

Fundamental parameters of traffic flow

CE740 Traffic Engineering

Introduction

- **Traffic flow**
 - Complex movements
 - Stochastic in nature
- **Traffic Engineering**
 - Control and management of facilities
 - By modeling driver, vehicle, road, and environmental conditions



Traffic stream parameters

- **Measures**

- Quantitative (for modeling)
- Qualitative (for evaluation)

- **Characteristics**

- Macroscopic
- Microscopic

Traffic stream parameters

- **Fundamental parameters**
 - Speed
 - Flow
 - Density
- **Derived parameters**
 - Time headway
 - Space headway
 - Travel time

Speed

- **A quality measurement of travel**
 - Drivers and passengers perception of journey
 - Rate of motion in distance per unit of time
 - Speed or velocity is given by

$$v = \frac{d}{t}$$

- Where
 - v is the speed of the vehicle in m/s
 - d is the distance traveled in meters
 - t time in seconds

Speed

- **Various types**
 - Spot speed
 - Running speed
 - Journey speed
 - Time mean speed
 - Space mean speed

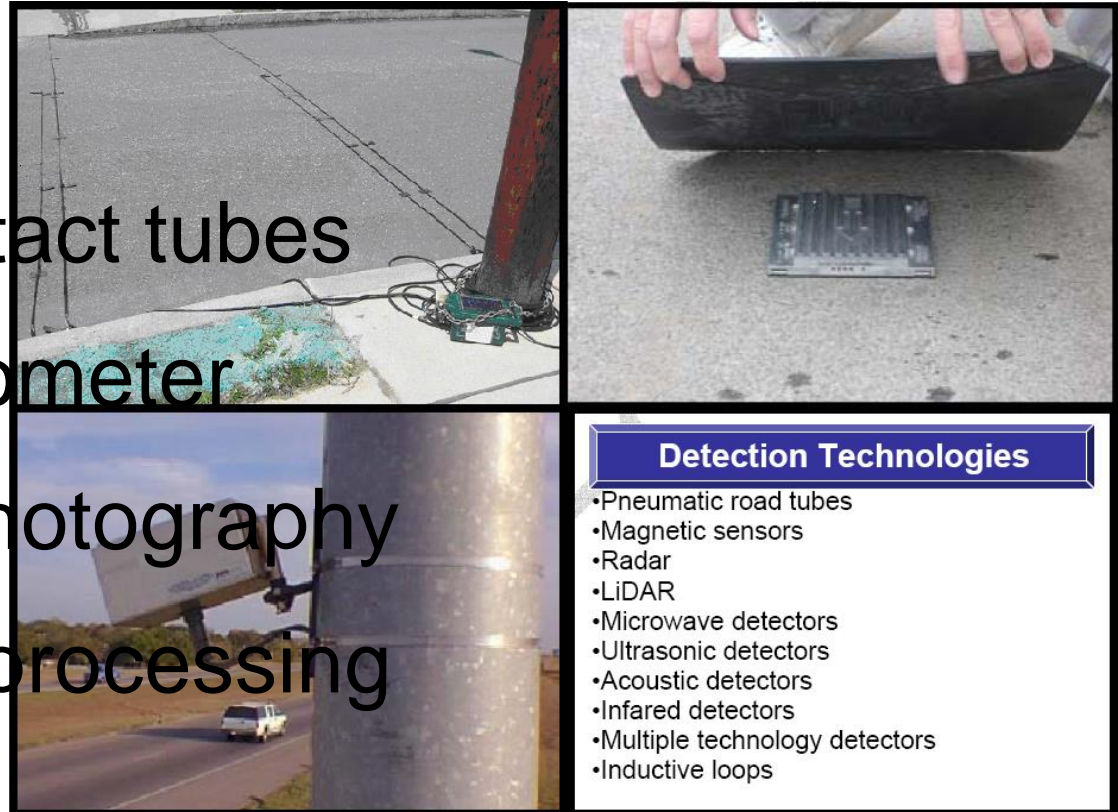
Speed

- Spot Speed
 - instantaneous speed at a point
 - Application:
 - Geometrical design
 - Location and size of signs
 - Design of signals
 - Safe speed
 - Speed zoning
 - Accident analysis
 - Congestion analysis

Speed

- **Spot Speed measurement**

- Enoscope
- Pressure contact tubes
- Radar speedometer
- Time-lapse photography
- Video image processing



Speed

- **Running speed**

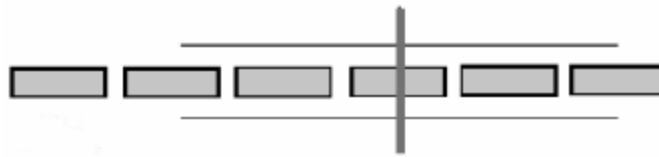
- Average speed over a stretch of road
- Does not consider stop time
- Takes care of variability in traffic and geometric conditions

Speed

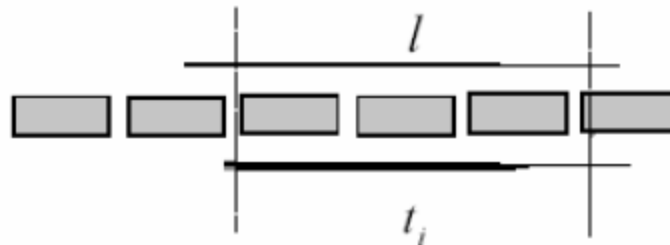
- **Journey speed**
 - Effective speed between two points
 - Journey speed $<$ Running speed
 - journey follows a stop-go traffic
 - Journey speed \approx Running speed
 - comfortable travel conditions.

Time and space mean speeds

- Time mean speed v_t



- Space mean speed v_s



Time and space mean speeds

- **Time mean speed v_t**
 - Average speed of all the vehicles passing a point on a highway over time period
 - Mean speed of vehicles over a period of time at a point in space
 - Point measurement

Time and space mean speeds

- **Space mean speed v_s**
 - Average speed of all the vehicles in a given section of a highway at a given time instant
 - Mean speed over a space at a given instant of time
 - It is an instantaneous measurement
- **Relationship**
 - $v_s \neq v_t$ normal traffic
 - $v_s = v_t$ if all vehicles have same speed

Flow

- **Definition**

- Number of vehicles that pass a point on a road during a specific time interval

$$q = \frac{n_t}{t}$$

- n_t number of vehicles passing a particular point in a road
- t time duration in hours
- q the flow vehicles/hour

Flow

- **Units**
 - Vehicle/day
 - Vehicle/hour
 - Vehicle/second
- **Variations of Volume with time**
 - Monthly
 - Weekly
 - Daily
 - Hourly

Flow

- **Type of averaging**
 - Average Annual Daily Traffic (AADT)
 - Average Annual Weekday Traffic (AAWT)
 - Average Daily Traffic (ADT)
 - Average Weekday Traffic (AWT)

Flow

- **Average Annual Daily Traffic (AADT)**
 - The average 24-hour traffic volume at a given location over a full 365-day year
 - Total number of vehicles passing the site in a year divided by 365

Flow

- **Average Annual Weekday Traffic (AAWT)**
 - The average 24-hour traffic volume occurring on weekdays over a full year
 - It is computed by dividing the total weekday traffic volume for the year by 260

Flow

- **Average Daily Traffic (ADT)**
 - An average 24-hour traffic volume at a given location for a period of time less than a year
 - Six months or a season
 - A month or week
 - ADT is a valid only for the period over which it was measured

Flow

- **Average Weekday Traffic (AWT)**
 - Average 24-hour traffic volume occurring on weekdays for some period of time less than one year
 - Six months or a season
 - A month or week
 - AWT is a valid only for the period over which it was measured

Flow

- **Measurements**
 - manual counting
 - detector/sensor counting
 - moving-car observer method

Density

- **Definition**

- Number of vehicles occupying a given stretch of road expressed as vehicles per km.

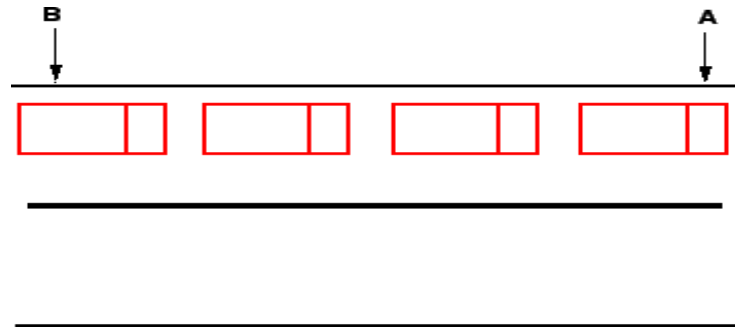
$$k = \frac{n_x}{x}$$

- n_x number of vehicles in the stretch
- x distance in km
- k flow vehicles/km

Density

- **Importance of density**

- Density is most perceived parameter by a driver
- One of the level of service concept
- Used in most of the traffic flow models



Derived parameters

- **Derived parameters**
 - time headway or headway
 - related to flow
 - distance headway or spacing
 - related to density
 - travel time
 - related to speed

Derived parameters

- **Time headway**

- Time difference between any two successive vehicles when they cross a given point
- Adding all headways

$$\sum_1^{n_t} h_i = t$$

- But flow is defined as $q = \frac{n_t}{t} = \frac{n_t}{\sum_1^{n_t} h_i} = \frac{1}{h_{av}}$

- Av. Headway = Inverse of flow

Derived parameters

- **Distance headway**

- Distance between corresponding points of two successive vehicles at any given time

- Adding all the spacing $\sum_1^{n_x} s_i = x$

- But density is defined as $k = \frac{n_x}{x} = \frac{n_x}{\sum_1^{n_x} s_i} = \frac{1}{s_{av}}$

- Av. Spacing = Inverse of density

Derived parameters

- **Travel time**

- Travel time is inversely proportional to the speed
- In practice, the speed of a vehicle fluctuates over time and the travel time represents an average measure

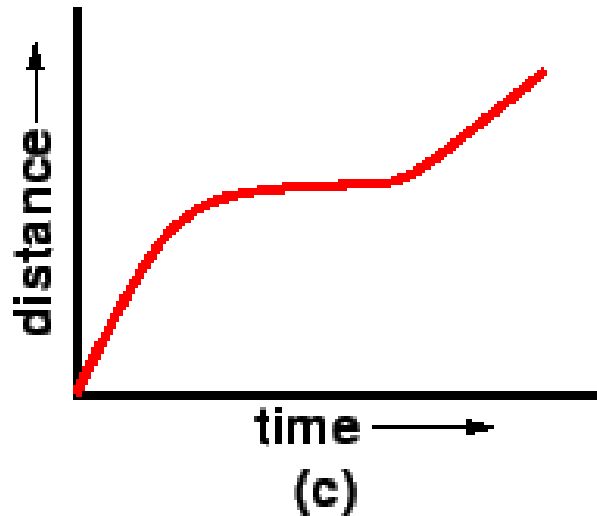
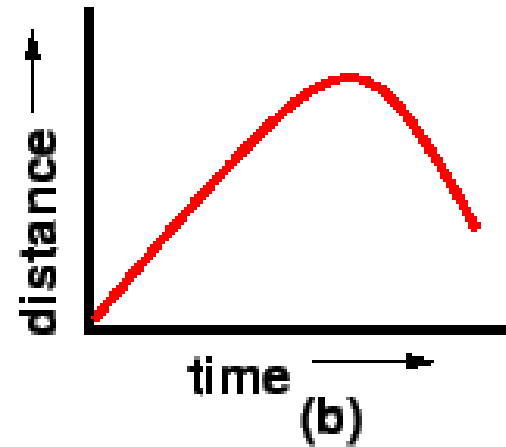
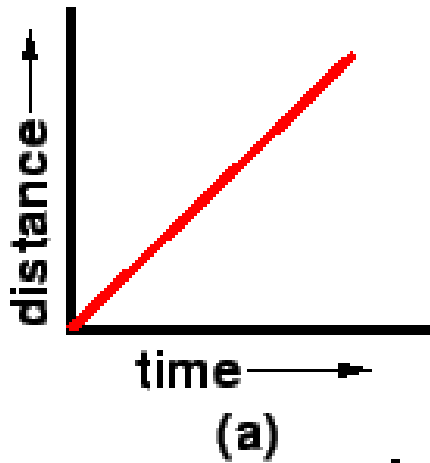
Time-space diagram

- **Trajectory**

- A graph which gives position of vehicle with respect to time
- The trajectory provide an intuitive, clear, and complete summary of vehicular motion in one dimension.

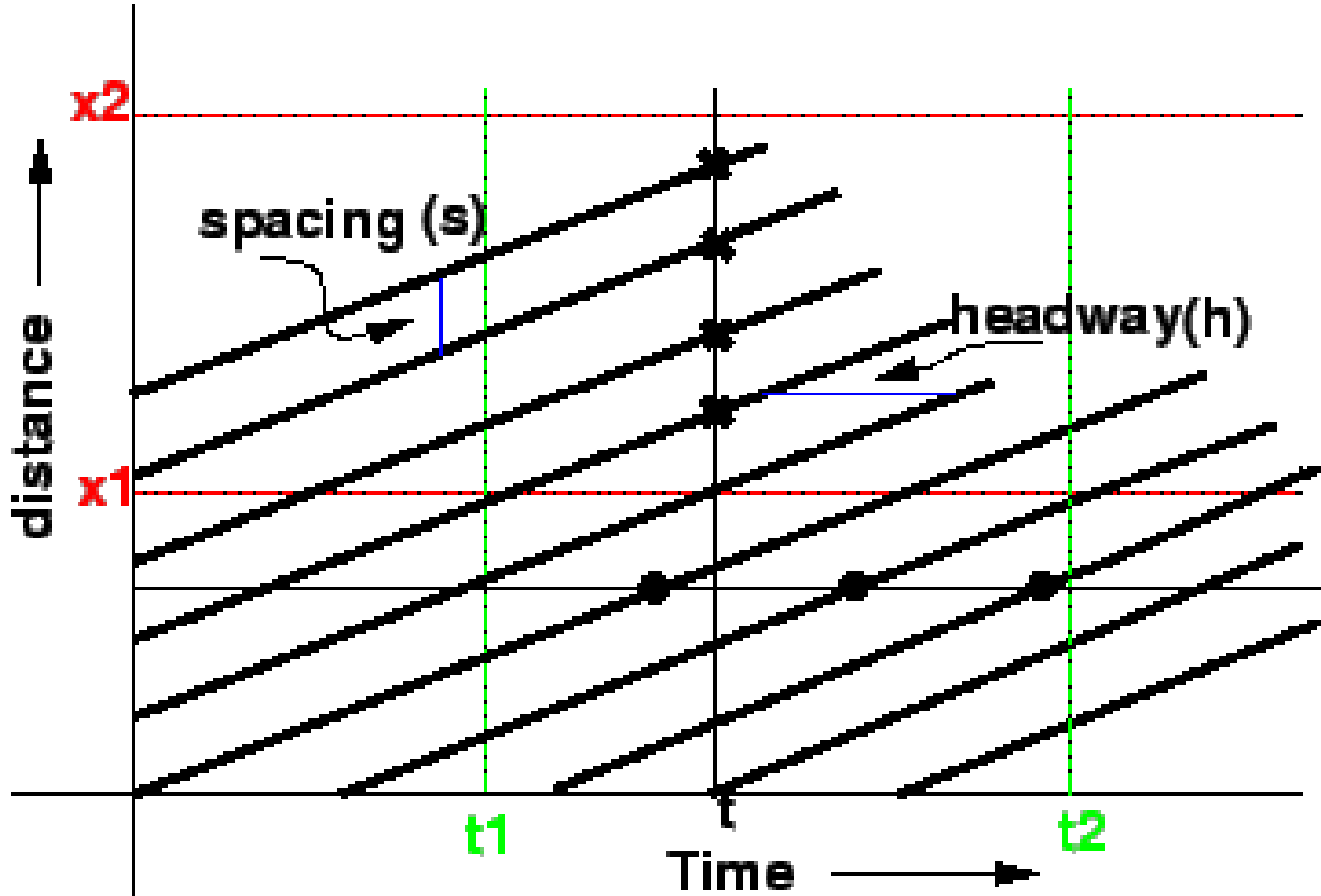
Time-space diagram

- Single vehicle



Time-space diagram

- Multiple vehicle



Conclusion

- **Fundamental Parameters**
 - Flow or volume q
 - Density or concentration k
 - Speed: Time and space mean v_s and v_t
- **Derived Parameters**
 - Headway h
 - Spacing s
 - Travel time t
- **Time-Space diagram**

Thank You