UNIT-3

Fundamental parameters of traffic flow

Overview

Traffic engineering pertains to the analysis of the behavior of traffic and to design the facilities for the smooth, safe and economical operation of traffic. Understanding traffic behavior requires a thorough knowledge of traffic stream parameters and their mutual relationships.

Traffic stream parameters

The traffic stream includes a combination of driver and vehicle behavior.

1. Speed

Speed is considered as a quality measurement of travel as the drivers and passengers will be concerned more about the speed of the journey than the design aspects of the traffic.

- Spot Speed
- Running speed

Time mean speed and space mean speed

Time mean speed is defined as the average speed of all the vehicles passing a point on a highway over some specified time period. Space mean speed is defined as the average speed of all the vehicles occupying a given section of a highway over some specified time period.

2. Flow

There are practically two ways of counting the number of vehicles on a road. One is flow or volume, which is defined as the number of vehicles that pass a point on a highway or a given lane or direction of a highway during a specific time interval.

Types of volume measurements

I. Average Annual Daily Traffic(AADT)
II. Average Annual Weekday Traffic(AAWT)
III. Average Daily Traffic(ADT)
IV. Average Weekday Traffic(AWT)

3. Density

Density is defined as the number of vehicles occupying a given length of highway or lane and is generally expressed as vehicles per km/mile**.**

Derived characteristics

Time headway

The microscopic character related to volume is the time headway or simply headway. Time headway is defined as the time difference between any two successive vehicles when they cross a given point.

Distance headway

Another related parameter is the distance headway. It is defined as the distance between corresponding points of two successive vehicles at any given time.

Travel time

Travel time is defined as the time taken to complete a journey.

Time-space diagram

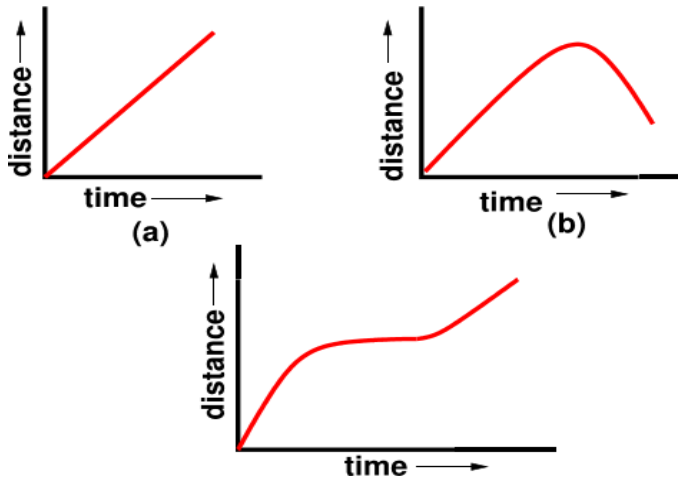

Fig. 12.1 Single vehicle

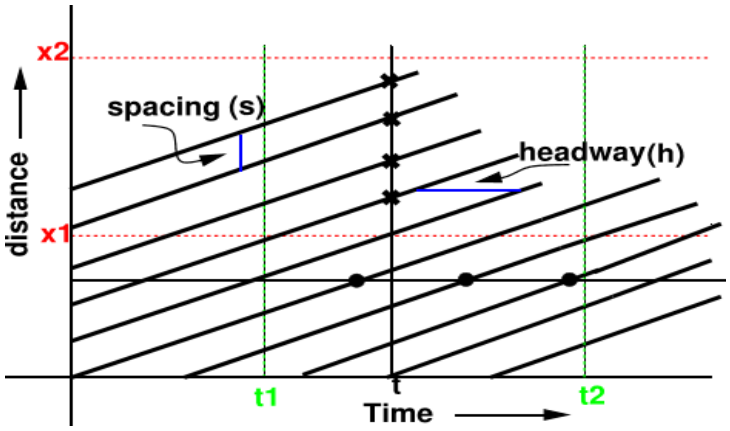

Fig. 12.2 Many vehicle

Fundamental relation of traffic parameter

Overview

Speed is one of the basic parameters of traffic flow and time mean speed and space mean speed are the two representations of speed.

- ✓ Time mean speed (v_t)
- ✓ Space mean speed (v_s)

Fundamental diagrams of traffic flow

The flow and density varies with time and location. The relation between the density and the corresponding flow on a given stretch of road is referred to as one of the fundamental diagram of traffic flow. Some characteristics of an ideal flow-density relationship is listed below:

1. When the density is zero, flow will also be zero,since there is no vehicles on the road.

2. When the number of vehicles gradually increases the density as well as flow increases.

3. When more and more vehicles are added, it reaches a situation where vehicles can't move. This is referred to as the jam density or the maximum density. At jam density, flow will be zero because the vehicles are not moving.

4. There will be some density between zero density and jam density, when the flow is maximum.

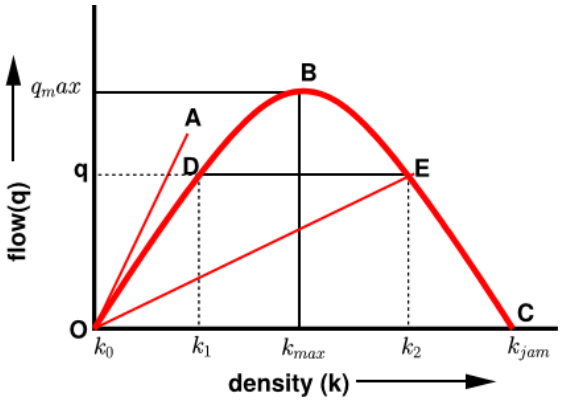

Fig.13.1 Flow density Curve

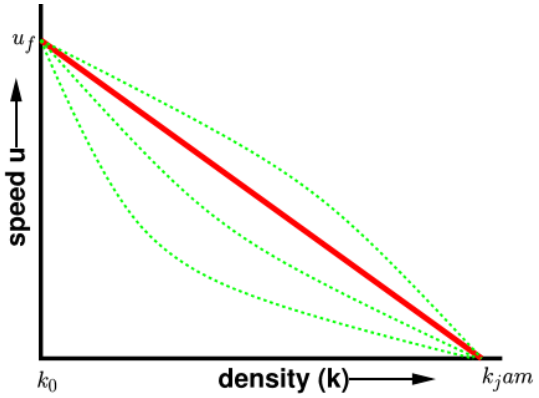

Fig.13.2 Speed-density diagram

Speed-density diagram

Similar to the flow-density relationship, speed will be maximum, referred to as the free flow speed, and when the density is maximum, the speed will be zero. The most simple assumption is that this variation of speed with density is linear

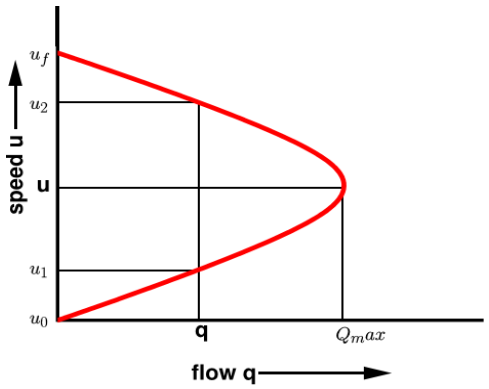

Fig.13.3 Speed-flow diagram

Traffic data collection

Overview

Unlike many other disciplines of the engineering, the situations that are interesting to a traffic engineer cannot be reproduced in a laboratory. Even if road and vehicles could be set up in large laboratories, it is impossible to simulate the behavior of drivers in the laboratory.

Data requirements

The measurement procedures can be classified based on the geographical extent of the survey into five categories:

(a) Measurement at point on the road,

(b) Measurement over a short section of the road (less than 500 metres)

(c) Measurement over a length of the road (more than about 500 metres)

(d) Wide area samples obtained from number of locations, and (e) the use of an observer moving in the traffic stream.

Measurements at a point

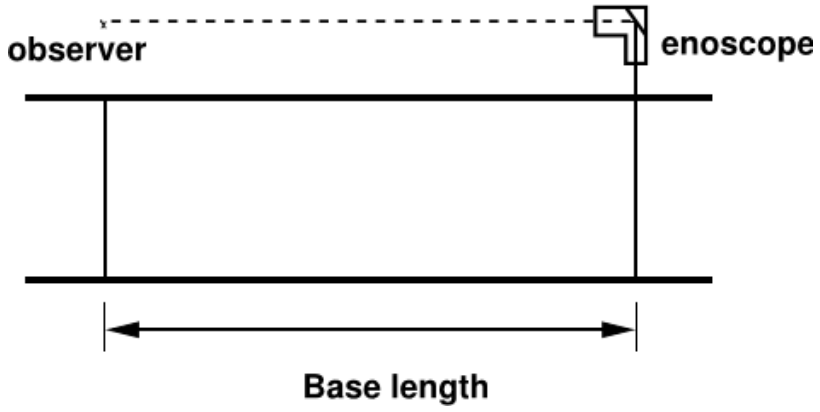

Fig. 14.1 Illustration of measurement over short section using enoscope

Measurements over short section

The main objective of this study is to find the spot speed of vehicles.

Measurements over long section

This is normally used to obtain variations in speed over a stretch of road.

Moving observer method for stream measurement

Determination of any of the two parameters of the traffic flow will provide the third one by the equation q = u.k. Moving observer method is the most commonly used method to get the relationship between the fundamental stream characteristics

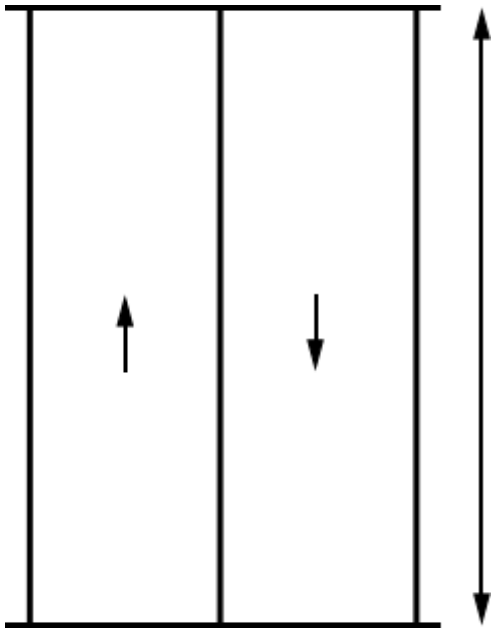

Fig. 14.2. Illustration of moving observer method

Capacity and Level of Service

Overview

Capacity and Level of service are two related terms. Capacity analysis tries to give a clear understanding of how much traffic a given transportation facility can accommodate. Level of service tries to answer how good the present traffic situation on a given facility is.

Capacity

Capacity is defined as the maximum number of vehicles, passengers, or the like, per unit time, which can be accommodated under given conditions with a reasonable expectation of occurrence. Some of the observations that are found from this definition can be now discussed.

Level of service

A term closely related to capacity and often confused with it is service volume. When capacity gives a quantitative measure of traffic, level of service or LOS tries to give a qualitative measure.

Highway capacity

Highway capacity is defined by the Highway Capacity Manual as the maximum hourly rate at which persons or vehicles can be reasonably expected to traverse a point or a uniform segment of a lane or roadway during a given time period under prevailing roadway, traffic and control conditions.

- ✓ Traffic conditions:
- ✓ Road way characteristics:
- ✓ Control conditions:

Factors affecting level of service

Level of service one can derive from a road under different operating characteristics and traffic volumes. The factors affecting level of service (LOS) can be listed as follows:

- Speed and travel time
- Traffic interruptions/restrictions
- Freedom to travel with desired speed
- Driver comfort and convenience
- Operating cost.

Traffic Sign

Overview

Traffic control device is the medium used for communicating between traffic engineer and road users. Unlike other modes of transportation, there is no control on the drivers using the road. Here traffic control devices comes to the help of the traffic engineer. The major types of traffic control devices used are-

1. Traffic signs
2. Road markings
3. Traffic signals
4. Parking control.

Requirements of traffic control devices

The control device should fulfill a need

It should command attention from the road users

It should convey a clear, simple meaning

Road users must respect the signs

The control device should provide adequate time for proper response from the road users

Types of traffic signs

1. Regulatory signs
2. Warning signs
3. Informative signs

Regulatory signs

These signs are also called mandatory signs because it is mandatory that the drivers must obey these signs. If the driver fails to obey them, the control agency has the right to take legal action against the driver.

- Right of way series
- Speed series
- Movement series
- Parking series
- Pedestrian series
- Miscellaneous

Warning signs

Warning signs or cautionary signs give information to the driver about the impending road condition. They advice the driver to obey the rules.

Informative signs

Informative signs also called guide signs, are provided to assist the drivers to reach their desired destinations. These are predominantly meant for the drivers who are unfamiliar to the place. The guide signs are redundant for the users who are accustomed to the location.

Fig.16.1 Examples of informative signs

Road Sign

Overview

The essential purpose of road markings is to guide and control traffic on a highway. They supplement the function of traffic signs. The markings serve as a psychological barrier and signify the delineation of traffic path and its lateral clearance from traffic hazards for the safe movement of traffic. Hence they are very important to ensure the safe, smooth and harmonious flow of traffic.

Classification of road markings

The road markings are defined as lines, patterns, words or other devices, except signs, set into applied or attached to the carriageway or kerbs or to objects within or adjacent to the carriageway, for controlling, warning, guiding and informing the users. The road markings are classified as

- Longitudinal markings
- Transverse markings
- Object markings
- Word messages
- Marking for parking
- Marking at hazardous locations

Longitudinal markings

Longitudinal markings are placed along the direction of traffic on the roadway surface, for the purpose of indicating to the driver, his proper position on the roadway.

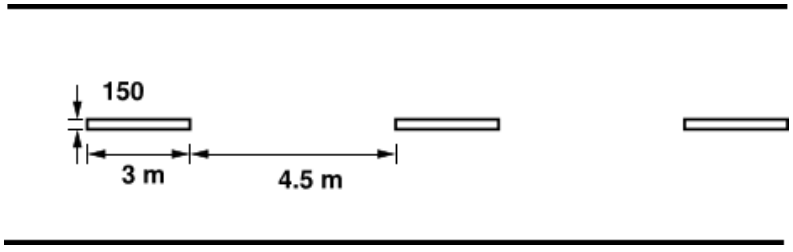

Fig.17.1 Centre line marking for a two lane road

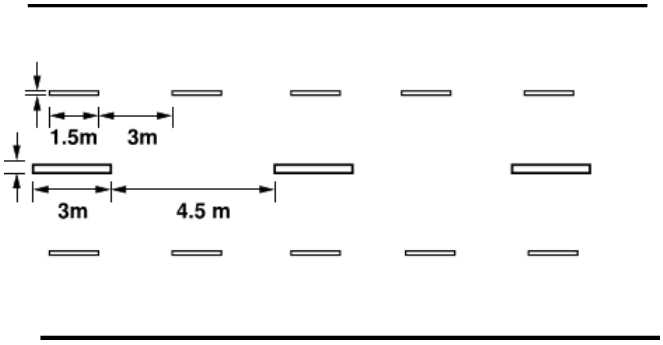

Fig.17.2 Centre line and lane marking for a four lane road

Centre line

Centre line separates the opposing streams of traffic and facilitates their movements. Usually no centre line is provided for roads having width less than 5 m and for roads having more than four lanes. The centre line may be marked with either single broken line, single solid line, double broken line, or double solid line depending upon the road and traffic requirements.

Traffic lane lines

The subdivision of wide carriageways into separate lanes on either side of the carriage way helps the driver to go straight and also curbs the meandering tendency of the driver.

No passing zones

No passing zones are established on summit curves, horizontal curves, and on two lane and three lane highways where overtaking maneuvers are prohibited because of low sight distance. It may be marked by a solid yellow line along the centre or a double yellow line.

Parking

Overview

Parking is one of the major problems that is created by the increasing road traffic.

Parking studies

Before taking any measures for the betterment of conditions, data regarding availability of parking space, extent of its usage and parking demand is essential. It is also required to estimate the parking fares also.

- Parking statistics
- Parking accumulation
- Parking volume
- Parking load
- Average parking duration
- Parking turnover
- Parking index

Parking surveys

- In-out survey
- Fixed period sampling
- License plate method of survey

On street parking

- ✓ Parallel parking
- ✓ 30 parking
- ✓ 45 parking
- ✓ 60 parking
- ✓ Right angle parking
- ✓

Off street

Parking In many urban centres, some areas are exclusively allotted for parking which will be at some distance away from the main stream of traffic. Such a parking is referred to as off-street parking.

Traffic Signal Design

Overview

The conflicts arising from movements of traffic in different directions is solved by time sharing of the principle. The advantages of traffic signal includes an orderly movement of traffic, an increased capacity of the intersection and requires only simple geometric design. However the disadvantages of the signalized intersection are it affects larger stopped delays, and the design requires complex considerations.

Definitions and notations

- Cycle
- Cycle length
- Interval
- Green interval
- Red interval
- Phase
- Lost time

Phase design

The signal design procedure involves six major steps.

They include the

1. phase design
2. determination of amber time and clearance time
3. determination of cycle length
4. apportioning of green time
5. pedestrian crossing requirements,
6. the performance evaluation

Two phase signals

Two phase system is usually adopted if through traffic is significant compared to the turning movements.

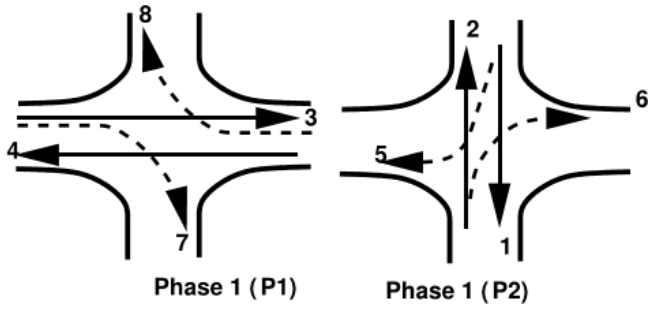

Fig. 19.1 Two phase signal

Four phase signals

There are at least three possible phasing options.

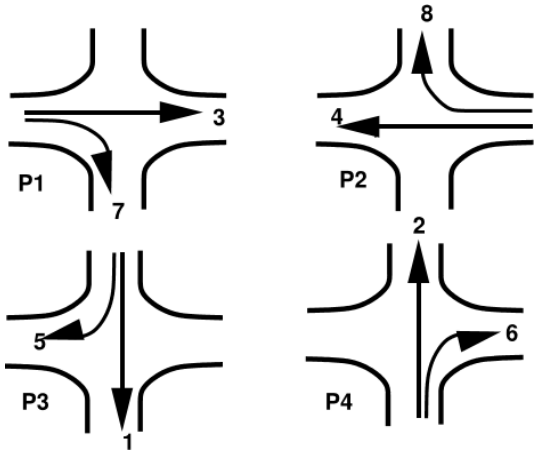

Fig.19.2 One way of providing four phase signals

Cycle time

Cycle time is the time taken by a signal to complete one full cycle of iterations. i.e. one complete rotation through all signal indications. It is denoted by C.

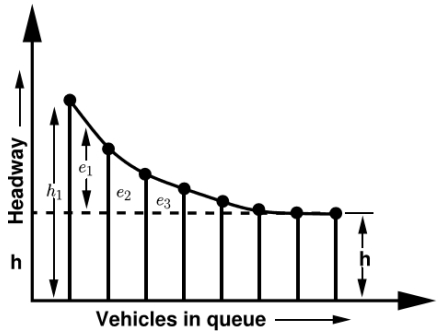

Fig.19.3 Headways departing signal