430 TURN LANE DESIGN

This section provides guidance for designing left and right turn lanes for at-grade highway intersections.

430.1 LEFT TURN LANES

In some instances it may be necessary to add the required widening to only one side of the roadway as shown in Figure 430-A. When widening only one side, the taper length is determined by the formula:

$$T = S \times W \qquad \text{for speeds of 45 mph or greater}$$

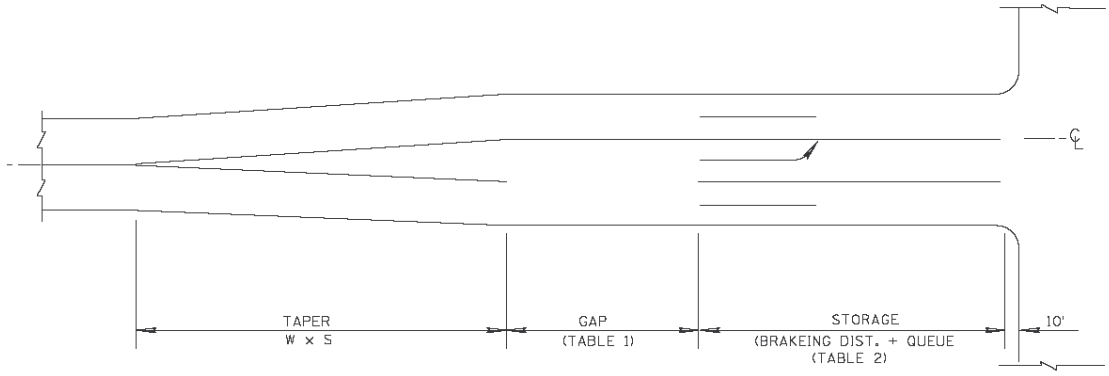
and by

$$T = \frac{S^2 \times W}{60} \qquad \text{for speeds under 45 mph}$$

where:

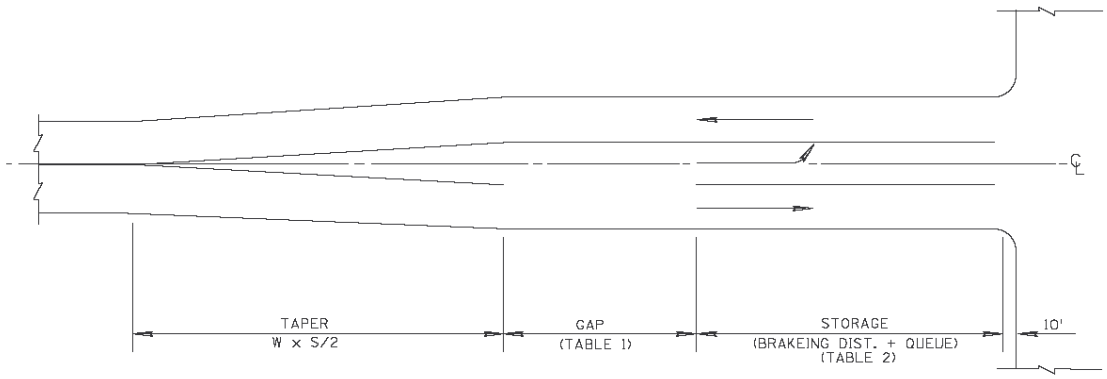
T = length of taper
W = width of the added lane
S = posted speed for existing roadways, or design speed for new or reconstructed roadways

Figure 430-A. Left Turn Lane - Widening One Side Only



The preferred way of creating a left turn lane is by widening the roadway on both sides equally as shown in Figure 430-B. This minimizes the amount of lateral shifting required for through traffic.
Taper lengths will be reduced by a proportional amount based on the proportion of widening on each side, e.g., by 1/2 for symmetrical widening. Similar adjustments must be made for other lane widths than the standard 12' illustrated.

Figure 430-B. Left Turn Lane - Symmetrical Widening



Example: *W = 12'* *Gap = 140'* *Storage = 415'* + 50' = 465'*
S = 65 mph *(From Table 430-1)*
T = 12 x 65 = 390' ** From Table 430-2*
2

low ADT, minimum trucks
Total Length = 390' + 140' + 465' = 995'

Gap Length

Table 430-1 provides the length of the gap for left turn lanes. See Standard Drawing 4-M-1.03 for the turn lane standard.

Table 430-1. Left Turn Lane Gap Lengths

POSTED or DESIGN SPEED (mph)	GAP (feet)
< 40	60
40 - 50	90
> 50	140

Storage Length

The storage length is a combination of the braking distance (Table 430-2) and a queue length dependent on the anticipated traffic control for the intersection and the traffic demand at the turn.

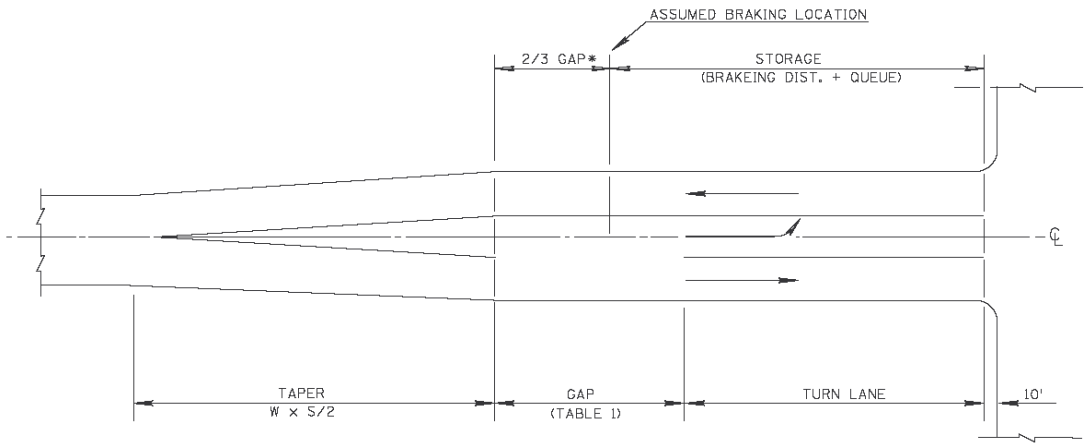
storage length = braking distance + queue length

Table 430-2. Braking Distance

POSTED or DESIGN SPEED (mph)	DESIRABLE		MINIMUM		
	BRAKING SPEED (mph)	BRAKING DISTANCE (feet)	ENTERING SPEED (mph)	BRAKING SPEED (mph)	BRAKING DISTANCE (feet)
30	29	80	20	20	20
35	34	115	25	25	40
40	38	150	30	29	50
45	43	200	35	34	85
50	47	245	40	38	120
55	52	300	45	42	145
60	56	360	50	47	200
65	60	415	55	52	265
70	64	490	60	56	315
75	70	585	65	61	400

The “Desirable” braking distance shown in Table 430-2 is based on the assumption that a vehicle will have lost a few miles per hour through retardation by the vehicle’s engine and drive train prior to braking and that braking will actually begin when the vehicle is fully into the turn lane. The “Minimum” braking distance shown is based on the assumption of: (a) a drop of 10 mph in the average speed of a vehicle by the time it begins to enter the opening or “gap” of the turn lane; (b) there will be a further reduction in speed through engine retardation while entering the turn lane; and (c) assumed braking will begin once the vehicle is 2/3 of the way into the turn lane (see Figure 430-C).

FIGURE 430-C. Minimum Braking Distance



** 2/3 Gap:* *40' for < 40 mph*
60' for 40 - 50 mph
95' for > 50 mph

Example: *W = 12'* *** Gap = 140'* *Storage = 265' *** +50' = 315'*
S = 65 mph *2/3 Gap = 95'*
T = 12 x 65 / 2 = 390' *difference = 45'* **** From Table 430-2*

*** From Table 430-1*

low ADT, minimum trucks
Total Length = 390' + 95' + 315' = 800'
Turn Lane Length = 315' – 45' = 270'

The queue length is the portion of the storage length required to temporarily store turning traffic until conditions allow the turning maneuver to be completed in a safe manner. It is in addition to the length required for braking. The queue length is dependent on the anticipated traffic control for the intersection and the traffic demand at the turn. A traffic analysis may be needed to determine arrival rates and queue lengths.

- Signal Control - The queue length depends on the signal cycle length, the signal phasing arrangement, and the rate of arrivals and departures of left-turning vehicles. Allow 1.5 to 2 times the average number of vehicles that would queue per cycle for periodic heavy demand in traffic flow.
- Cross Road Stop Sign Control - The queue length is based on the number of turning vehicles likely to arrive in the average two minute period within the peak hour. The length should be adjusted for a lack of adequate gaps in opposing through traffic.

- All-Way Stop Sign Control - The queue length is based on the number of turning vehicles likely to arrive in the average two minute period within the peak hour. The length should be further adjusted for a lack of adequate gaps in both opposing through traffic and cross road traffic activity.

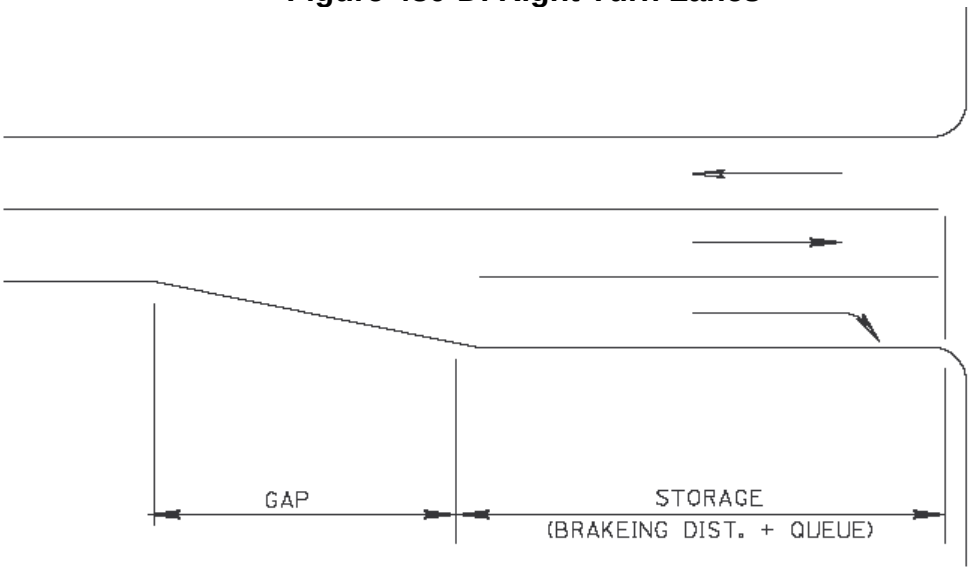
Each passenger vehicle and each truck are assumed to be 25 and 60 feet in length, respectively.

The minimum queue length for all traffic control situations should accommodate two passenger vehicles or one passenger vehicle and one truck when the truck percentage is greater than 10%, i.e., 50 foot and 85 foot minimum queue lengths, respectively.

Where a two-way left-turn lane is to be interrupted with a one-way left-turn lane, the two-way left-turn lane should end a sufficient distance in advance of the interruption to allow the placement of a minimum gap and necessary storage (see Standard Drawing M-2).

430.2 RIGHT TURN LANES

Figure 430-D. Right Turn Lanes



Taper Length

Lengthy tapers are generally not required for right turn lanes, and similarly for left turn lanes where the median width is 30 feet or greater, since the lane may be simply added to the outside of the traveled way; however, a shorter taper equal in length to the gap (Table 430-1) is provided to transition the edge line from the normal pavement cross section to the edge of the turn lane.

Gap Length

The gap for right turn lanes is the same as that for left turn lanes (see Table 430-1).

Storage Length

The storage length for right turn lanes is the same as that for left turn lanes; however, when space available for a turn lane is limited and a yield condition or free-flowing right turn is provided, it may be appropriate to assume that braking continues, not to a stop as with left turns, but rather to the turning speed at the intersection radius return. Where traffic slows to 10 mph to turn right, 20 feet may be deducted from the right turn lane queue length.

430.3 SUMMARY

These guidelines assume that the intersection is not skewed, is on relatively flat grade, does not contain significant vertical or horizontal curves, has adequate sight distance, and has 12-foot wide through lanes.

The "Desirable" design is normally used for new construction or reconstruction of a roadway. The "Minimum" design is normally used for retrofits or minor intersection improvements.

It is recognized that design methodology must be somewhat flexible in meeting the highway users' needs and that circumstances vary from one location to another so that rigid application of rules or guidelines may not fit every situation. Engineering judgment must frequently be exercised in determining the end product. For instance, shorter turn lanes than the minimum established by this guideline may be acceptable if approved in writing by the Regional Traffic Engineer having jurisdiction.