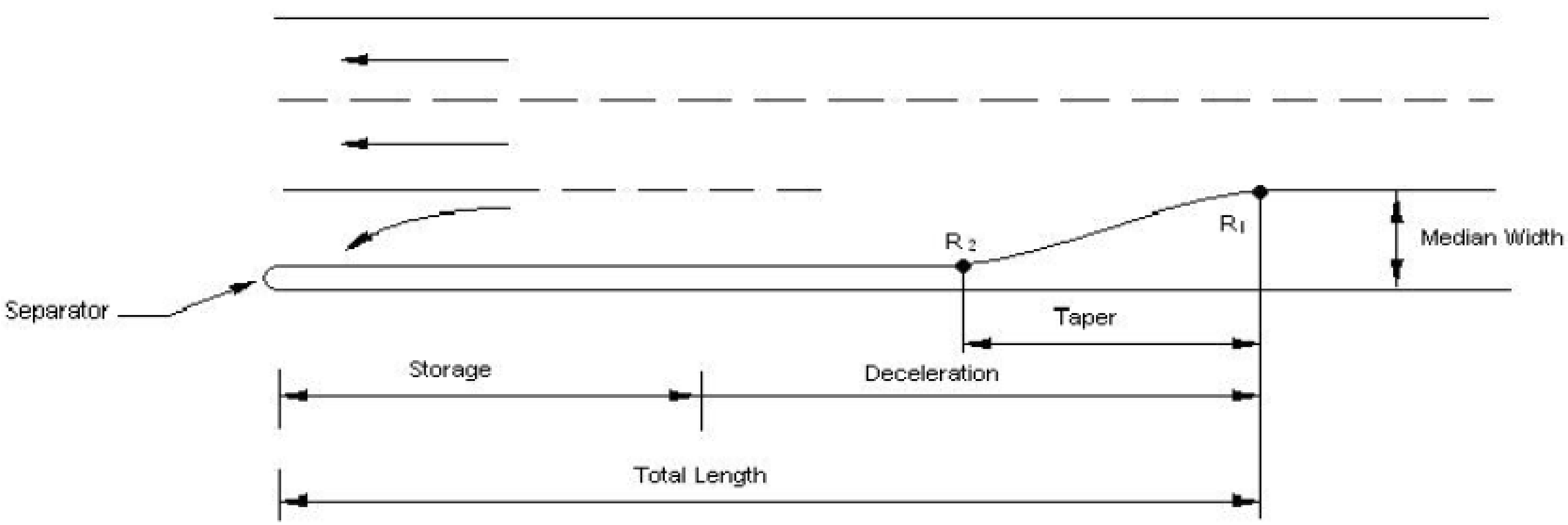
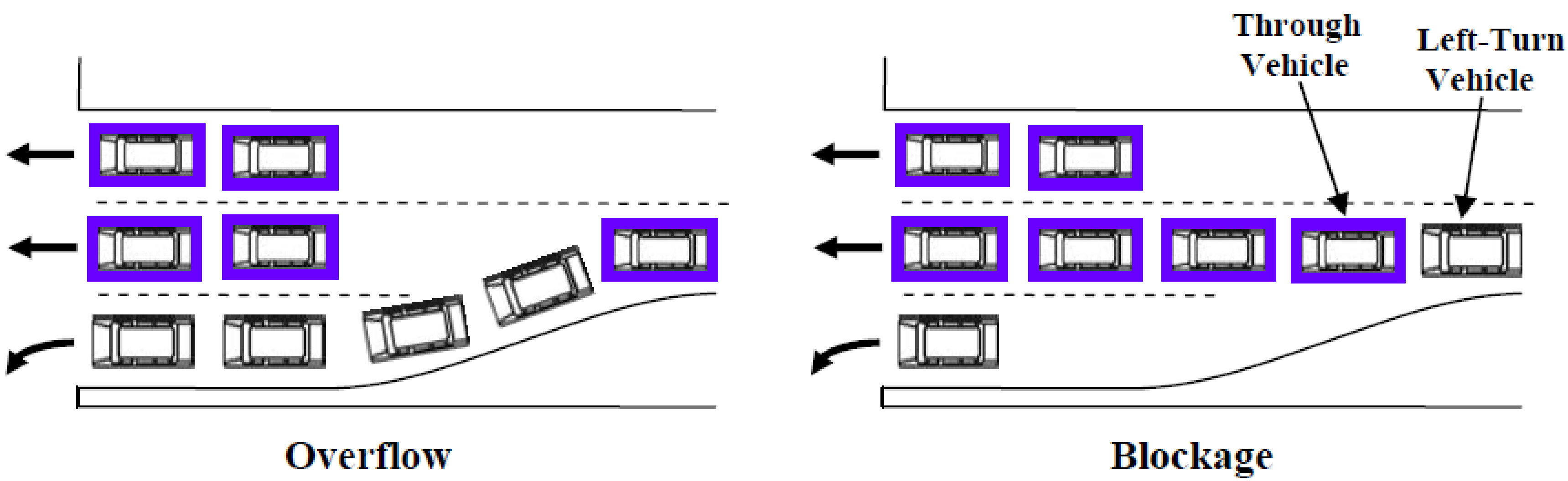
Left Turn Bay Design

CIVL 4162/6162

Single Left Turn Lane



Overflow and Blockage



Available Methods

Length

Existing Methods by Categories			Reference	Major Results
Rule of Thumb Methods			• TxDOT Roadway Design Manual • NCHRP Report 279 • NCHRP Report 348	• Equations (4) & (5)
Analytical-Based Methods	Unsignalized Intersections	Regression based	• Basha (1992) • Gard (2001)	• Equations (8) and (9) • Table 9
		Queuing theory based	• Lertworawanich et al. (2003)	• Table 10
		Vehicle arrivals in a given interval	• NDOR Roadway Design Manual (2005)	• Equations (13) to (15) • Table 11
	Signalized Intersections	Queuing theory based	• Oppenlander at al (1989)	• Equations (16) to (18) • Table 12
		DTMC based	• Kikuchi et al.(1993)	• Tables 13 and 13
		Vehicle arrivals in the red phase	• Kikuchi et al.(2004)	• Table 14
Simulation-Based Methods			• Oppenlander et al. (1994, 1996, 1999 and 2002) • Lakkundi et al. (2004)	• Tables 15 and 16 • Figures 7 and 8

Rule of Thumb Method

$L = K\ (V/\ N_C)\ S$ for signalized intersection

and $L = K\ [V/(3600/I)]S$ for unsignalized intersection (3)

where:

L = storage length (ft)

V = left-turn flow rate during the peak hour (vph)

K = a constant to reflect random arrival of vehicles (usually 2)

N_C = number of cycles per hour (for signalized intersection)

I = average vehicle waiting interval in seconds (for unsignalized intersection)

S = average queue storage length per vehicle (average distance, front bumper-to-bumper of a car in queue)

Queuing Based Method: Signalized

$$n = (\log P_n - \log(1-\lambda/\mu))/\log(\lambda/\mu) \quad (16)$$

where:

n = number of vehicles in the queue

P_n = probability of n vehicles in the queue

λ = arrival rate, equivalent passenger cars per second (pcps)

μ = service rate, equivalent passenger cars per second (pcps)

and, λ *and* μ can be estimated by following Equations:

$$\lambda = 1.1 \times V/3600 \quad (17)$$

$$\mu = S \times (G/C)/3600 \quad (18)$$

where:

"1.1" = adjustment factor for the equivalence of left-turn vehicles with a separate phase

V = left- turn volume, equivalent passenger cars per hour (pcph)

S = lane saturation flow, equivalent passenger cars per hour of green (pcphg)

G/C = ratio of green time to cycle length (cycle split) for the turning-lane phase

Regression Based Method-Unsignalized

- Since queuing is not prevalent

$$Q = f_2(D, G)$$

and $$G = f_1(V) \qquad (6)$$

where:

Q = maximum left-turn lane length, in vehicles

D = left-turn volume, in vehicles per interval

G = total acceptable gap times in opposing traffic in a specific interval, sec

V = opposing traffic volume, in vehicle per interval

The functions f_1 and f_2 were derived by regression analysis and the general forms of these two equations were given in Equation (7).

$$G = f_1(V) = \alpha_1^G V^{\beta_1^G}$$