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 number of vehicles passing a point on 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

$$DDHV = \frac{DDHV}{DHV} * \frac{DHV}{AADT} * AADT$$

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 = $V/(4 \times V_{15})$
- PHF range –

  1.0 (each 15 minute period equal) to

  0.25 (one 15 min period contains all traffic)

Example-PHF

15 min period	Vehicle Count	Flow Rate (vph)
7:20AM	389	1556
7:35AM	495	1980
7:50AM	376	1504
8:05AM	363	1452
7:20-8:20AM	1623	1623

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

Treatment of Left Turns (1)

- 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

Treatment of Left Turns (2)

- Two conditions needs 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)
  - $xprod = VLT * (\frac{v_0}{N_0}) \geq 50{,}000$

where,

V_{LT} -> Left-turn flow rate, veh/hr

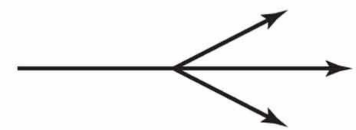
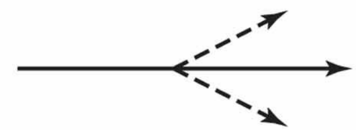
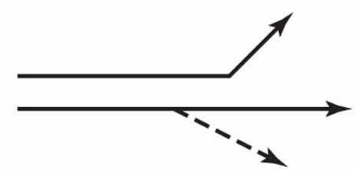
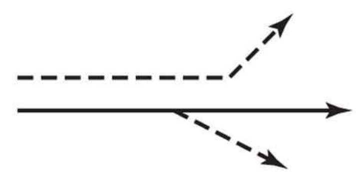
V_o-> Opposing through movement flow rate, veh/hr

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

Signal Phase and Arrows Illustration

Through movement without turning movement.	
Through movement with protected right and left turns from shared lanes.	
Through movement with permitted right and left turns from shared lanes.	
Through movement with protected left turn from exclusive lane and permitted right turn from shared lane.	
Through movement with permitted left turn from exclusive lane and permitted right turn from shared lane.	

Two Phase Signal