

Design Guides for New and Reconstructed Highways

Design Manual
Chapter 1
General Information

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The tables in this section contain recommended design values for various roadway features. These tables are only for new and reconstructed highways. Higher values to increase safety (for features like the clear zone, stopping sight distance, radius, etc.) should be used within reasonable economic limits.



These guides are not meant to be applied rigidly to every situation. There will be situations when special site conditions (such as environmental, aesthetic, or economic considerations) warrant deviation from the values in the tables. It is acceptable to deviate from these values with the approval of the Design Engineer. Design exceptions should be prepared when appropriate.

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Freeways (English)

Definition: Multi-lane divided highways with full access control—access allowed only at interchanges.

	Rural		Urban	
	outside lane	inside lane(s)	outside lane	inside lane(s)
design speed (mph)	70		60	
expected regulatory speed (mph)	65		55	
level of service (capacity analysis)	B		C	
clear zone (ft)	(a)		(a)	
minimum radius (ft)	2050 (b)(c)		1340 (b)(c)	
horizontal curves—minimum length (ft)	1050 (b)(d)		900 (b)(d)	
vertical curves—minimum length (ft)	210 (b)		180 (b)	
crest vertical curves—desirable k	405 (b)		245 (b)	
sag vertical curves—minimum k	181 (b)		136 (b)	
stopping sight distance (ft)	730 (b)		570 (b)	
maximum gradient (%)	3 (e)		3 (e)	
normal median width (ft)	64 (f)		varies	
lane pavement width (ft)	14 (g)	12	14 (g)	12
shoulder width (ft)	10 (h)	6 (i)	10 (h)	6 (i)
shoulder type	(j)		(j)	
curbs	NA		(k)	
foreslope	6:1 (l)		6:1 (l)	
normal outside ditch (depth × width) (ft)	5 × 10 (m)		5 × 10 (m)	
normal median ditch depth (ft)	4		4	
backslope	2.5:1		2.5:1	
bridge width—new (ft)	lane pavement widths + shoulder widths			
bridge width—existing (ft)	lane widths + 3 foot offset on each side (n)			
transverse slopes	(o)		(o)	
vertical clearance—over primary (ft)	16.5 (p)		16.5 (p)	
vertical clearance—over non-primary (ft)	15.0 (p)(q)		15.0 (p)(q)	
vertical clearance—over railroad (ft)	23.0 (r)		23.0 (r)	
vertical clearance—under any structure (ft)	16.5 (p)		16.5 (p)	

- (a) Depends on design speed, traffic volume, cross section, and horizontal alignment. See Section 1C-2 of this manual. Measured from edge-of-traveled way.
- (b) Based on design speed. See Section 6D-1 of this manual for more information regarding stopping sight distance and Section 6D-5 for more information regarding vertical curve design.
- (c) Based on $e_{\max} = 6\%$.
- (d) Includes spiral length.
- (e) 4 % is acceptable on non-interstate freeways.
- (f) From edge-of-pavement to edge-of-pavement.
- (g) Actual driving-lane width is 12 feet. Painted edge line is offset 12 feet from the inside edge of the lane. On PCC pavement, roughness pattern is used outside the painted edge line, regardless of shoulder type.
- (h) Shoulder width includes 2 feet of lane pavement width outside the painted edge line.
- (i) 10-foot shoulder width should be used when there are 3 or more through lanes in one direction.
- (j) See Section 3C-4 of this manual.
- (k) See Section 3C-2 of this manual.
- (l) Barn-roof cross section is acceptable at high-fill locations as illustrated on Typical 2112.
- (m) May use 4 × 8, 3 × 5, or swale depending on right-of-way impacts.
- (n) Design loading should be sufficient to accommodate legal loads. Bridge rail and approach guardrail should be upgraded, if necessary.
- (o) 8:1 with drainage structures. 10:1 without drainage structures.
- (p) Includes provision for 3" HMA overlay. Vertical clearance is maintained above all lanes and shoulders. See Section 1C-2 for vertical clear zone guidelines.
- (q) The designer may provide additional vertical clearance when site conditions warrant.
- (r) May vary. Need to verify each railroad's requirement.

Freeways (Metric)

Definition: Multi-lane divided highways with full access control—access allowed only at interchanges.

	Rural		Urban	
	outside lane	inside lane(s)	outside lane	inside lane(s)
design speed (km/h)	110		100	
expected regulatory speed (mph)	65		55	
level of service (capacity analysis)	B		C	
clear zone (meters)	(a)		(a)	
minimum radius (meters)	560 (b)(c)		435 (b)(c)	
horizontal curves—minimum length (meters)	330 (b)(d)		300 (b)(d)	
vertical curves—minimum length (meters)	66 (b)		60 (b)	
crest vertical curves—desirable k	120 (b)		85 (b)	
sag vertical curves—minimum k	55 (b)		45 (b)	
stopping sight distance (meters)	220 (b)		185 (b)	
maximum gradient (%)	3 (e)		3 (e)	
normal median width (meters)	20.8 (f)		varies	
lane pavement width (meters)	4.2 (g)	3.6	4.2 (g)	3.6
shoulder width (meters)	3.0 (h)	1.8 (i)	3.0 (h)	1.8 (i)
shoulder type	(j)		(j)	
curbs	NA		(k)	
foreslope	6:1 (l)		6:1 (l)	
normal outside ditch (depth × width) (meters)	1.5 × 3 (m)		1.5 × 3 (m)	
normal median ditch depth (meters)	1.2		1.2	
backslope	2.5:1		2.5:1	
bridge width—new (meters)	lane pavement widths + shoulder widths			
bridge width—existing (meters)	lane widths + 0.9 meter offset on each side (n)			
transverse slopes	(o)		(o)	
vertical clearance—over primary (meters)	5.1 (p)		5.1 (p)	
vertical clearance—over non-primary (meters)	4.6 (p)(q)		4.6 (p)(q)	
vertical clearance—over railroad (meters)	7.01 (r)		7.01 (r)	
vertical clearance—under any structure (meters)	5.1 (p)		5.1 (p)	

- (a) Depends on design speed, traffic volume, cross section, and horizontal alignment. See Section 1C-2 of this manual. Measured from edge-of-traveled way.
- (b) Based on design speed. See Section 6D-1 of this manual for more information regarding stopping sight distance and Section 6D-5 for more information regarding vertical curve design.
- (c) Based on $e_{\max} = 6\%$.
- (d) Includes spiral length.
- (e) 4 % is acceptable on non-interstate freeways.
- (f) From edge-of-pavement to edge-of-pavement.
- (g) Actual driving-lane width is 3.6 meters. Painted edge line is offset 3.6 meters from the inside edge of the lane. On PCC pavement, roughness pattern is used outside the painted edge line, regardless of shoulder type.
- (h) Shoulder width includes 0.6 meters of lane pavement width outside the painted edge line.
- (i) 3.0-meter shoulder width should be used when there are 3 or more through lanes in one direction.
- (j) See Section 3C-4 of this manual.
- (k) See Section 3C-2 of this manual.
- (l) Barn-roof cross section is acceptable at high-fill locations as illustrated on Typical 2112.
- (m) May use 1.2×2.4 , 1.0×1.5 , or swale depending on right-of-way impacts.
- (n) Design loading should be sufficient to accommodate legal loads. Bridge rail and approach guardrail should be upgraded, if necessary.
- (o) 8:1 with drainage structures. 10:1 without drainage structures.
- (p) Includes provision for 75 mm HMA overlay. Vertical clearance is maintained above all lanes and shoulders. See Section 1C-2 for vertical clear zone guidelines.
- (q) The designer may provide additional vertical clearance when site conditions warrant.
- (r) May vary. Need to verify each railroad's requirement.

Expressways (English)

Definition: Multi-lane divided highways with at-grade intersections, often in combination with interchanges at high-volume intersections and primary routes.

	Rural		Urban	
design speed (mph)	70		60	
expected regulatory speed (mph)	65		55	
level of service (capacity analysis)	B		C	
clear zone (ft)	(a)		(a)	
minimum radius (ft)	2050 (b)(c)		1505 (b)(d)	
horizontal curves—minimum length (ft)	1050 (b)(e)		900 (b)(e)	
vertical curves—minimum length (ft)	210 (b)		180 (b)	
crest vertical curves—desirable k	405(b)		245 (b)	
sag vertical curves—minimum k	181 (b)		136 (b)	
stopping sight distance (ft)	730 (b)		570 (b)	
maximum gradient (%)	4		4	
normal median width (ft)	64 (f)		varies	
	outside lane	inside lane(s)	outside lane	inside lane(s)
lane pavement width (ft)	14 (g)	12	14 (g)	12
shoulder width (ft)	10 (h)	6 (i)	10 (h)	6 (i)
shoulder type	granular (j)		granular (j)	
turn-lane width (ft)	12		12	
auxiliary-lane width (ft)	12		12	
curbs	NA		(k)	
foreslope	6:1 (l)		6:1 (l)	
normal outside ditch (depth × width) (ft)	5 × 10 (m)		5 × 10 (m)	
normal median ditch depth (ft)	4		4	
backslope	2.5:1		2.5:1	
bridge width—new (ft)	lane pavement widths + shoulder widths			
bridge width—existing (ft)	lane widths + 3 foot offset on each side (n)			
transverse slopes	(o)		(o)	
vertical clearance—over primary (ft)	16.5 (p)		16.5 (p)	
vertical clearance—over non-primary (ft)	15.0 (p)(q)		15.0 (p)(q)	
vertical clearance—over railroad (ft)	23.0 (r)		23.0 (r)	
vertical clearance—under any structure (ft)	16.5 (p)		16.5 (p)	

- (a) Depends on design speed, traffic volume, cross section, and horizontal alignment. See Section 1C-2 of this manual. Measured from edge-of-traveled way.
- (b) Based on design speed. See Section 6D-1 of this manual for more information regarding stopping sight distance and Section 6D-5 for more information regarding vertical curve design.
- (c) Based on $e_{\max} = 6\%$.
- (d) Based on $e_{\max} = 4\%$.
- (e) Includes spiral length.
- (f) From edge-of-pavement to edge-of-pavement.
- (g) Actual driving-lane width is 12 feet. Painted edge line is offset 12 feet from the inside edge of the lane. On PCC pavement, roughness pattern is used outside the painted edge, regardless of shoulder type.
- (h) Shoulder width includes 2 feet of lane pavement width outside the painted edge line.
- (i) 10-foot shoulder width should be used when there are 3 or more through lanes in one direction.
- (j) See Section 3C-4 of this manual.
- (k) See Section 3C-2 of this manual.
- (l) Barn-roof cross section is acceptable at high-fill locations as illustrated on Typical 2112.
- (m) May use 4 × 8, 3 × 5, or swale depending on right-of-way impacts.
- (n) Design loading should be sufficient to accommodate legal loads. Bridge rail and approach guardrail should be upgraded, if necessary.
- (o) 8:1 with drainage structures. 10:1 without drainage structures. 6:1 at sideroads.
- (p) Includes provision for 3" HMA overlay. Vertical clearance is maintained above all lanes and shoulders. See Section 1C-2 for vertical clear zone guidelines.
- (q) The designer may provide additional vertical clearance when site conditions warrant.
- (r) May vary. Need to verify each railroad's requirement.

Expressways (Metric)

Definition: Multi-lane divided highways with at-grade intersections, often in combination with interchanges at high-volume intersections and primary routes.

	Rural		Urban	
	outside lane	inside lane(s)	outside lane	inside lane(s)
design speed (km/h)	110		100	
expected regulatory speed (mph)	65		55	
level of service (capacity analysis)	B		C	
clear zone (meters)	(a)		(a)	
minimum radius (meters)	560 (b)(c)		435 (b)(d)	
horizontal curves—minimum length (meters)	330 (b)(e)		300 (b)(e)	
vertical curves—minimum length (meters)	66 (b)		60 (b)	
crest vertical curves—desirable k	120 (b)		85 (b)	
sag vertical curves—minimum k	55 (b)		45 (b)	
stopping sight distance (meters)	220 (b)		185 (b)	
maximum gradient (%)	4		4	
normal median width (meters)	20.8 (f)		varies	
lane pavement width (meters)	4.2 (g)	3.6	4.2 (g)	3.6
shoulder width (meters)	3.0 (h)	1.8 (i)	3.0 (h)	1.8 (i)
shoulder type	granular (j)		granular (j)	
turn-lane width (meters)	3.6		3.6	
auxiliary-lane width (meters)	3.6		3.6	
curbs	NA		(l)	
foreslope	6:1 (l)		6:1 (l)	
normal outside ditch (depth × width) (meters)	1.5 × 3 (m)		1.5 × 3 (m)	
normal median ditch depth (meters)	1.2		1.2	
backslope	2.5:1		2.5:1	
bridge width—new (meters)	lane pavement widths + shoulder widths			
bridge width—existing (meters)	lane widths + 0.9 meter offset on each side (n)			
transverse slopes	(o)		(o)	
vertical clearance—over primary (meters)	5.1 (p)		5.1 (p)	
vertical clearance—over non-primary (meters)	4.6 (p)(q)		4.6 (p)(q)	
vertical clearance—over railroad (meters)	7.01 (r)		7.01 (r)	
vertical clearance—under any structure (meters)	5.1 (p)		5.1 (p)	

- (a) Depends on design speed, traffic volume, cross section, and horizontal alignment. See Section 1C-2 of this manual. Measured from edge-of-traveled way.
- (b) Based on design speed. See Section 6D-1 of this manual for more information regarding stopping sight distance and Section 6D-5 for more information regarding vertical curve design.
- (c) Based on $e_{\max} = 6\%$.
- (d) Based on $e_{\max} = 4\%$.
- (e) Includes spiral length.
- (f) From edge-of-pavement to edge-of-pavement.
- (g) Actual driving-lane width is 3.6 meters. Painted edge line is offset 3.6 meters from the inside edge of the lane. On PCC pavement, roughness pattern is used outside the painted edge line, regardless of shoulder type.
- (h) Shoulder width includes 0.6 meters of lane pavement width outside the painted edge line.
- (i) 3.0-meter shoulder width should be used when there are 3 or more through lanes in one direction.
- (j) See Section 3C-4 of this manual.
- (k) See Section 3C-2 of this manual.
- (l) Barn-roof cross section is acceptable at high-fill locations as illustrated on Typical 2112.
- (m) May use 1.2×2.4 , 1.0×1.5 , or swale depending on right-of-way impacts.
- (n) Design loading should be sufficient to accommodate legal loads. Bridge rail and approach guardrail should be upgraded, if necessary.
- (o) 8:1 with drainage structures. 10:1 without drainage structures. 6:1 at sideroads.
- (p) Includes provision for 75mm HMA overlay. Vertical clearance is maintained above all lanes and shoulders. See Section 1C-2 for vertical clear zone guidelines.
- (q) The designer may provide additional vertical clearance when site conditions warrant.
- (r) May vary. Need to verify each railroad's requirement.

Super-Two Highways (English)

Definition: Rural two-lane undivided highways with enhanced geometrics to improve operational and safety features. Intersections are at-grade.

design speed (mph)	70	shoulder type	See Section 3C-4
expected regulatory speed (mph)	55	turn-lane width (ft)	12 (h)(i)
level of service (capacity analysis)	B	auxiliary-lane width (ft)	12 (j)
clear zone (ft)	(a)	foreslope	6:1 (k)
minimum radius (ft)	2050 (b)(c)	normal ditch (depth × width) (ft)	5 × 10 (l)
horizontal curves minimum length (ft)	1050 (b)(d)	backslope	2.5:1
vertical curves minimum length (ft)	210 (b)	bridge width—new (ft)	lane pavement widths + shoulder widths (m)
crest vertical curves desirable k	405 (b)	bridge width—existing (ft)	lane widths + offset (n)
sag vertical curves minimum k	181 (b)	transverse slopes	(o)
stopping sight distance (ft)	730 (b)	vertical clearance—over primary (ft)	16.5 (p)
maximum gradient (%)	4 (e)	vertical clearance—over non-primary (ft)	15.0 (p) (q)
lane pavement width (ft)	14 (f)	vertical clearance—over railroad (ft)	23.0 (r)
shoulder width (ft)	10 (g)(h)	vertical clearance—under any structure (ft)	16.5 (p)

- (a) Depends on design speed, traffic volume, cross section, and horizontal alignment. See Section 1C-2 of this manual. Measured from edge-of-traveled way.
- (b) Based on design speed. See Section 6D-1 of this manual for more information regarding stopping sight distance and Section 6D-5 for more information regarding vertical curve design.
- (c) Based on $e_{max} = 6\%$.
- (d) Includes spiral length.
- (e) Maximum gradient up to 6% is allowed for areas with mountainous terrain (see definition in AASHTO’s *A Policy on Geometric Design of Highways and Streets*).
- (f) Actual driving-lane width is 12 feet. Painted edge line is offset 12 feet from centerline. On PCC pavement, roughness pattern is used outside the painted edge line.
- (g) Shoulder width includes 2 feet of lane pavement width outside the painted edge line.
- (h) Shoulder width adjacent to right-turn lanes is 6 feet.
- (i) See Section 6A-1 for right and left-turn lane warrants.
- (j) Includes passing lanes, climbing lanes, and speed-differential lanes.
- (k) Barn-roof cross section is acceptable at high-fill locations as illustrated on Typical 2113.
- (l) May use 4 × 8, 3 × 5, or swale depending on right-of-way impacts.
- (m) When bridge length is greater than 800 feet, 8-foot shoulders are desirable for storage of vehicles in emergencies, but 6-foot shoulders are acceptable.
- (n) Design loading should be sufficient to accommodate legal loads. Bridge rail and approach guardrail should be upgraded, if necessary.

Design Year ADT	Offset—each side (feet)
0–750	0
751–2000	1
2001–4000	2
> 4000	3

- (o) 8:1 with drainage structures. 10:1 without drainage structures. 6:1 at sideroads.
- (p) Includes provision for 3” HMA overlay. Vertical clearance is maintained above all lanes and shoulders. See Section 1C-2 for vertical clear zone guidelines.
- (q) The designer may provide additional vertical clearance when site conditions warrant.
- (r) May vary. Need to verify each railroad’s requirement.

Super-Two Highways (Metric)

Definition: Rural two-lane undivided highways with enhanced geometrics to improve operational and safety features. Intersections are at-grade.

design speed (km/h)	110	shoulder type	See Section 3C-4
expected regulatory speed (mph)	55	turn-lane width (meters)	3.6 (h)(i)
level of service (capacity analysis)	B	auxiliary-lane width (meters)	3.6 (j)
clear zone (meters)	(a)	foreslope	6:1 (k)
minimum radius (meters)	560 (b)(c)	normal ditch (depth × width) (meters)	1.5 × 3 (l)
horizontal curves minimum length (meters)	330 (b)(d)	backslope	2.5:1
vertical curves minimum length (meters)	66 (b)	bridge width—new (meters)	lane pavement widths + shoulder widths (m)
crest vertical curves desirable k	121 (b)	bridge width—existing (meters)	lane widths + offset (n)
sag vertical curves minimum k	55 (b)	transverse slopes	(o)
stopping sight distance (meters)	220 (b)	vertical clearance—over primary (meters)	5.1 (p)
maximum gradient (%)	4 (e)	vertical clearance—over non-primary (meters)	4.6 (p)(q)
lane pavement width (meters)	4.2 (f)	vertical clearance—over railroad (meters)	7.01 (r)
shoulder width (meters)	3.0 (g)(h)	vertical clearance—under any structure (meters)	5.1 (p)

- (a) Depends on design speed, traffic volume, cross section, and horizontal alignment. See Section 1C-2 of this manual. Measured from edge-of-traveled way.
- (b) Based on design speed. See Section 6D-1 of this manual for more information regarding stopping sight distance and Section 6D-5 for more information regarding vertical curve design.
- (c) Based on $e_{\max} = 6\%$.
- (d) Includes spiral length.
- (e) Maximum gradient up to 6% is allowed for areas with mountainous terrain (see definition in AASHTO's *A Policy on Geometric Design of Highways and Streets*).
- (f) Actual driving-lane width is 3.6 meters. Painted edge line is offset 3.6 meters from centerline. On PCC pavement, roughness pattern is used outside the painted edge line.
- (g) Shoulder width includes 0.6 meters of lane pavement width outside the painted edge line.
- (h) Shoulder width adjacent to right-turn lanes is 1.8 meters.
- (i) See Section 6A-1 for right and left-turn lane warrants.
- (j) Includes passing lanes, climbing lanes, and speed-differential lanes.
- (k) Barn-roof cross section is acceptable at high-fill locations as illustrated on Typical 2113.
- (l) May use 1.2×2.4 , 1.0×1.5 , or swale depending on right-of-way impacts.
- (m) When bridge length is greater than 250 meters, 2.4-meter shoulders are desirable for storage of vehicles in emergencies, but 1.8-meter shoulders are acceptable.
- (n) Design loading should be sufficient to accommodate legal loads. Bridge rail and approach guardrail should be upgraded, if necessary.

Design Year ADT	Offset—each side (meters)
0–750	0
751–2000	0.3
2001–4000	0.6
> 4000	0.9

- (o) 8:1 with drainage structures. 10:1 without drainage structures. 6:1 at sideroads.
- (p) Includes provision for 75 mm HMA overlay. Vertical clearance is maintained above all lanes and shoulders. See Section 1C-2 for vertical clear zone guidelines.
- (q) The designer may provide additional vertical clearance when site conditions warrant.
- (r) May vary. Need to verify each railroad's requirement.

Rural Two-Lane Highways (English)

Definition: Rural undivided highways with at-grade intersections.

design speed (mph)	60	
expected regulatory speed (mph)	55	
level of service (capacity analysis)	B	
clear zone (ft)	(a)	
minimum radius (ft)	1340 (b)(c)	
horizontal curves—minimum length (ft)	900 (b)(d)	
vertical curves—minimum length (ft)	180 (b)	
crest vertical curves—desirable k	245 (b)	
sag vertical curves—minimum k	136(b)	
stopping sight distance (ft)	570 (b)	
maximum gradient (%)	4 (e)	
	NHS	Non-NHS
lane pavement width (ft)	14 (f)	14 (f)
shoulder width (ft)	10 (g)(h)	10 (g)(h)(i)
shoulder type	See Section 3C-4 of this manual	
turn-lane width (ft)	12 (h)(j)	
auxiliary-lane width (ft)	12	
foreslope	6:1 (k)	
normal ditch (depth × width) (ft)	5 × 10 (l)	
backslope	2.5:1	
bridge width—new (ft)	lane pavement widths + shoulder widths (m)	
bridge width—existing (ft)	lane widths + offset (n)	
transverse slopes	(o)	
vertical clearance—over primary (ft)	16.5 (p)	
vertical clearance—over non-primary (ft)	15.0 (p)(q)	
vertical clearance—over railroad (ft)	23.0 (r)	
vertical clearance—under any structure (ft)	16.5 (p)	

- (a) Depends on design speed, traffic volume, cross section, and horizontal alignment. See Section 1C-2 of this manual. Measured from edge-of-traveled way.
- (b) Based on design speed. See Section 6D-1 of this manual for more information regarding stopping sight distance and Section 6D-5 for more information regarding vertical curve design.
- (c) Based on $e_{\max} = 6\%$.
- (d) Includes spiral length.
- (e) Maximum gradient up to 6% is allowed for areas with mountainous terrain (see definition in AASHTO's *A Policy on Geometric Design of Highways and Streets*).
- (f) Actual driving-lane width is 12 feet. Painted edge line is offset 12 feet from centerline. On PCC pavement, roughness pattern is used outside the painted edge line.
- (g) Shoulder width includes 2 feet of lane pavement width outside the painted edge line.
- (h) Shoulder width adjacent to major right-turn lanes is 6 feet. Shoulder width adjacent to minor right-turn lanes is 4 feet.
- (i) If design year ADT < 3000, shoulder width may be 8 feet. If design year ADT < 2000, shoulder width may be 6 feet.
- (j) See Section 6A-1 for right and left-turn lane warrants.
- (k) Barn-roof cross section is acceptable at high-fill locations as illustrated on Typical 2113.
- (l) May use 4 × 8, 3 × 5, or swale depending on right-of-way impacts.
- (m) When bridge length is over 1000 feet, 8-foot shoulders are desirable for storage of vehicles in emergencies, but 4-foot shoulders are acceptable.
- (n) Design loading should be sufficient to accommodate legal loads. Bridge rail and approach guardrail should be upgraded, if necessary.

Design Year ADT	Offset—each side (feet)
0–750	0
751–2000	1
2001–4000	2
> 4000	3

- (o) 8:1 with drainage structures. 10:1 without drainage structures. 6:1 at sideroads.
- (p) Includes provision for 3" HMA overlay. Vertical clearance is maintained above all lanes and shoulders. See Section 1C-2 for vertical clear zone guidelines.
- (q) The designer may provide additional vertical clearance when site conditions warrant.
- (r) May vary. Need to verify each railroad's requirement.

Rural Two-Lane Highways (Metric)

Definition: Rural undivided highways with at-grade intersections.

design speed (km/h)	100	
expected regulatory speed (mph)	55	
level of service (capacity analysis)	B	
clear zone (meters)	(a)	
stopping sight distance (meters)	185 (b)	
minimum radius (meters)	435 (b)(c)	
horizontal curves—minimum length (meters)	300 (b)(d)	
vertical curves—minimum length (meters)	60 (b)	
crest vertical curves—desirable k	85 (b)	
sag vertical curves—minimum k	45 (b)	
maximum gradient (%)	4 (e)	
	NHS	Non-NHS
lane pavement width (meters)	4.2 (f)	4.2 (f)
shoulder width (meters)	3.0 (g)(h)	3.0 (g)(h)(i)
shoulder type	See Section 3C-4 of this manual	
turn-lane width (meters)	3.6 (h)(j)	
auxiliary-lane width (meters)	3.6	
foreslope	6:1 (k)	
normal ditch (depth × width) (meters)	1.5 × 3 (l)	
backslope	2.5:1	
bridge width—new (meters)	lane pavement widths + shoulder widths (m)	
bridge width—existing (meters)	lane widths + offset (n)	
transverse slopes	(o)	
vertical clearance—over primary (meters)	5.1 (p)	
vertical clearance—over non-primary (meters)	4.6 (p)(q)	
vertical clearance—over railroad (meters)	7.01 (r)	
vertical clearance—under any structure (meters)	5.1 (p)	

- (a) Depends on design speed, traffic volume, cross section, and horizontal alignment. See Section 1C-2 of this manual. Measured from edge-of-traveled way.
- (b) Based on design speed. See Section 6D-1 of this manual for more information regarding stopping sight distance and Section 6D-5 for more information regarding vertical curve design.
- (c) Based on $e_{\max} = 6\%$.
- (d) Includes spiral length.
- (e) Maximum gradient up to 6% is allowed for areas with mountainous terrain (see definition in AASHTO's *A Policy on Geometric Design of Highways and Streets*).
- (f) Actual driving-lane width is 3.6 meters. Painted edge line is offset 3.6 meters from centerline. On PCC pavement, roughness pattern is used outside the painted edge line.
- (g) Shoulder width includes 0.6 meters of lane pavement width outside the painted edge line.
- (h) Shoulder width adjacent to major right-turn lanes is 1.8 meters. Shoulder width adjacent to minor right-turn lanes is 1.2 meters.
- (i) If design year ADT < 3000, shoulder width may be 2.4 meters. If design year ADT < 2000, shoulder width may be 1.8 meters.
- (j) See Section 6A-1 for right and left-turn lane warrants.
- (k) Barn-roof cross section is acceptable at high-fill locations as illustrated on Typical 2113.
- (l) May use 1.2 × 2.4, 1.0 × 1.5, or swale depending on right-of-way impacts.
- (m) When bridge length is over 300 meters, 2.4-meter shoulders are desirable for storage of vehicles in emergencies, but 1.2-meter shoulders are acceptable.
- (n) Design loading should be sufficient to accommodate legal loads. Bridge rail and approach guardrail should be upgraded, if necessary.

Design Year ADT	Offset—each side (meters)
0–750	0
751–2000	0.3
2001–4000	0.6
> 4000	0.9

- (o) 8:1 with drainage structures. 10:1 without drainage structures. 6:1 at sideroads.
- (p) Includes provision for 75 mm HMA overlay. Vertical clearance is maintained above all lanes and shoulders. See Section 1C-2 for vertical clear zone guidelines.
- (q) The designer may provide additional vertical clearance when site conditions warrant.
- (r) May vary. Need to verify each railroad's requirement.

Transitional Facilities (English)

Definition: Roadways that transition between a high-speed rural driving environment and a reduced-speed urban environment.

design speed (mph)	55	50	45
expected regulatory speed (mph)	50	45	40
level of service (capacity analysis)	B	C	C
clear zone (ft)	(a)	(a)	(a)
minimum radius (ft)	1190 (b)(c)	930 (b)(c)	730 (b)(c)
vertical curves—minimum length (ft)	165 (b)	150 (b)	135 (b)
crest vertical curves—desirable k	185 (b)	140 (b)	100 (b)
sag vertical curves—minimum k	115 (b)	96 (b)	79 (b)
stopping sight distance (ft)	495 (b)	425 (b)	360 (b)
maximum gradient (%)	5	6	6
lane pavement width (ft)	same width as connecting rural facility		
shoulder width (ft)	same width as connecting rural facility (d)		
shoulder type	same as connecting rural facility (d)		
turn-lane width (ft)	12	12	12
auxiliary-lane width (ft)	12	12	12
curbs	(d)	(d)	(d)
foreslope	6:1 (e)	6:1 (e)	6:1 (e)
normal outside ditch (depth × width) (ft)	5 × 10 (f)	5 × 10 (f)	5 × 10 (f)
backslope	2.5:1	2.5:1	2.5:1
bridge width—new (ft)	lane pavement widths + shoulder widths (g)		
bridge width—existing (ft)	lane widths + offset (h)		
transverse slopes	(i)	(i)	(i)
vertical clearance—over primary (ft)	16.5 (j)	16.5 (j)	16.5 (j)
vertical clearance—over non-primary (ft)	15.0 (j)(k)	15.0 (j)(k)	15.0 (j)(k)
vertical clearance—over railroad (ft)	23.0 (l)	23.0 (l)	23.0 (l)
vertical clearance—under any structure (ft)	16.5 (j)	16.5 (j)	16.5 (j)

- (a) Depends on design speed, traffic volume, cross section, and horizontal alignment. See Section 1C-2 of this manual. Measured from edge-of-traveled way.
- (b) Based on design speed. See Section 6D-1 of this manual for more information regarding stopping sight distance and Section 6D-5 for more information regarding vertical curve design.
- (c) Based on $e_{\max} = 4\%$. For nonsuperelevated curves, minimum radii are 8670 ft. for a 55 mph design speed, 7240 ft. for a 50 mph design speed, and 5950 ft. for a 45 mph design speed.
- (d) If an urban cross section is used, see Section 3C-2 of this manual.
- (e) Barn-roof cross section is acceptable at high-fill locations as illustrated on Typical 2112 and 2113.
- (f) May use 4 × 8, 3 × 5, or swale depending on right-of-way impacts.
- (g) If an urban cross section is used, the bridge width should be the lane widths plus 3 feet. Present and future need for sidewalk(s) should be evaluated for each bridge. Bridge endposts should be shielded with guardrail or an impact attenuator.
- (h) Design loading should be sufficient to accommodate legal loads. Bridge rail and approach guardrail should be upgraded, if necessary.

Design Year ADT	Offset—each side (feet)
0–750	0
751–2000	1
2001–4000	2
> 4000	3

- (i) 8:1 with drainage structures. 10:1 without drainage structures. 6:1 at sideroads.
- (j) Includes provision for 3" HMA overlay. Vertical clearance is maintained above all lanes and shoulders. See Section 1C-2 for vertical clear zone guidelines.
- (k) The designer may provide additional vertical clearance when site conditions warrant.
- (l) May vary. Need to verify each railroad's requirement.

Transitional Facilities (Metric)

Definition: Roadways that transition between a high-speed rural driving environment and a reduced-speed urban environment.

design speed (km/h)	90	80	70
expected regulatory speed (mph)	50	45	40
level of service (capacity analysis)	B	C	C
clear zone (meters)	(a)	(a)	(a)
minimum radius (meters)	375 (b)(c)	280 (b)(c)	215 (b)(c)
vertical curves—minimum length (meters)	54 (b)	48 (b)	42 (b)
crest vertical curves—desirable k	64 (b)	42 (b)	28 (b)
sag vertical curves—minimum k	38 (b)	30 (b)	23 (b)
stopping sight distance (meters)	160 (b)	130 (b)	105 (b)
maximum gradient (%)	5	6	7
lane pavement width (meters)	same width as connecting rural facility		
shoulder width (meters)	same width as connecting rural facility		
shoulder type	same as connecting rural facility		
turn-lane width (meters)	3.6	3.6	3.6
auxiliary-lane width (meters)	3.6	3.6	3.6
curbs	(d)	(d)	(d)
foreslope	6:1 (e)	6:1 (e)	6:1 (e)
normal outside ditch (depth × width) (meters)	1.5 × 3 (f)	1.5 × 3 (f)	1.5 × 3 (f)
backslope	2.5:1	2.5:1	2.5:1
bridge width—new (meters)	lane pavement widths + shoulder widths (g)		
bridge width—existing (meters)	lane widths + offset (h)		
transverse slopes	(i)	(i)	(i)
vertical clearance—over primary (meters)	5.1 (j)	5.1 (j)	5.1 (j)
vertical clearance—over non-primary (meters)	4.6 (j)(k)	4.6 (j)(k)	4.6 (j)(k)
vertical clearance—over railroad (meters)	7.01 (l)	7.01 (l)	7.01 (l)
vertical clearance—under any structure (meters)	5.1 (j)	5.1 (j)	5.1 (j)

- (a) Depends on design speed, traffic volume, cross section, and horizontal alignment. See Section 1C-2 of this manual. Measured from edge-of-traveled way.
- (b) Based on design speed. See Section 6D-1 of this manual for more information regarding stopping sight distance and Section 6D-5 for more information regarding vertical curve design.
- (c) Based on $e_{\max} = 4\%$. For nonsuperelevated curves, minimum radii are 2645 meters for a 90 km/h design speed, 2165 meters for an 80 km/h design speed, and 1745 meters for a 70 km/h design speed.
- (d) If an urban cross section is used, see Section 3C-2 of this manual.
- (e) Barn-roof cross section is acceptable at high-fill locations as illustrated on Typical 2112 and 2113.
- (f) May use 1.2 × 2.4, 1.0 × 1.5, or swale depending on right-of-way impacts.
- (g) If an urban cross section is used, the bridge width should be the lane widths plus 0.9 meters. Present and future need for sidewalk(s) should be evaluated for each bridge. Bridge endposts should be shielded with guardrail or an impact attenuator.
- (h) Design loading should be sufficient to accommodate legal loads. Bridge rail and approach guardrail should be upgraded, if necessary.

Design Year ADT	Offset—each side (meters)
0–750	0
751–2000	0.3
2001–4000	0.6
> 4000	0.9

- (i) 8:1 with drainage structures. 10:1 without drainage structures. 6:1 at sideroads.
- (j) Includes provision for 75 mm HMA overlay. Vertical clearance is maintained above all lanes and shoulders. See Section 1C-2 for vertical clear zone guidelines.
- (k) The designer may provide additional vertical clearance when site conditions warrant.
- (l) May vary. Need to verify each railroad's requirement.

Reduced-Speed Urban Facilities (English)

Definition: Roadways with urban cross sections and reduced speeds. A roadway with an urban cross section controls surface drainage using curbs and an enclosed storm sewer system.

design speed (mph)	40	35	30
expected regulatory speed (mph)	35	30	25
level of service (capacity analysis)	C	C	C
clear zone (ft)	10 (a)	10 (a)	10 (a)
minimum radius (ft)	565 (b)(c)	420 (b)(c)	300 (b)(c)
vertical curves—minimum length (ft)	120 (b)	105 (b)	90 (b)
crest vertical curves—desirable k	70 (b)	50 (b)	30 (b)
sag vertical curves—minimum k	64 (b)	49 (b)	37 (b)
stopping sight distance (ft)	305 (b)	250 (b)	200 (b)
maximum gradient (%)	6	7	8
lane width (ft)	12 (d)	12 (d)	12 (d)
parking-lane width (ft)	10 (e)	10 (e)	10 (e)
turn-lane width (ft)	12 (f)	12 (f)	12 (f)
curbs	(g)	(g)	(g)
bridge width—new (ft)	lane widths + 3-foot offset on each side (h)		
bridge width—existing (ft)	lane widths + offset (i)		
vertical clearance—over primary (ft)	16.5 (j)	16.5 (j)	16.5 (j)
vertical clearance—over non-primary (ft)	15.0 (j)(k)	15.0 (j)(k)	15.0 (j)(k)
vertical clearance—over railroad (ft)	23.0 (l)	23.0 (l)	23.0 (l)
vertical clearance—under any structure (ft)	16.5 (j)	16.5 (j)	16.5 (j)

- (a) Clear zone is measured from back-of-curb.
- (b) Based on design speed. See Section 6D-1 of this manual for more information regarding stopping sight distance and Section 6D-5 for more information regarding vertical curve design.
- (c) Based on $e_{\max} = 4\%$. Nonsuperelevated curves should be according to AASHTO's *A Policy on Geometric Design of Highways and Streets* Exhibit 3-40.
- (d) A 31-foot pavement section is used for two-lane facilities as shown on Standard Road Plan RH-45B. A 53-foot pavement section is used for four-lane facilities as shown on Standard Road Plan RH-47B. Narrower cross sections may be used with approval of the Design Engineer in areas with restricted right-of-way.
- (e) Curb offset width may be included as part of the parking-lane width.
- (f) For continuous two-way left-turn lanes, 14 feet should be used. Widths of 10 to 12 feet may be used with approval of the Design Engineer. See Section 6C-6 for more information regarding continuous two-way left-turn lanes.
- (g) See Section 3C-2.
- (h) Lane widths do not include curb and gutter. Present and future need for sidewalk(s) should be evaluated for each bridge.
- (i) Lane widths do not include curb and gutter. Design loading should be sufficient to accommodate legal loads.
- | Design Year ADT | Offset—each side (feet) |
|-----------------|-------------------------|
| 0–750 | 0 |
| 751–2000 | 1 |
| 2001–4000 | 2 |
| > 4000 | 3 |
- (j) Includes provision for 3" HMA overlay. Vertical clearance is maintained above all lanes and shoulders. See Section 1C-2 for vertical clear zone guidelines.
- (k) The designer may provide additional vertical clearance when site conditions warrant.
- (l) May vary. Need to verify each railroad's requirement.

Reduced-Speed Urban Facilities (Metric)

Definition: Roadways with urban cross sections and reduced speeds. A roadway with an urban cross section controls surface drainage using curbs and an enclosed storm sewer system.

design speed (km/h)	60	60	50
expected regulatory speed (mph)	35	30	25
level of service (capacity analysis)	C	C	C
clear zone (meters)	3 (a)	3 (a)	3 (a)
minimum radius (meters)	150 (b)(c)	150 (b)(c)	100 (b)(c)
vertical curves—minimum length (meters)	36 (b)	36 (b)	30 (b)
crest vertical curves—desirable k	18 (b)	18 (b)	11 (b)
sag vertical curves—minimum k	18 (b)	18 (b)	13 (b)
stopping sight distance (meters)	85 (b)	85 (b)	65 (b)
maximum gradient (%)	7	7	8
lane width (meters)	3.6 (d)	3.6 (d)	3.6 (d)
parking-lane width (meters)	3 (e)	3 (e)	3 (e)
turn-lane width (meters)	3.6 (f)	3.6 (f)	3.6 (f)
curbs	(g)	(g)	(g)
bridge width—new (meters)	lane widths + 0.9-meter offset on each side (h)		
bridge width—existing (meters)	lane widths + offset (i)		
vertical clearance—over primary (meters)	5.1 (j)	5.1 (j)	5.1 (j)
vertical clearance—over non-primary (meters)	4.6 (j)(k)	4.6 (j)(k)	4.6 (j)(k)
vertical clearance—over railroad (meters)	7.01 (l)	7.01 (l)	7.01 (l)
vertical clearance—under any structure (meters)	5.1 (j)	5.1 (j)	5.1 (j)

- (a) Clear zone is measured from back-of-curb.
- (b) Based on design speed. See Section 6D-1 of this manual for more information regarding stopping sight distance and Section 6D-5 for more information regarding vertical curve design.
- (c) Based on $e_{\max} = 4\%$. Nonsuperelevated curves should be according to AASHTO's *A Policy on Geometric Design of Highways and Streets* Exhibit 3-40.
- (d) A 9.4-meter pavement section is used on two-lane facilities as shown on Standard Road Plan RH-45B. A 16.0-meter pavement section is used on four-lane facilities as shown on Standard Road Plan RH-47B. Narrower cross sections may be used with approval of the Design Engineer in areas with restricted right-of-way.
- (e) Curb offset width may be included as part of the parking-lane width.
- (f) For continuous two-way left-turn lanes, 4.2 meters should be used. Widths of 3.0 to 3.6 meters may be used with approval of the Design Engineer. See Section 6C-6 for more information regarding two-way left-turn lanes.
- (g) See Section 3C-2.
- (h) Lane widths do not include curb and gutter. Present and future need for sidewalk(s) should be evaluated for each bridge.
- (i) Lane widths do not include curb and gutter. Design loading should be sufficient to accommodate legal loads.
- | Design Year ADT | Offset—each side (meters) |
|-----------------|---------------------------|
| 0–750 | 0 |
| 751–2000 | 0.3 |
| 2001–4000 | 0.6 |
| > 4000 | 0.9 |
- (j) Includes provision for 75 mm HMA overlay. Vertical clearance is maintained above all lanes and shoulders. See Section 1C-2 for vertical clear zone guidelines.
- (k) The designer may provide additional vertical clearance when site conditions warrant.
- (l) May vary. Need to verify each railroad's requirement.

Ramps and Loops (English)

Definition: Facilities that allow access at interchanges.

	one-lane ramps		two-lane ramps		loops	
design speed (mph)	60 (a)		60 (a)		30 (b)	
clear zone (ft)	(c)		(c)		(c)	
maximum superelevation (%)	6		6		6	
horizontal curves—minimum length (ft)	300 (d)		300 (d)		NA	
vertical curves—minimum length (ft)	180 (d)		180 (d)		30 (d)	
crest vertical curves—desirable k	245 (d)		245 (d)		30 (d)	
sag vertical curves—minimum k	136 (d)		136 (d)		37 (d)	
stopping sight distance (ft)	570 (d)		570 (d)		200 (d)	
maximum gradient (%)	5 (e)		5 (e)		5 (e)	
lane width (ft)	16 (f)		24 (g)		18 (h)	
	left (i)	right (i)	left (i)	right (i)	left (i)	right (i)
shoulder width (ft)	4	6	(j)	(j)	4	6
shoulder type	(k)		(k)		(k)	
foreslope	6:1 (l)		6:1 (l)		6:1 (l)	
normal ditch (depth × width) (ft)	5 × 10 (m)		5 × 10 (m)		5 × 10 (m)	
backslope	2.5:1		2.5:1		2.5:1	
bridge width—new (ft)	lane widths + full shoulder width					
bridge width—existing (ft)	lane widths + 3-foot offset on each side (n)					
vertical clearance—over primary (ft)	16.5 (o)		16.5 (o)		16.5 (o)	
vertical clearance—over non-primary (ft)	15.0 (o)(p)		15.0 (o)(p)		15.0 (o)(p)	
vertical clearance—over railroad (ft)	23.0 (q)		23.0 (q)		23.0 (q)	
vertical clearance—under any structure (ft)	16.5 (o)		16.5 (o)		16.5 (o)	

- (a) Applicable to high speed merge/diverge areas and adjacent curves. Other curves along ramp should meet or exceed anticipated operating speed.
- (b) 25 mph and 35 mph design speeds are acceptable under certain conditions.
- (c) Depends on design speed, traffic volume, cross section, and horizontal alignment. See Section 1C-2 of this manual. Measured from edge-of-traveled way.
- (d) Based on design speed. See Section 6D-1 of this manual for more information regarding stopping sight distance and Section 6D-5 for more information regarding vertical curve design.
- (e) May be increased to 6% if steeper gradient complements desired vehicle operations.
- (f) If any portion of the ramp is designed with a radius between 150 and 249 feet, a lane width of 18 feet should be used for that portion.
- (g) Both lanes. Avoid degrees of curvature less than 9°30' to preclude lane-widening requirement.
- (h) 18 feet if the radius of the major portion of the loop curvature (not the tapers) is 150–250 ft. Otherwise, 16 feet. Radii less than 150 feet are not recommended.
- (i) When facing in the direction of travel.
- (j) Depends on ramp type. See Section 6B-1.
- (k) Shoulders for ramps shall be the same material as the mainline shoulders. Both shoulders of loops shall be paved.
- (l) Barn-roof cross section is acceptable at high-fill locations as illustrated on Typical 2113.
- (m) May use 4 × 8, 3 × 5, or swale depending on right-of-way impacts.
- (n) Design loading should be sufficient to accommodate legal loads. Bridge rail and approach guardrail should be upgraded, if necessary.
- (o) Includes provision for 3" HMA overlay. Vertical clearance is maintained above all lanes and shoulders. See Section 1C-2 for vertical clear zone guidelines.
- (p) The designer may provide additional vertical clearance when site conditions warrant.
- (q) May vary. Need to verify each railroad's requirement.

Ramps and Loops (Metric)

Definition: Facilities that allow access at interchanges.

	one-lane ramps		two-lane ramps		loops	
	left (i)	right (i)	left (i)	right (i)	left (i)	right (i)
design speed (km/h)	100 (a)		100 (a)		50 (b)	
clear zone (meters)	(c)		(c)		(c)	
maximum superelevation (%)	6		6		6	
horizontal curves—minimum length (meters)	100 (d)		100 (d)		NA	
vertical curves—minimum length (meters)	60 (d)		60 (d)		30 (d)	
crest vertical curves—desirable k	85 (d)		85 (d)		11 (d)	
sag vertical curves—minimum k	45 (d)		45 (d)		13 (d)	
stopping sight distance (meters)	185 (d)		185 (d)		65 (d)	
maximum gradient (%)	5 (e)		5 (e)		5 (e)	
lane width (meters)	4.8 (f)		7.2 (g)		5.5 (h)	
shoulder width (meters)	1.2	1.8	(j)	(j)	1.2	1.8
shoulder type	(k)		(k)		(k)	
foreslope	6:1 (l)		6:1 (l)		6:1 (l)	
normal ditch (depth × width) (meters)	1.5 × 3 (m)		1.5 × 3 (m)		1.5 × 3 (m)	
backslope	2.5:1		2.5:1		2.5:1	
bridge width—new (meters)	lane widths + shoulder widths					
bridge width—existing (meters)	lane widths + 0.9-meter offset on each side (n)					
vertical clearance—over primary (meters)	5.1 (o)		5.1 (o)		5.1 (o)	
vertical clearance—over non-primary (meters)	4.6 (o)(p)		4.6 (o)(p)		4.6 (o)(p)	
vertical clearance—over railroad (meters)	7.01 (q)		7.01 (q)		7.01 (q)	
vertical clearance—under any structure (meters)	5.1 (o)		5.1 (o)		5.1 (o)	

- (a) Applicable to high speed merge/diverge areas and adjacent curves. Other curves along ramp should meet or exceed anticipated operating speed.
- (b) 40 km/h and 60 km/h design speeds are acceptable under certain conditions.
- (c) Depends on design speed, traffic volume, cross section, and horizontal alignment. See Section 1C-2 of this manual. Measured from edge-of-traveled way.
- (d) Based on design speed. See Section 6D-1 of this manual for more information regarding stopping sight distance and Section 6D-5 for more information regarding vertical curve design.
- (e) May be increased to 6% if steeper gradient complements desired vehicle operations.
- (f) If any portion of the ramp is designed with a radius of 90 meters or less, a lane width of 5.5 meters should be used for that portion.
- (g) Both lanes. Avoid radii less than 250 meters to preclude lane widening requirement.
- (h) 5.5 meters if the radius of the major portion of the loop curvature (not the tapers) is 50–90 meters. Otherwise, 4.8 meters. Radii less than 50 meters are not recommended.
- (i) When facing in the direction of travel.
- (j) Depends on ramp type. See Section 6B-1.
- (k) Shoulders for ramps shall be the same material as the mainline shoulders. Both shoulders of loops shall be paved.
- (l) Barn-roof cross section is acceptable at high-fill locations as illustrated on Typical 2113.
- (m) May use 1.2 × 2.4, 1.0 × 1.5, or swale depending on right-of-way impacts.
- (n) Design loading should be sufficient to accommodate legal loads. Bridge rail and approach guardrail should be upgraded, if necessary.
- (o) Includes provision for 75 mm HMA overlay. Vertical clearance is maintained above all lanes and shoulders. See Section 1C-2 for vertical clear zone guidelines.
- (p) The designer may provide additional vertical clearance when site conditions warrant.
- (q) May vary. Need to verify each railroad's requirement.