

Class 5 – Traffic Stream Characteristics – Part B

Speed and Travel Time

Speed is defined as a rate of motion in distance per unit of time

$$S = d/t$$

Where,

S – Speed (mph or ft per second)

d – Distance Traversed (mile or ft)

t – Time to traverse distance “d” (hr or sec)

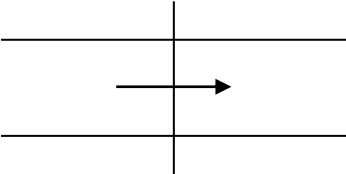
Travel time is the time taken to traverse a defined section of roadway

Traffic stream does not have a single characteristic speed but rather a distribution of individual vehicle speeds

Speed (contd.)

Time Mean Speed (TMS)

TMS is defined as the average speed of all vehicles passing a point on a highway or lane over some specified time period.

$$\text{TMS} = \frac{1}{n} \sum_i d/t_i$$
A diagram showing two horizontal parallel lines representing a highway section. A vertical line crosses both horizontal lines, and a horizontal arrow points to the right from the intersection point, indicating the direction of traffic flow.

n – number of observed vehicles

d – distance traversed, ft

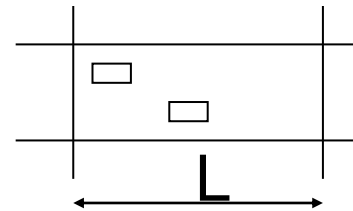
t_i – time for vehicle “ i ” to traverse the section, sec.

Speed (contd.)

Space Mean Space (SMS)

SMS is defined as the average speed of all vehicles occupying a given section or lane of a highway over some specified time period.

$$SMS = \frac{d}{\left(\frac{\sum t_i}{n} \right)} = \frac{nd}{\sum t_i}$$



Where:

n – number of observed vehicles

d – distance traversed, ft

t_i – time for vehicle “i” to traverse the section, sec.

TMS is a point measure, while SMS is a measure relating the length of highway or lane

Example of Speed

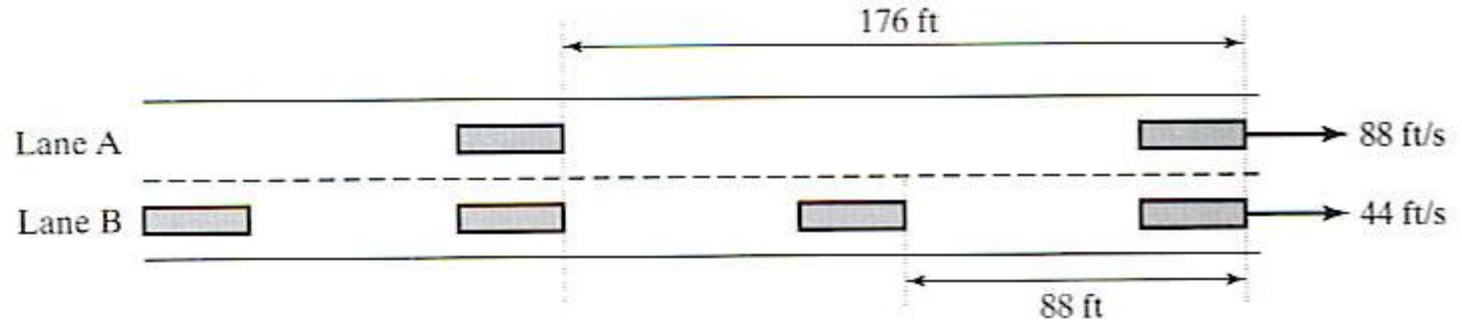


Figure 5.1: Space Mean and Time Mean Speed Illustrated

$$\text{TMS} = \frac{88.0 + 44.0}{2} = 66.0 \text{ ft/s}$$

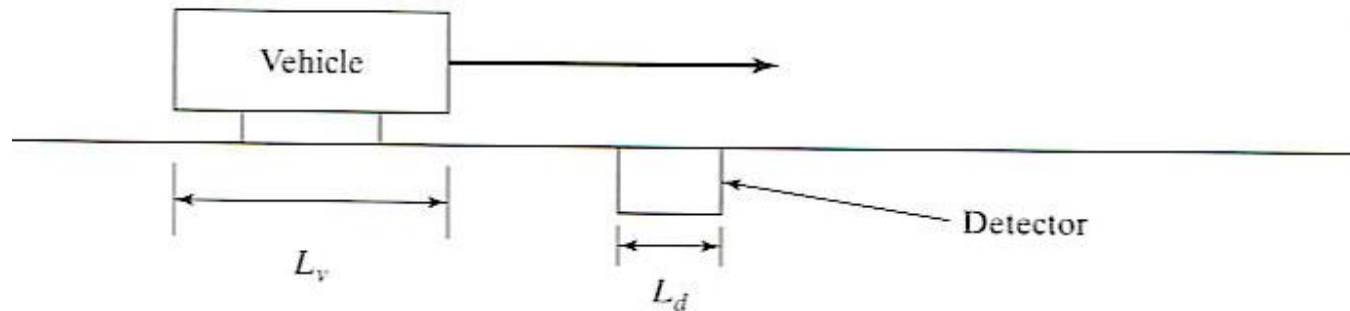
$$\text{SMS} = \frac{(88.0 + 2 * 44.0)}{3} = 58.7 \text{ ft/s}$$

Density and Occupancy

- Density (k) is defined as the number of vehicles occupying a given length of highway or lane, expressed as vehicles per mile or vehicles per mile per lane
- Density is difficult to measure directly
- Density is perhaps the most important of the three primary traffic stream parameters because it is the measure most directly related to traffic demand
- Speed and density combine to give the observed rate of flow
- It is a measure of the proximity of other vehicles

Density and Occupancy (contd.)

- Occupancy (O) is defined as the proportion of time that a detector is “occupied”, or covered, by a vehicle in a defined time period



$$D = \frac{5,280 * O}{L_v + L_d}$$

Where:

L_v = is the average length of a vehicle (ft)

L_d = is the length of the detector (which is normally a magnetic loop detector, in ft)

Occupancy is measured for a specific detector in a specific lane, then density is vehicles per mile per lane

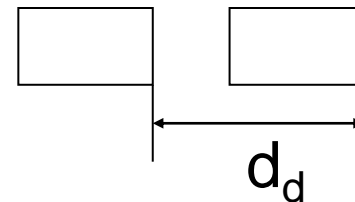
Spacing and Headway

Volume, speed and density are macroscopic measures.

Spacing and headway are microscopic measures that describe individual vehicles within the traffic stream, or specific pairs of vehicles within the traffic stream

Spacing (d_d) is defined as the distance between successive vehicles in a traffic lane, measured from some common reference point on the vehicles, such as the front bumper or front wheels

$$D = \frac{5,280}{d_d}$$



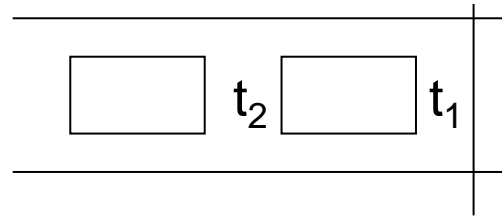
Where: D = density, veh/mi/ln

d_d = average spacing between vehicles in the lane, ft

Spacing and Headway (contd.)

Headway (h) is defined as the time interval between successive vehicles as they pass a point along the lane, also measured between common reference points on the vehicles.

$$h = |t_1 - t_2|$$



The average headway in a lane is directly related to the rate of flow

$$v = \frac{3,600}{h_a}$$

Where:

v = rate of flow, veh/h/ln

h_a = average headway in the lane, sec