Traffic Flow Characteristics

CIVL 4162/6162
(Traffic Engineering)
Lesson Objective

- Define microscopic traffic stream parameters
- Establish the relationship between traffic stream parameters
- Calculate and compute parameters with given data
Remainder

- Macroscopic traffic flow parameters
  - Volume
    - Rate of flow
    - AADT
    - AAWT
    - ADT
    - AWT
  - Speed
  - Density
# Traffic Flow Basics-Summary (1)

<table>
<thead>
<tr>
<th>Flow</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>veh/hr</td>
<td>veh/mi</td>
</tr>
<tr>
<td>Measured over time at a fixed point</td>
<td>Measured over space at a fixed time</td>
</tr>
<tr>
<td>How many vehicles are getting somewhere?</td>
<td>How crowded is the roadway?</td>
</tr>
<tr>
<td>Can measure with a point detector</td>
<td>Can measure with an aerial photo</td>
</tr>
</tbody>
</table>

$q$  $k$
# Traffic Flow Basics-Summary (1)

<table>
<thead>
<tr>
<th>Individual vehicle</th>
<th>Traffic stream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed [L/T]</td>
<td>Flow [V/T]</td>
</tr>
<tr>
<td></td>
<td>Density [V/L]</td>
</tr>
</tbody>
</table>

- **Speed [L/T]**
- **Flow [V/T]**
- **Density [V/L]**
Traffic Flow Basics-Summary (3)

Classify the quantities

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</tr>
<tr>
<td>Flow [V/T]</td>
<td></td>
</tr>
<tr>
<td>Density [V/L]</td>
<td></td>
</tr>
</tbody>
</table>

Brackets describe units... L = Length, T = time, V = vehicles
Traffic Flow Basics-Summary (4)
Let’s try to fill in the rest of the table.

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<tbody>
<tr>
<td>Speed [L/T]</td>
<td></td>
</tr>
<tr>
<td>Time Headway [T]</td>
<td>Flow [V/T]</td>
</tr>
<tr>
<td></td>
<td>Density [V/L]</td>
</tr>
</tbody>
</table>
Traffic Flow Basics - Time Headway

The **time headway** is the time between two vehicles passing a point.
Traffic Flow Basics-Space Headway

On a space-time diagram, it is the **horizontal distance** between two adjacent trajectories.
**Traffic Flow Basics-Summary (5)**

Let’s try to fill in the rest of the table.

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<td>Speed [L/T]</td>
<td>Flow [V/T]</td>
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<tr>
<td>Time Headway [T]</td>
<td>Density [V/L]</td>
</tr>
<tr>
<td>Space Headway [L]</td>
<td></td>
</tr>
</tbody>
</table>
The space headway is the distance between two vehicles.

Diagram:

- **Time** ($t$)
- **Distance** ($x$)
Traffic Flow Basics - Space Headway (2)

On a space-time diagram, it is the **vertical distance** between two adjacent trajectories.
# Traffic Flow Basics-Summary

Let’s try to fill in the rest of the table.

<table>
<thead>
<tr>
<th>Individual vehicle</th>
<th>Traffic stream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed [L/T]</td>
<td>Average Speed [L/T]</td>
</tr>
<tr>
<td>Time Headway [T]</td>
<td>Flow [V/T]</td>
</tr>
<tr>
<td>Space Headway [L]</td>
<td>Density [V/L]</td>
</tr>
</tbody>
</table>
Basic Equation for Uninterrupted Flow:

\[ q = ku \ (v = SD \text{ in your book}) \]

where:

- \( q = \text{flow rate, vph or veh/h/ln} \)
- \( k = \text{density, veh/mi or veh/mi/ln} \)
- \( u = \text{space mean speed, mph} \)
Three Parameters of Traffic Flow

- **Macroscopic:**
  - Speed \( (V) \)
  - Density \( (K) \)
  - Flow \( (Q) \)

\[ Q = KV \]
Spacing

- **Spacing** is defined as the distance between successive vehicles in a traffic lane; measured from common reference
  - Front bumper or
  - Front wheels

- **Average spacing** in a traffic lane is related to density

\[
d_a = \frac{5,280}{k}
\]

Where,
- \( k \) = density in veh/mile/lane
- \( d_a \) = Average spacing between vehicles in ft
Headway

- **Headway** is defined as the time interval between successive vehicles as they pass along a lane.
- Also measured between common point of reference.

\[
h_a = \frac{3,600}{q}
\]

Where,
- \( q \) = traffic volume in veh/hour/lane
- \( h_a \) = Average headway in the lane in sec
Example

- Traffic in an interstate at 7:15 AM is observed to have spacing of 250 feet; and average headway of 3 sec. Estimate
  - Volume
  - Density
  - Speed
Solution

Step 1: Calculate flow

\[ q = \frac{3,600}{h_a} = \frac{3,600}{3} = 1,200 \text{ veh/hour/lane} \]

Step 2: Calculate density

\[ k = \frac{5,280}{d_a} = \frac{5,280}{250} = 21.12 \text{ veh/miile/lane} \]

Step 3: Calculate Speed

\[ q = uk \Rightarrow u = \frac{q}{k} = \frac{1200}{21.12} = 56.81 \text{ miles/hour} \]
Example

A study of freeway flow at a particular site has resulted in a calibrated speed-density relationship as follows:

(Note the difference in notation)

\[ S = 57.5(1 - 0.008D) \]

For this relationship, determine:

a. Free-flow speed
b. Jam density
c. Speed-flow relationship
d. Flow-density relationship
e. Capacity