Cairo University
Faculty of Engineering
Public Works Department

Traffic Engineering

Intersection Delay and LOS Analysis

Dr. Dalia Said,
Associate Professor, Highway and Traffic Engineering
Civil Engineering Department,
Cairo University,
dalia_said@yahoo.com

Capacity

- *Saturation flow rate*, *S* (veh/h) = maximum hourly volume assuming green signal displayed constantly
- Portion of saturation flow used = portion of cycle which is effectively green
- *Capacity*, *c* (veh/h) = maximum hourly volume that can use the lane group

$$c = S\,(G_e/C)$$

Capacity (vph) — c

Effective green time (sec) — G_e

Cycle length (sec) — C

Saturation flow rate under prevailing conditions (vphg) — S

For a given approach or lane group

Saturation Flow Rate Prediction

$$S = S_o \cdot N \cdot f_w \cdot f_{HV} \cdot f_g \cdot f_p \cdot f_{bb} \cdot f_a \cdot f_{LU} \cdot f_{LT} \cdot f_{RT}$$

where:

S = saturation flow rate for subject lane group, expressed as a total for all lanes in lane group (veh/h);
S_o = base saturation flow rate per lane = 1900 (pc/h/ln);
N = number of lanes in lane group;
f_w = adjustment factor for lane width;
f_{HV} = adjustment factor for heavy vehicles in traffic stream;
f_g = adjustment factor for approach grade;
f_p = adjustment factor for existence of a parking lane and parking activity adjacent to lane group;
f_{bb} = adjustment factor for blocking effect of local buses that stop within intersection area;
f_a = adjustment factor for area type;
f_{LU} = adjustment factor for lane utilization; **use default values**
f_{LT} = adjustment factor for left turns in lane group ;
f_{RT} = adjustment factor for right turns in lane group.

Saturation Flow Rate Prediction

$$f_w = 1 + \frac{(W - 12)}{30}$$

W = lane width (ft)

$$f_{HV} = \frac{100}{100 + \%HV(E_T - 1)}$$

$\% HV$ = percent heavy vehicles for lane group volume

$$f_g = 1 - \frac{\%G}{200}$$

$\% G$ = percent grade on a lane group approach

$$f_p = \frac{N - 0.1 - \frac{18N_m}{3600}}{N}$$

N = number of lanes in lane group
N_m = number of parking maneuvers/h

$$f_{bb} = \frac{N - \frac{14.4N_B}{3600}}{N}$$

N = number of lanes in lane group
N_B = number of buses stopping/h

f_a = 0.900 in CBD
f_a = 1.0 in all other areas

Saturation Flow Rate Prediction

f_{LU}:

Through or shared lane group:

f_{LU}=0.95

Exclusive left turn or right turn

f_{LU}=1

f_{LT}:

Shared lane group:

f_{LT}=1/ (1+0.05 P_{LT})

Exclusive left turn :

f_{LT}=0.95

P_{LT} = proportion of LTs in lane group

f_{RT}:

Exclusive right turn :

f_{RT}=0.85

Shared lane :

f_{RT}=1- 0.15P_{RT}

P_{RT} = proportion of RTs in lane group

Intersection Delay and LOS analysis

Delay for each lane group

$$d_{li} = 0.5C \frac{\left(1 - \frac{gi}{C}\right)^2}{1 - (\frac{gi}{C})[\min\left(X_{i,} 1.0\right)]}$$

Where:

d_{Ii} = delay per vehicle for lane group *i* (sec/veh),

C = cycle length (seconds),

g_i = effective green time for lane group *i* (seconds),

X_i = volume/capacity (v/c) ratio for lane group *i*

Intersection Delay and LOS analysis 6

Delay for each approach

Approach Delay is a weighted average of the stopped delays of all lane groups on that approach.

$$d_A = \frac{\sum_i d_i v_i}{\sum_i v_i}$$

Where:
d_A = average delay per vehicle for approach A in seconds,
d_i = average delay per vehicle for lane group i (on approach A) in seconds, and
v_i = analysis flow rate for lane group i in veh/h.

Intersection Delay and LOS analysis 7

Delay for Intersection

Intersection Delay is the weighted average of the stopped delays of all approaches .

$$d_I = \frac{\sum_A d_A v_A}{\sum_A v_A}$$

Where:
d_I = average delay per vehicle for intersection in seconds, and
d_A = average delay per vehicle for approach A in seconds, and
v_A = analysis flow rate for approach A in veh/h.

Intersection Delay and LOS analysis 8

LOS at intersections

LOS	Signalized Intersection
A	≤10 sec
B	10–20 sec
C	20–35 sec
D	35–55 sec
E	55–80 sec
F	≥80 sec

Example: find the delay for the intersection designed in previous lecture, and the LOS of each lane group, approach , and intersection.

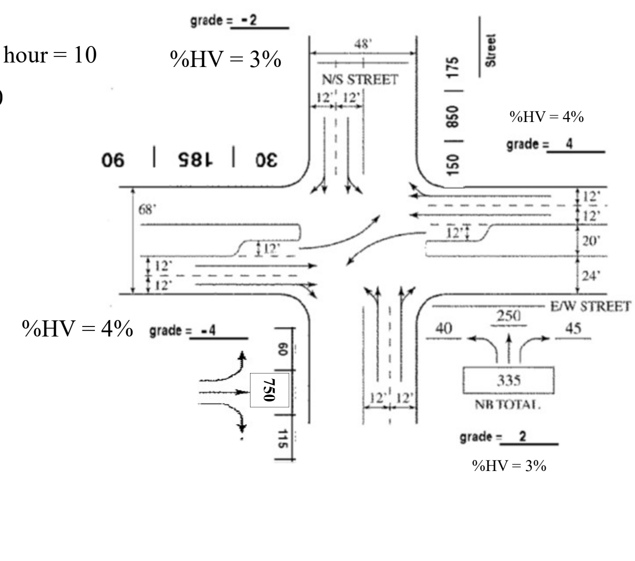
Example

Givens: Look at dwg.

No. of parking maneuvers per hour = 10

No. of bus blockage/hour = 10

PHF = 0.85



Solution:

$$f_{HV} = \frac{100}{100 + 4(2-1)} = 0.962$$

$$f_g = 1 - \left(\frac{-4}{200}\right) = 1.02$$

$$f_p = \left(\frac{2 - 0.1 - \left(\frac{18 \times 10}{3600}\right)}{2}\right) = 0.925$$

$$f_{bb} = \left[\frac{2 - \frac{14.4 \times 10}{3600}}{2}\right] = 0.98$$

$$P_{RT} = \left(\frac{115/0.85}{865/0.85}\right) = 0.133$$

$$f_{RT} = 1.0 - (0.15)0.133 = 0.980$$

Example

1. West Approach: Through-Right Lane group

$S = S_o \cdot N \cdot f_w \cdot f_{HV} \cdot f_g \cdot f_p \cdot f_{bb} \cdot f_a \cdot f_{LU} \cdot f_{LT} \cdot f_{RT}$

=1900*2* 1* 0.962*1.02*0.925*0.98*1 * 0.95*1* 0.98=

2. West Approach: Left Lane group

$S = S_o \cdot N \cdot f_w \cdot f_{HV} \cdot f_g \cdot f_p \cdot f_{bb} \cdot f_a \cdot f_{LU} \cdot f_{LT} \cdot f_{RT}$

=1900*1*1*0.962*1.020*1*1*1*1*0.95*1 =