CIVL - 7904/8904

TRAFFIC FLOW THEORY

LECTURE - 15
Announcement

- Visit to the TDOT Traffic Management Center (April 17, at 1:00) - 5344 Boswell Avenue
Traffic Stream Characteristics

- **Volume and Rate of Flow**
  - Daily volume
  - Hourly volume
  - Sub-hourly volume
- **Speed and Travel Time**
- **Density and Occupancy**
- **Spacing and Headway**
  - Spacing
  - Microscopic features
- **Saturation Flow**
Volume and Rate of Flow

- Traffic volume is defined as the number of vehicles passing a point on a highway or a given lane during a specified time interval.
- The unit of traffic volume is expressed as:
  - Vehicles per unit time
  - Vehicles per hour
  - Vehicles per day
Daily Volumes (1)

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

- **Average Annual Weekday Traffic**
  - The average 24-hour volume occurring on weekdays at a given location over a full 252 day year
  - The number of vehicles passing a site in a year divided by 252
Daily Volumes (2)

- **Average Daily Traffic**
  - The average 24-hour volume at a given location over a defined time period less than one year.
  - A common application is to measure an ADT for each month of the year

- **Average Weekday Traffic**
  - The average 24-hour weekday volume at a given location over a defined time period less than one year.
  - A common application is to measure an AWT for each month of the year
Hourly Volumes

- A single hour of the day that has highest hourly volume is referred as peak hour
- Peak hour is of great interest to the traffic engineers
- Peak hour volume is generally stated as directional volume (each direction flow is counted separately)
- Highways and controls must be designed to adequately serve the peak direction flow.
- When directionality is significant, reversible lanes are provided.
Directional Design Hourly Volume

\[ DDHV = \frac{DDHV}{DHV} \times \frac{DHV}{AADT} \times AADT \]

\[ DDHV = Directional design hourly volume in major direction \]
\[ DHV = Design hourly volume combining both direction \]
\[ AADT = Annual Average Daily Traffic combining both direction \]

Alternatively,

\[ DDHV = D*K*AADT \]

\[ D = Ratio of design hourly volume in major direction to the two way design hourly volume \]
\[ K = Ratio of the two way design hourly volume to the two way AADT \]
Peak Hour Factor

- Peak hour factor – describes the relationship between hourly volume and maximum rate of flow within the hour
  - PHF = hourly volume/maximum rate of flow OR
  - PHF = V/(4 x V_{15})

- PHF range –
  1.0 (each 15 minute period equal) to 0.25 (one 15 min period contains all traffic)
## Example-PHF

<table>
<thead>
<tr>
<th>15 min period</th>
<th>Vehicle Count</th>
<th>Flow Rate (vph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:20AM</td>
<td>389</td>
<td>1556</td>
</tr>
<tr>
<td>7:35AM</td>
<td>495</td>
<td>1980</td>
</tr>
<tr>
<td>7:50AM</td>
<td>376</td>
<td>1504</td>
</tr>
<tr>
<td>8:05AM</td>
<td>363</td>
<td>1452</td>
</tr>
<tr>
<td>7:20-8:20AM</td>
<td>1623</td>
<td>1623</td>
</tr>
</tbody>
</table>
Signal Design and Timing (1)

- Development of a safe and effective phase plan and sequence
- Determination of vehicular signal needs
  - Timing of yellow (change) and all-red (clearance) intervals of each signal phase
  - Determination of critical lane volumes
  - Determination of lost times per phase and per cycle
  - Allocation of effective Green Time
Signal Design and Timing (2)

- Determination of pedestrian signal needs
  - Determine minimum pedestrian “green” times
  - Check to see if vehicular greens meet minimum pedestrian needs
  - If pedestrian needs are unmet by vehicular signal timing, adjust timing and/or add pedestrian actuators to ensure pedestrian safety
Summary of Signal Design

Signal Phase Plans
- Treatment of Left Turns
- General Considerations
- Phase and Ring Diagrams
- Common Phase Plans and Their Use

Vehicular Needs
- Change and Clearance Intervals
- Determine Lost Times
- Determine Critical Lane Volumes
- Desired Cycle Length
- Splitting the Green

Pedestrian Needs
- Minimum Pedestrian Crossing Needs
- Adjustment of Effective Green
Left turns can be handled in two ways

- **Permitted Left Turn**
  - Left turn is allowed along with opposing through movement

- **Protected Left Turn**
  - Left turn is allowed when opposing through movement is stopped
Two conditions need to be met for left turn to be protected

**Condition-1 (Left Turn Flow Rate)**
- $V_{LT} \geq 200$ veh/hour

**Condition-2 (Cross-Product Rule)**
- $xprod = VLT \times \left( \frac{V_o}{N_o} \right) \geq 50,000$

where,
- $V_{LT} ->$ Left-turn flow rate, veh/hr
- $V_o ->$ Opposing through movement flow rate, veh/hr
- $N_o ->$ Number of lanes for opposing through movement
General Considerations

- Phasing can be used to minimize crash risks by separating competing movements.
- All phase plans must be in accordance with MUTCD.
- The phase plans must be consistent with intersection geometry.
<table>
<thead>
<tr>
<th>Through movement without turning movement.</th>
<th><img src="image1.png" alt="Diagram" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>Through movement with protected right and left turns from shared lanes.</td>
<td><img src="image2.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Through movement with permitted right and left turns from shared lanes.</td>
<td><img src="image3.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Through movement with protected left turn from exclusive lane and permitted right turn from shared lane.</td>
<td><img src="image4.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Through movement with permitted left turn from exclusive lane and permitted right turn from shared lane.</td>
<td><img src="image5.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>
Two Phase Signal

(a) Intersection Layout
(exclusive LT/RT lanes optional)

(b) Phase Diagram

(c) Ring Diagram

\( \phi_A \)

\( \phi_B \)