectives without any road construction needed. Traffic management include the technique that use to make the movement of goods and humans become easier by using the existing road and direct road users towards a safer and more efficient use of the other existing infrastructure and also improve environment.

Traffic management focuses on how to use the existing roads and infrastructures to maximize the effectiveness of the system to reduce traffic ingestion. Traffic management can be in long term and in short term. It is therefore an essential element in increasing the efficiency and safety of transport networks and operations

4.1.1 The factors causing accident:

a. Human
b. Road condition
c. Vehicle

Human Factor

Percent of accident for human factor contribute 85.74 %.

Factor: -

- Factors of vision, hearing, comfort, fatigue and emotional drivers.
- Hasty attitude and selfish
- Driving while intoxicated, unreal @ sleepy.
- Interfere with driver attention.
- Pedestrians do not obey the traffic rules

Figure 4-1: Human Factors

Road Condition

- Poor road design,
- Sample design and junction layout is not ideal, less visibility.
- Poor environment
- Example:- a flooded road surface causing a slippery roads, poor maintenance, and weather conditions.
- Less equipment and road markings
- Signs and road lines that is not enough and not clear, and lighting is not good.
- Narrow roads cause many vehicles do not have room to move in the event of an emergency.

Vehicle Factors

- Vehicle defects
- Such as tires and brake defects (the vehicle is not functioning properly).
- Capacity against resistance and skid
- If the vehicle is in good condition vehicle can stop safely (tires).
- Acceleration and deceleration
- Good vehicle is a vehicle that can acceleration and deceleration quickly.

Figure 4-2: Vehicle Factors

4.1.2 The functions of traffic management

- To ease traffic congestion
- Enhance road safety
- Improve traffic flow
- Improve the transportation of people and goods
- Reduce the impacts of traffic on the environment
- Create a balance modal split

4.1.3 Traffic management techniques:

a. **Physical management of road system**
b. **Instruct form and traffic regulation management**
c. **Management of information to road user**
d. **Management of payment for traffic facilities.**

Physical management of road system

- Separation of traffic movement
- Junction improvement
- Geometry of local area improvement
- Physical detention of traffic movement
- Changing of level, texture of surface and alignment for speed control purpose
- Introduce the coordination of phase traffic control Modification of traffic sign and road sign
- Provision of public transport facilities
- Provision of facilities for pedestrian and cyclist
- Modification of landscape and road tools
- Example: Car park control and Metered ramp

Instruct form and traffic regulation management

- Traffic Control
- Turning movement barriers
- One-way street
- Limiting vehicle speed
- Tidal flow method (Tidal)
- Road Marking

Management of information to road user

- Traffic direction sign
- Control traffic route
- High occupant vehicles campaign program (HOV)

Management of payment for traffic facilities

- Method of Additional License
- Parking Management
- Appreciation Blockade
- Physical Barriers
- Reward system path

Advantages and disadvantages of providing a one-way road system

Table 4-1: Advantages and disadvantages of providing a one-way road system

Advantages:	*Dis advantages:*
Road traffic increases	Long travel distance
Vehicle speed increases	Local residents' amenities were lost
Safety level increases	Business lost
Economic	Increased accident level
Wider parking space	Road users may be confuse

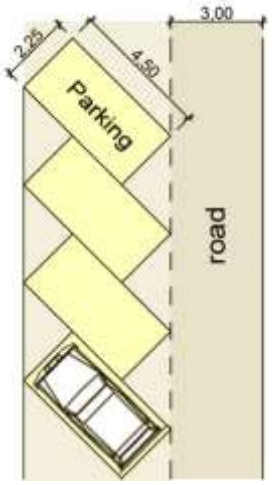
4.2 THE CAR PARK NECESSITY FOR VARIOUS TYPES OF USERS

The observation of the car park

Main Purpose: To identify the necessity of car park and to determine the physical necessity so that the car park supply can be change or added.

The importance of car park management

- To improve the value of the passenger/vehicle
- To decrease the time travel
- To decrease traffic jam
- To reduce pollution and noise
- To reduce accident



4.2.1 The effects of car park areas on traffic flow

a) Traffic congestion

- road capacity is reduced
- pedestrian speed will decrease
- travel time will increase
- delays

b) Accident

- can caused accident
- users tend to change the direction of movement towards parking
- Parking at the wrong place can caused accident.
- the user opened and come out from the vehicles suddenly

c) Obstacle to the operation of the fire extinguishing

- Blocked traffic may interfere with the passage of emergency vehicles travelling to their destinations where they are urgently need.

4.2.2 The method of preparing inventory, car park area and types of car park area

- Inventory Preparation
- Inventory of parking space
- Things needed in preparing the inventory/information on parking space
- Data related to the amount of space, location and potential areas for parking.
- Detailed study area with the mark in the form of a map or plan.
- Divides the study area into several fractions according to the streets.
- Parking spaces on a smaller scale or not gazetted also be considered.

The data relating to parking facilities should be record as follows: -

- The number and length of the road.
- The amount of space available on the road somewhere. Location of bus stops and taxi, pedestrian crossings and other.
- Management rules as a one-way street, airport and other turning.
- The amount and types of traffic signs.
- Private streets.
- Vacant land, abandoned the right to be the parking space.

4.2.3 The method of car park area usage

Term studies

- To determine the length of time that the vehicle is placed in the study area.
- Continuous observations need to be conduct in all areas of the possible car park.
- Reviewers should sit within an area, which is quite, hidden for fear of disturbing the observed values.
- Different travel to be consider in this review should not be too long, as it will affect both the observed values.
- Information about the period also possible can be obtain through parking tickets.

Interview study

- It is the most detailed survey parking.
- Common questions are about where the journey starts destination and purpose of trips made.
- Details on the duration and concentration parking can also be collect during the survey interview.
- In this method, the survey area is divide into several areas.
- When limited reconnaissance personnel, especially for areas long-term parking, information obtained through interviews indirectly derived through survey questionnaires sent back.
- In the above case, the questionnaire given to the driver
- The questionnaires should include a request for each driver to answer the questions asked by complete and return it by post.

4.2.4 Administrative ways and car park area control method

Methods to control the parking:

- Time limit (20 minute/hour and etc)
- Using Car Park Meter
- Through parking tape or other card show.

Parking control

- Raising parking fees
- Prevent parking for a long time
- Limit parking space

Solution to congestion and traffic barriers

- System of traffic control or retaining
- car pooling
- Lift giving
- Car sharing
- Van pooling
- Modification of traffic flow
- Prohibition round to the right
- One-way street
- Edges occlude

Figure 4-3: Parking control

The differences between Parking Demand and Parking Turnover

- *Parking demand is the number of vehicles whose drivers desire to park at a specific location or in a general area where parking turnover is a number of vehicles utilizing the same stall over a given period of time (four or more during an 8-hour period indicates a high turnover rate)*
- *Parking demand is usually expressed as the number of vehicles during the peak parking hour but parking turnover measures utilization.*

Notes:

Parking turnover: It is the ratio of number of vehicles parked in a duration to the number of parking bays available. This can be express as number of vehicles per bay per time duration.

How the Parking Area Functions

a) On street parking

On street parking mean the vehicles are park on the sides of the street itself. This will be usually control by government agencies itself. Common types of on-street parking are as listed below. As per IRC the standard dimensions of a car is take as 5 x 2.5 m and that for a truck is 3.75x7.5 m.

Figure 4-4: On street Parking

b) Off street parking

Off street parking means vehicles are park off the street itself. This will be usually control by commercial agencies itself.

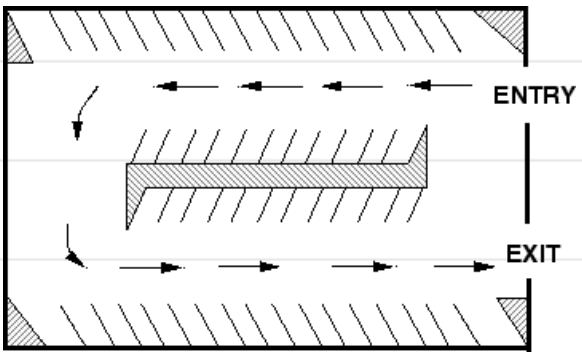


Figure 4-5: Off street Parking

c) Parallel parking

The vehicles are park along the length of the road. Here there is no backward movement involved while parking or unparking the vehicle. Hence, it is the safest parking from the accident perspective. However, it consumes the maximum curb length and therefore only a minimum number of vehicles can be parked for a given kerb length. This method of parking produces least obstruction to the on-going track on the road since least road width is used.

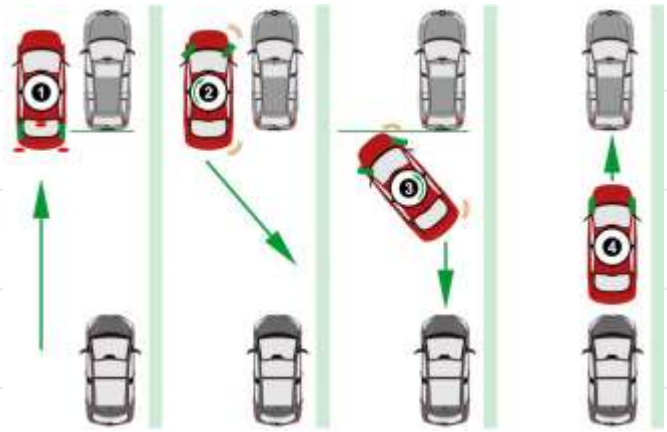


Figure 4-6: Parallel Parking

d) **30 degree parking**

In thirty degree parking, the vehicles are park at 30 degree with respect to the reined alignment. In this case, more vehicles can be park compared to parallel parking. In addition, there is better maneuverability. Delay caused to the track is also minimum in this type of parking.

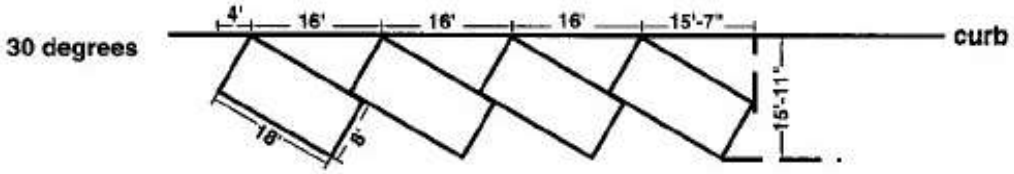


Figure 4-7: 30 degree Parking

e) **45 degree parking**

As the angle of parking increases, more number of vehicles can be park. Hence, compared to parallel parking and thirty degree parking, more number of vehicles can be accommodate in this type of parking.

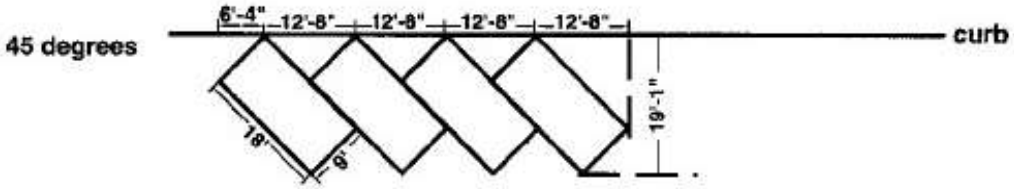


Figure 4-8: 45 degree Parking

f) **60 degree parking**

The vehicles are park at 60 degree to the direction of road. More number of vehicles can be accommodate in this parking type.

4.3 THE CONCEPT OF ROAD ACCIDENT AND TRAFFIC MANAGEMENT

Road accident is a tragedy that affects all people whether as drivers, passengers, or pedestrians. Term accident according to the "Dewan Bahasa dan Pustaka" means an unexpected event occurs. Accident rate in Malaysia is increasing and disturbing our society today. Road accidents occur in many places no matter straight road, cross roads, traffic lights and roundabouts. Road accidents occur on a daily basis, whether a minor injury or casualties.

9.3.1 How traffic management reduce road accidents

Traffic Management can help to reduce road accidents through **Engineering, Law Enforcements, Road studies and researches,** and **Road safety** awareness campaign and administration.

Engineering - Various engineering measures can be conduct. This includes the elements of road design, road geometry, road signs, street lighting and visibility.

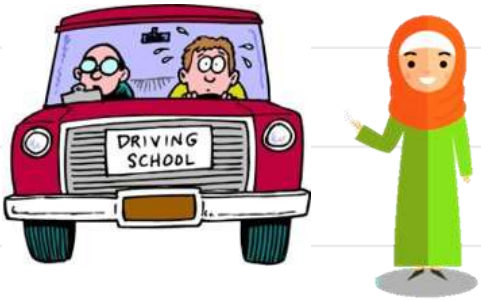
Enforcement and Legal - The law should be tightened further and impose fines for those who violate the speed limit, the vehicle in non-emoting, not parking in a reserved and so forth.

Research - Research on road safety should be enhanced as driver attitude, psychological drivers, driver training and engineering aspects to reduce accidents.

Road Safety Administration - Funding should be sufficient to carry out a road safety precautions.

For example;

- Provide a toll system at the entrance to the city.
- Prohibit the park on the side of the road for the critical areas.
- Build a pedestrian bridge and build a fence on the road under the bridge so that pedestrians have to use the bridge.
- Widening of the critical path.
- Provide car sharing program.
- Provide parking zone on the outskirts of the city center and basement.
- Provide zebra crossings if it is at the crossroads Conner then made sharp at the junction.
- Prohibit heavy vehicles entering the city center at certain times.
- Increase the one-way street.
- Transfer out to the edge of the city bus station.



ASSESSMENT 4

1. State FOUR (4) factor of road condition

(4 marks)

2. Classify FOUR (4) traffic management techniques.

(4 marks)

3. Describe the data relating to parking facilities should be recorded

(4 marks)

FEEDBACK ON ASSESSMENT 4

1. State FOUR (4) factor of road condition

(4 marks)

- Poor road design (geometric / material)
- Poor environment condition
- Topography condition
- Less equipment and road marking

2. Clasify FOUR (4) traffic management techniques.

(4 marks)

- Traffic physical management techniques
- Instruction form and traffic regulation management
- Management of information to road users
- Management of payment for traffic facilities

3. Describe the data relating to parking facilities should be recorded

(4 marks)

- The length of the road
- The number of parking space available on the road
- Location of bus and taxi stops, pedestrians crossing and other
- Management rules as one-way street, airport and other turning
- The amount and types of traffic signs
- Private streets
- Vacant land, abandoned the right to be parking space area

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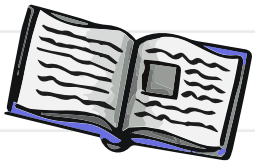

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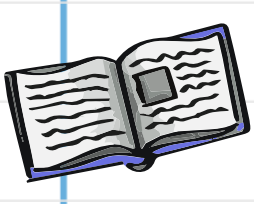

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