

12-3.0 FREEWAY/RAMP JUNCTIONS

12-3.01 Exit Ramps

12-3.01.01 Deceleration Lanes

Sufficient deceleration distance is needed to safely and comfortably allow an exiting vehicle to leave the freeway mainline. All deceleration should occur within the full width of the deceleration lane. The length of the deceleration lane will depend upon the design speed of the mainline and the design speed of the first governing geometric control on the exit ramp. This will most often be a horizontal curve but could be, for example, stopping sight distance on a vertical curve. Figure 12-3A provides the deceleration distances for various combinations of highway design speeds and ramp design speeds. Greater distances should be provided if practical. If the deceleration lane is on a grade of 3% or more, the length of the lane should be adjusted according to the criteria in Figure 12-3B.

The specific use of the deceleration criteria to horizontal curves warrants some elaboration. The following will apply:

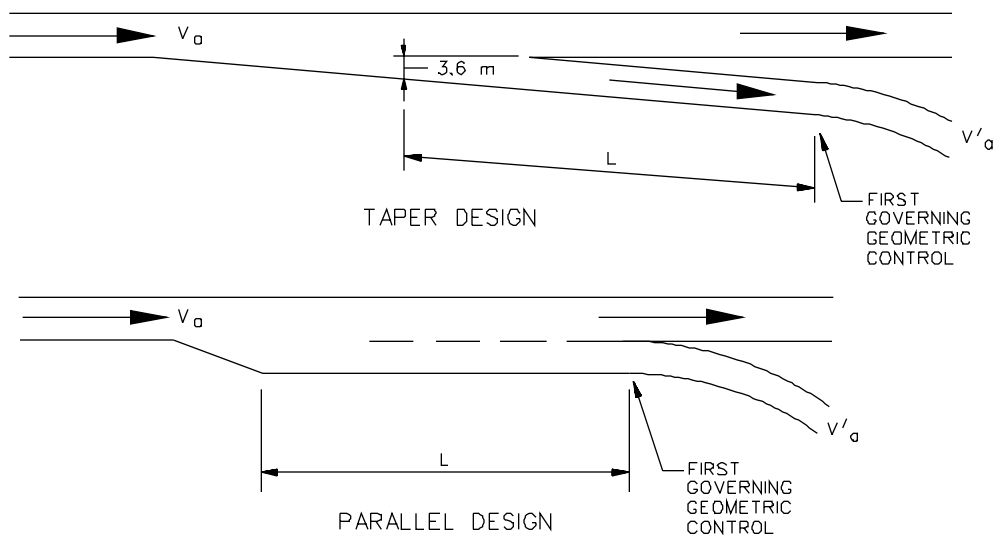
1. Based on the highway design speed and the design speed of the first curve on the exit ramp, Figure 12-3A will yield the required length of the deceleration lane. This will apply from the point where the deceleration lane becomes 3.6 m to the PC of the horizontal curve.
2. For compound curves on the ramp, the minimum length of the entering flatter curve should allow for safe deceleration to the design speed of the sharper curve. Figure 12-3A provides the criteria to determine the minimum distance between the PC and PCC or between the PCC and PCC.

Department policy is that taper ramps will be used for all freeway exits. Figure 12-3C illustrates the typical design for a freeway taper exit. However, at restrictive sites where a taper design cannot provide the needed deceleration for sharp curvature, a parallel lane may be considered. If used, it should be introduced with a taper of 25:1. The AASHTO *A Policy on Geometric Design of Highways and Streets* provides the design criteria for parallel lane designs.

12-3.01.02 Sight Distance

Where practical, decision sight distance should be provided for drivers approaching an exit. This sight distance is particularly important for exit loops immediately beyond the structure. Vertical curvature or bridge piers can obstruct the exit points if not carefully designed. When measuring for

Highway Design Speed (km/h) (V)	Speed Reached (km/h) (V _a)	L = Deceleration Length (m)							
		For Design Speed of First Governing Geometric Control (km/h) (V')							
		Stop	20	30	40	50	60	70	80
		For Average Running Speed on Exit Curve (km/h) (V' _a)							
		0	20	28	35	42	51	63	70
50	47	75	70	60	45	-	-	-	-
60	55	95	90	80	65	55	-	-	-
70	63	110	105	95	85	70	55	-	-
80	70	130	125	115	100	90	80	55	-
90	77	145	140	135	120	110	100	75	60
100	85	170	165	155	145	135	120	100	85
110	91	180	180	170	160	150	140	120	105



Notes:

1. The deceleration lengths are calculated from the distance needed for a passenger car to decelerate from the average running speed of the highway mainline to the average running speed of the first governing geometric control.
2. These values are for grades less than 3%. See Figure 12-3B for steeper upgrades or downgrades.

MINIMUM LENGTH OF DECELERATION LANES

Figure 12-3A

Direction of Grade	Ratio of Deceleration Lane Length on Grade to Length on Level			
	$< 3\%$	$3\% \leq G < 5\%$	$5\% \leq G < 7\%$	$G \geq 7\%$
Upgrade	1.0	0.9	0.8	0.7
Downgrade	1.0	1.2	1.35	1.5

- Notes:
1. Table applies to all highway design speeds.
 2. The "grade" in the table is the average grade over the distance used for measuring the length of the deceleration lane. See Figure 12-3C.

Example

Given:

Highway Design Speed	-	110 km/h
First Exit Curve Design Speed	-	70 km/h
Average Grade	-	5% downgrade

Problem: Determine length of deceleration lane.

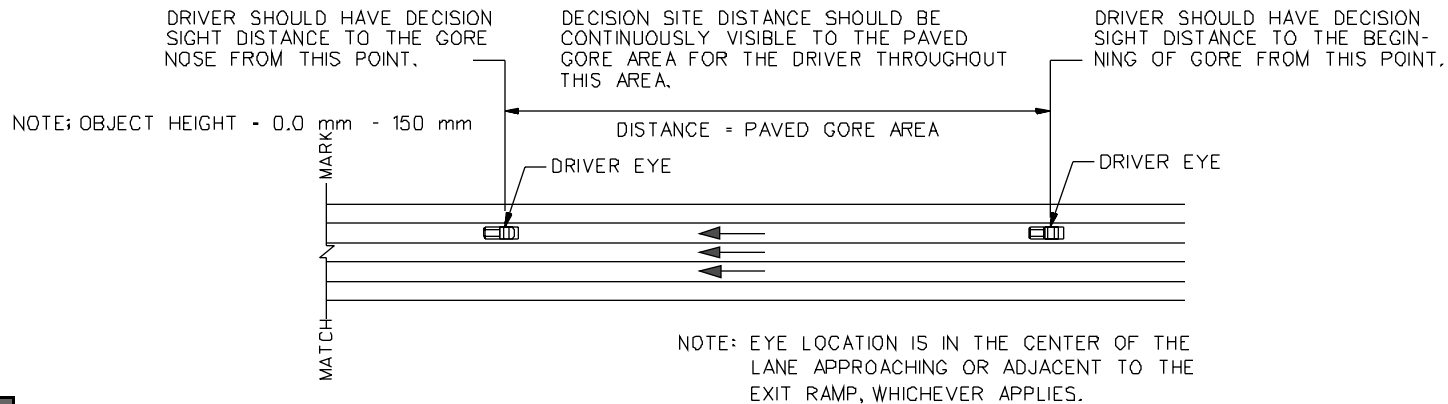
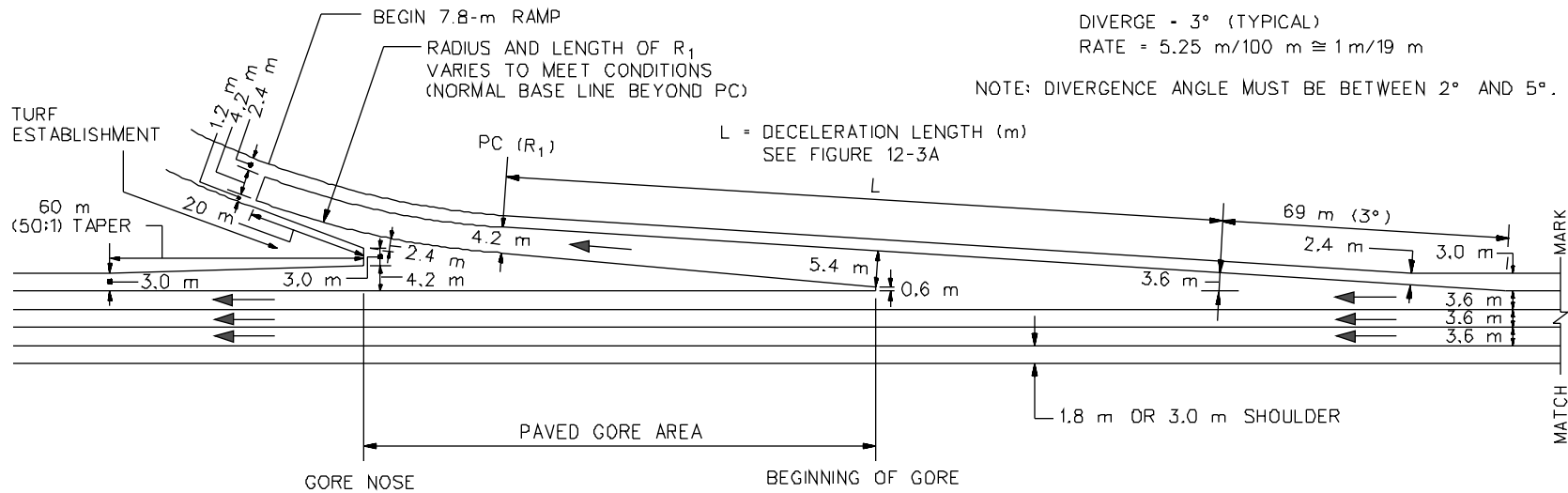
Solution: Figure 12-3A yields a minimum deceleration lane of 120 m on the level. According to Figure 12-3B, this should be increased by 1.35.

Therefore: $L = 120 \times 1.35$
 $L = 162 \text{ m}$

A 162-m deceleration lane would be provided from the full width of the lane to the PC of the first exit curve.

GRADE ADJUSTMENTS ON DECELERATION LANES

Figure 12-3B



TYPICAL EXIT RAMP DESIGN (3° Divergence)

Figure 12-3C

adequate sight distance, the height of object should be 0.0 mm (the roadway surface); however, it is acceptable to use 150 mm. Figure 12-3C illustrates the application of the decision sight distance to freeway exits.

12-3.01.03 Superelevation

The superelevation at an exit ramp must be developed to properly transition the driver from the mainline to the curvature at the exit. The principles of superelevation for rural highways and high-speed urban facilities, as discussed in Section 8-2.0, should be applied to the exit ramp design.

The maximum superelevation rate is 6%. Figure 8-2A presents the design superelevation rate for various combinations of radii and design speed. Typically, the exit lane should be transitioned so that 0.67 of the design superelevation is reached at the PC of the first exit curve. At a minimum, the length of runoff should be based on the distances provided in Figure 8-2A.

12-3.01.04 Gore Area

The gore area is normally considered to be both the paved triangular area between the through lane and the exit lane, plus the graded area which may extend 100 m or more downstream beyond the gore nose. The following should be considered when designing the gore:

1. Traffic Control Devices. If practical, the area beyond the gore nose should be free of signs and luminaire supports for approximately 100 m beyond the gore nose. If they must be present, they must be yielding or breakaway or shielded by guide rail or a crash cushion. (See Chapter Thirteen).
2. Grading. The graded area beyond the gore nose should be as flat as practical. If the elevation between the exit ramp or loop and the mainline increases rapidly, this may not be practical. These areas will likely be non-traversable and the gore design must shield these areas from the motorist. At some sites, the vertical divergence of the ramp and mainline will warrant protection for both roadways beyond the gore.
3. Paved Gore. The paved triangular gore area between the through lane and exit lane should be safely traversable. The effects of snow storage and melt in the gore area design must be carefully considered. The typical gore grading design will collect the highway runoff in a swale section and direct it off the highway into the earth gore or collect it in a subsurface drainage system. This will minimize icing problems during winter maintenance activities. The maximum break in pavement cross slopes through the swale area should not exceed 8% at any point. Where this treatment is not practical, a straight cross slope may be used provided drainage and snow melt issues are adequately addressed. In no case should the cross slope

of gore be steeper than the adjacent travel lane cross slope. To ensure adequate consideration is given to the combination of drainage and geometric factors, careful evaluation will be necessary early in the design process.

4. Signing. Signing in advance of the exit and at the divergence should be according to current ConnDOT practices. This also applies to the pavement markings in the triangular area upstream from the gore nose. Signing and pavement markings should be coordinated with the Division of Traffic Engineering.

12-3.01.05 Cross Slope Rollover

The cross slope rollover is the algebraic difference between the slope of the through lane and the slope of the exit lane, when these two are adjacent to each other (i.e., before the gore begins). The maximum algebraic difference is 4% to 5%.

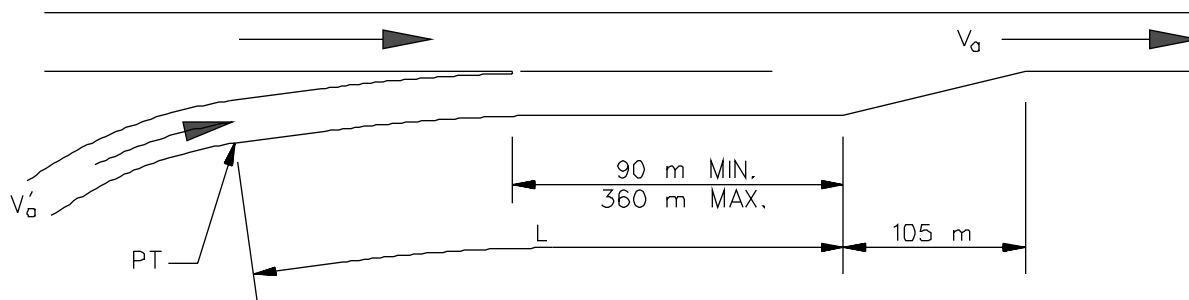
12-3.02 Entrance Ramps

12-3.02.01 Acceleration Lanes

A properly designed acceleration lane will facilitate driver comfort, traffic operations and safety. The length of the acceleration lane will primarily depend upon the design speed of the last (or controlling) curve on the entrance ramp and the design speed of the mainline. Figure 12-3D provides the criteria for minimum lengths of acceleration lanes. These lengths are for the full width of the acceleration lane; taper lengths, typically 105 m, are in addition to the table lengths. However, in restrictive locations, up to 15 m of the taper length may be used to meet the criteria for the acceleration distance. Where grades of 3 percent or more occur on the acceleration lane, adjustments should be made in its length according to Figure 12-3E. Figure 12-3F illustrates the typical design for entrance ramps. The designer should coordinate with the Design Development Team to determine the actual length of the acceleration lane.

The values in Figure 12-3D provide sufficient distance for vehicular acceleration; they may not safely allow a vehicle to merge into the mainline if traffic volumes are high. Where the mainline and ramp will carry traffic volumes approaching the design capacity of the merging area, the parallel portion of the acceleration lane should be increased to a maximum of 360 m in length.

Highway Design Speed (km/h) (V)	Speed Reached (km/h) (V_a)	L = Acceleration Length (m)							
		For Entrance Curve Design Speed (km/h)							
		Stop	20	30	40	50	60	70	80
		And Initial Speed (km/h) (V'_a)							
		0	20	28	35	42	51	63	70
50	37	60	-	-	-	-	-	-	-
60	45	100	85	70	-	-	-	-	-
70	53	145	125	110	85	50	-	-	-
80	60	195	180	165	135	100	55	-	-
90	67	275	260	240	210	175	130	50	-
100	75	370	345	330	300	265	220	145	55
110	81	430	405	390	360	330	285	210	120



Notes:

1. The acceleration lengths are calculated from the distance needed for a passenger car to accelerate from the average running speed of the entrance curve to a speed of 10 km/h below the average running speed on the mainline.
2. These values are for grades less than 3%. See Figure 12-3E for steeper upgrades or downgrades.
3. Use the value of L or 90 m beyond the 0.6-m nose, whichever is greater.

MINIMUM LENGTH OF ACCELERATION LANES

Figure 12-3D

Design Speed of Highway (km/h)	Acceleration Lanes					
	Ratio of Length on Grade to Length for Design Speed of Entrance Ramp Curve (km/h)					
	40	50	60	70	80	All Speeds
	3% to 4% upgrade					3% to 4% downgrade
60	1.3	1.4	1.4	-	-	0.7
70	1.3	1.4	1.4	1.5	-	0.65
80	1.4	1.5	1.5	1.5	1.6	0.65
90	1.4	1.5	1.5	1.5	1.6	0.6
100	1.5	1.6	1.7	1.7	1.8	0.6
110	1.5	1.6	1.7	1.7	1.8	0.6
120	1.5	1.6	1.7	1.7	1.8	0.6
	5% to 6% upgrade					5% to 6% downgrade
60	1.5	1.5	-	-	-	0.6
70	1.5	1.6	1.7	-	-	0.6
80	1.5	1.7	1.9	1.8	-	0.55
90	1.6	1.8	2.0	2.1	2.2	0.55
100	1.7	1.9	2.2	2.4	2.5	0.5
110	2.0	2.2	2.6	2.8	3.0	0.5
120	2.3	2.5	3.0	3.2	3.5	0.5

- Notes:
1. No adjustment is needed on grades less than 3%.
 2. The "grade" in the table is the average grade measured over the distance for which the acceleration length applies. See Figure 12-3F.

Example

Given:

Highway Design Speed	-	110 km/h
Entrance Ramp Curve Design Speed	-	60 km/h
Average Grade	-	5% upgrade

Problem: Determine length of acceleration lane.

Solution: Figure 12-3D yields an acceleration lane of 285 m on the level. According to the above, this should be increased by a factor of 2.6.

Therefore:

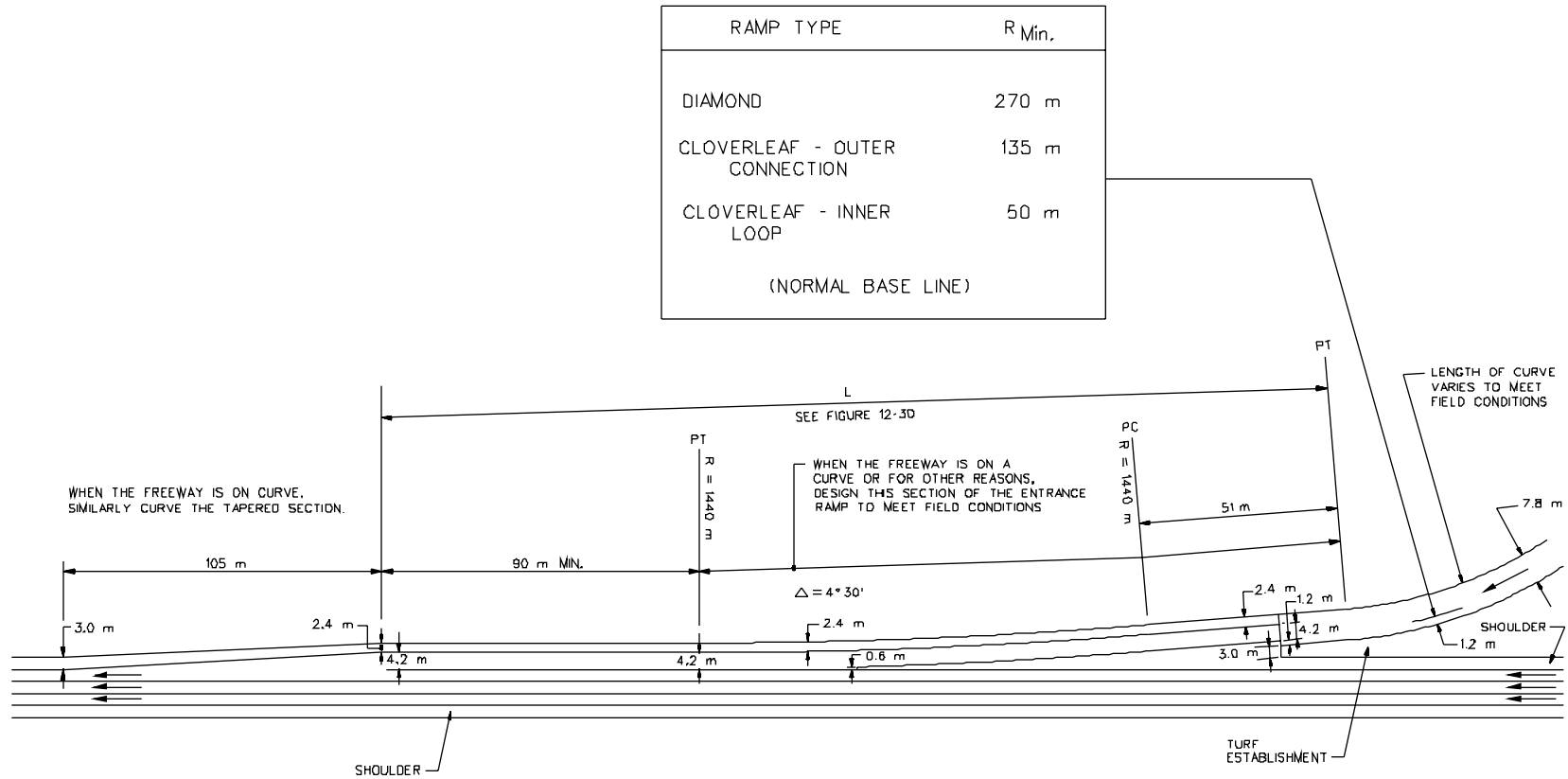
$$L = 285 \times 2.6$$

$$L = 741 \text{ m}$$

A 741-m acceleration lane should be provided from the PT of the entrance ramp curve to the beginning of the taper.

GRADE ADJUSTMENTS ON ACCELERATION LANES

Figure 12-3E



TYPICAL ENTRANCE RAMP DESIGN

Figure 12-3F

12-3.02.02 Sight Distance

Where practical, decision sight distance should be provided for drivers on the mainline approaching an entrance terminal. They need sufficient distance to see the merging traffic so they can adjust their speed or change lanes to allow the merging traffic to enter the freeway. Likewise, drivers on the entrance ramp need to see a sufficient distance upstream from the entrance to locate gaps in the traffic stream for merging.

12-3.02.03 Superelevation

The ramp superelevation should be gradually transitioned to meet the normal cross slope of the mainline. The principles of superelevation for rural highways, as discussed in Section 8-2.0, should be applied to the entrance design. The following criteria should be used:

1. The maximum superelevation rate is 6%.
2. The maximum algebraic difference between the slopes of the acceleration lane and through lane is 4% to 5%, when these two lanes are adjacent to each other.
3. At a minimum the superelevation runoff length should be based on the distance provided in Figure 8-2A.

12-3.03 Critical Design Elements

The designer should provide a freeway/ramp junction design which meets all criteria presented in Section 12-3.0. However, the following elements are especially important to the safety and proper operation of the junction:

1. the minimum length of deceleration for an exit ramp (Figure 12-3A),
2. the deflection (taper) angle for a taper exit ramp (Figure 12-3C),
3. the minimum length of acceleration for an entrance ramp (Figure 12-3D), and
4. the parallel portion of the acceleration lane for an entrance ramp (360 m minimum).