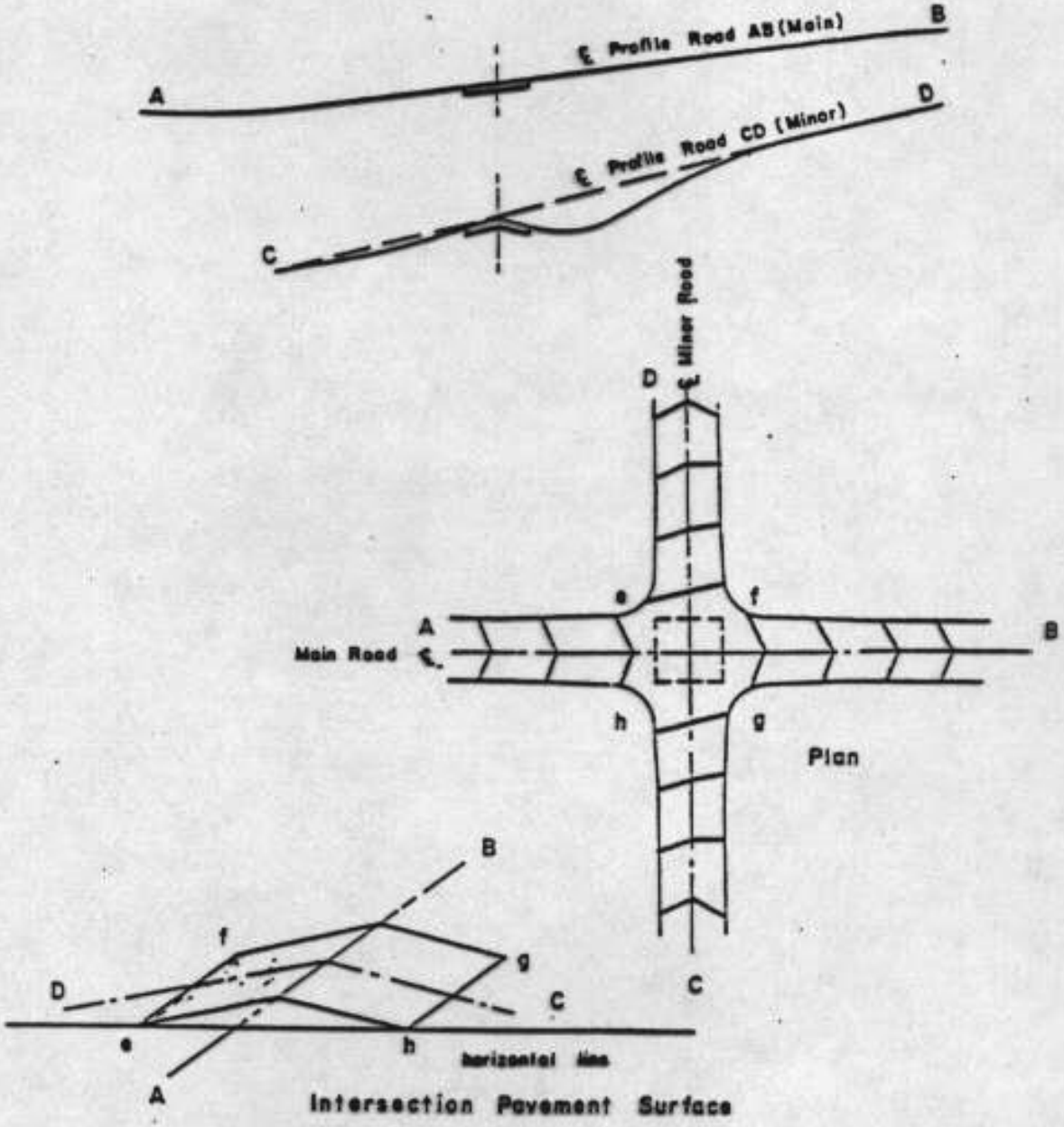
At-Grade Intersection Design

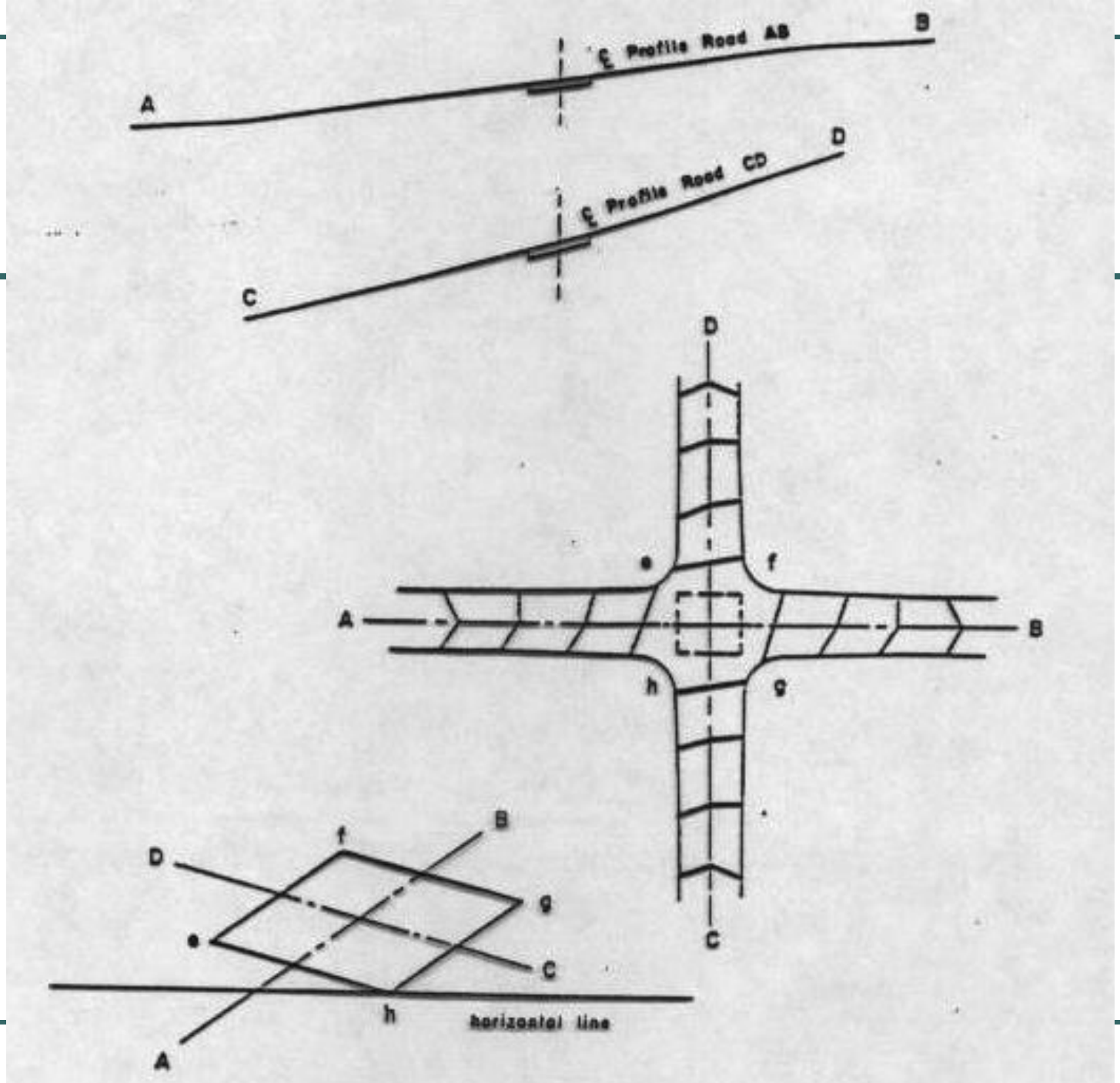
For a nice overview of intersection design, see
http://www.fhwa.dot.gov/environment/flex/ch08.htm

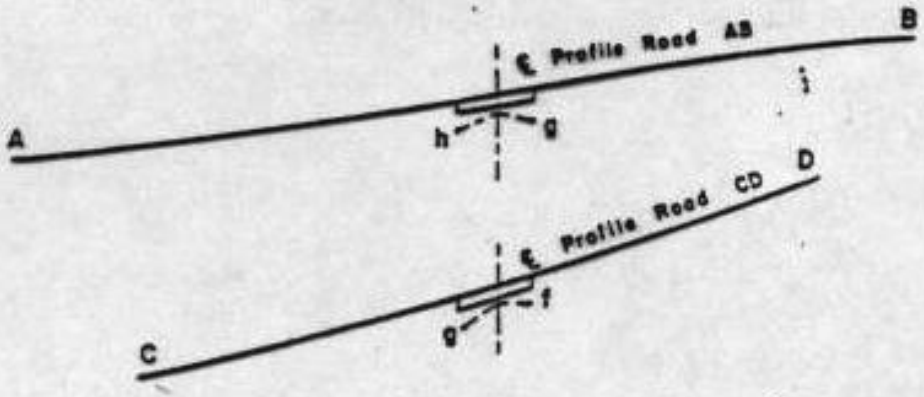
Objectives

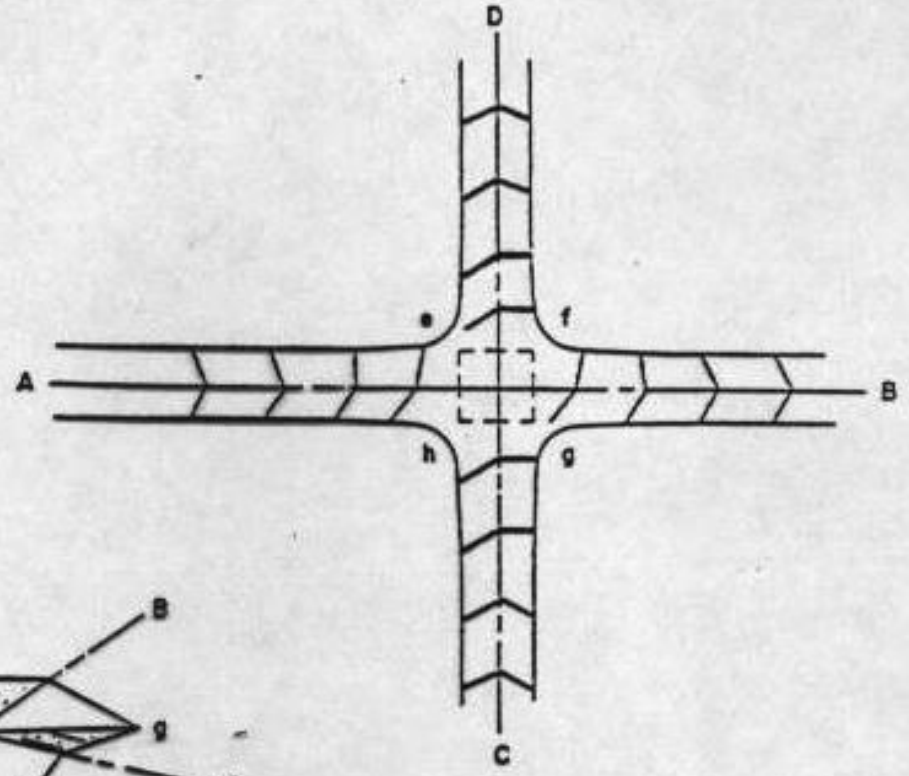
- Basic intersection dimensions
- Turning templates
- High-speed intersections
- Other considerations

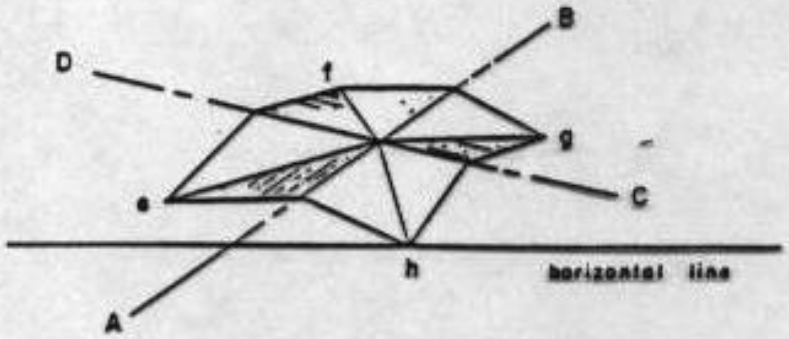


Source: Reference (4)


A
B
℄ Profile Road AB
C
D
℄ Profile Road CD
A
B
C
D
e
f
g
h
A
B
C
D
e
f
g
h
horizontal line


Profile Road AB
A
B
h
g
Profile Road CD
C
D
f


D
e
f
A
B
h
g
C


B
D
f
g
e
C
h
horizontal line
A

Design Vehicle

Highway Type	Design Vehicle
Rural Highways	
Interstate/freeway ramp terminals	WB-50
Primary arterials	WB-50
Minor arterials	WB-50 OR WB-40
Collectors	SU-30
Local Streets	SU-30
Urban Streets	
Freeway ramp terminals	WB-50
Primary arterials	WB-50 or WB-40
Minor arterials	WB-40 or B-40
Collectors	B-40 or SU-30
Residential/local streets	SU-30 or P

Source: www\fhwa\Flexibility in Highway Design - Chapter 8 - FHWA.htm

Curb Radius

- Factors of influence:
  - Design vehicle
  - Intersection angle
  - Approach width and parking
  - Channelization
  - Pedestrians
  - Allowable speed reduction

Curb Radius

- Green Book minimums assume:
  - Turning Speed ≤ 10 mph
  - Vehicle properly positioned beginning and end
  - Vehicle doesn't cross inner edge of pavement

Radius Designs

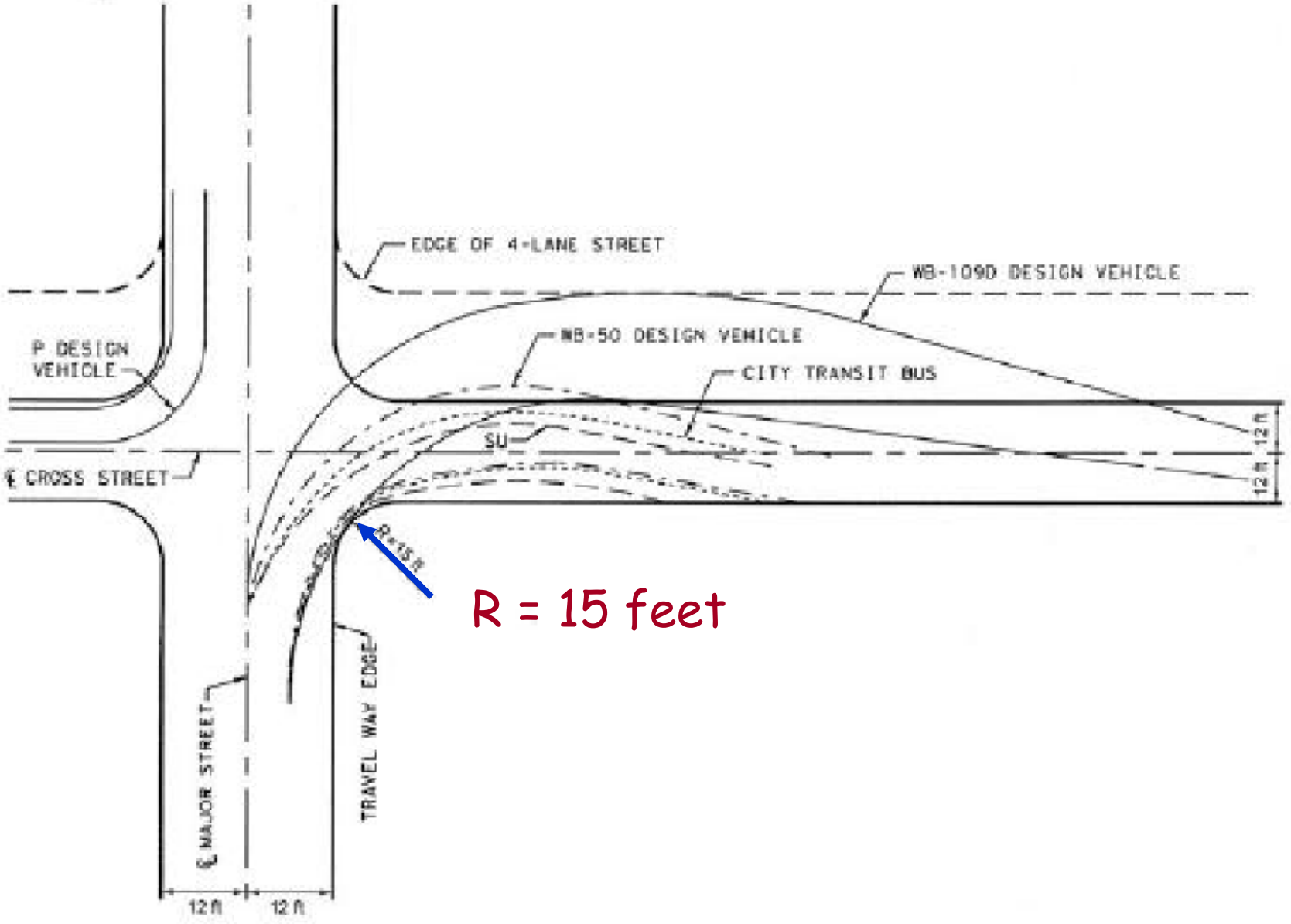
- Simple curve
  - Low speed collector, local streets
- Simple circle with taper
- 3-centered compound curve

Curb Radius

- General Guidance
  - 10 to 25 ft. local
  - 25 to 30 ft. collectors
  - 30 to 35 ft. unchannelized intersections with

Corner Radius	Operatoinal Characteristics
<5	Not appropriate for even P-design vehicles
10	Crawl-speed turn for P vehicles
20-30	Low speed turn for P vehicles: crawl-speed turn for SU vehicles with minor lane encroachment
40	Moderate speed turn for P vehicles; low-speed turn for SU vehicles with minor lane encroachment
50	Moderate-speed turns for all vehicles up to WB-50

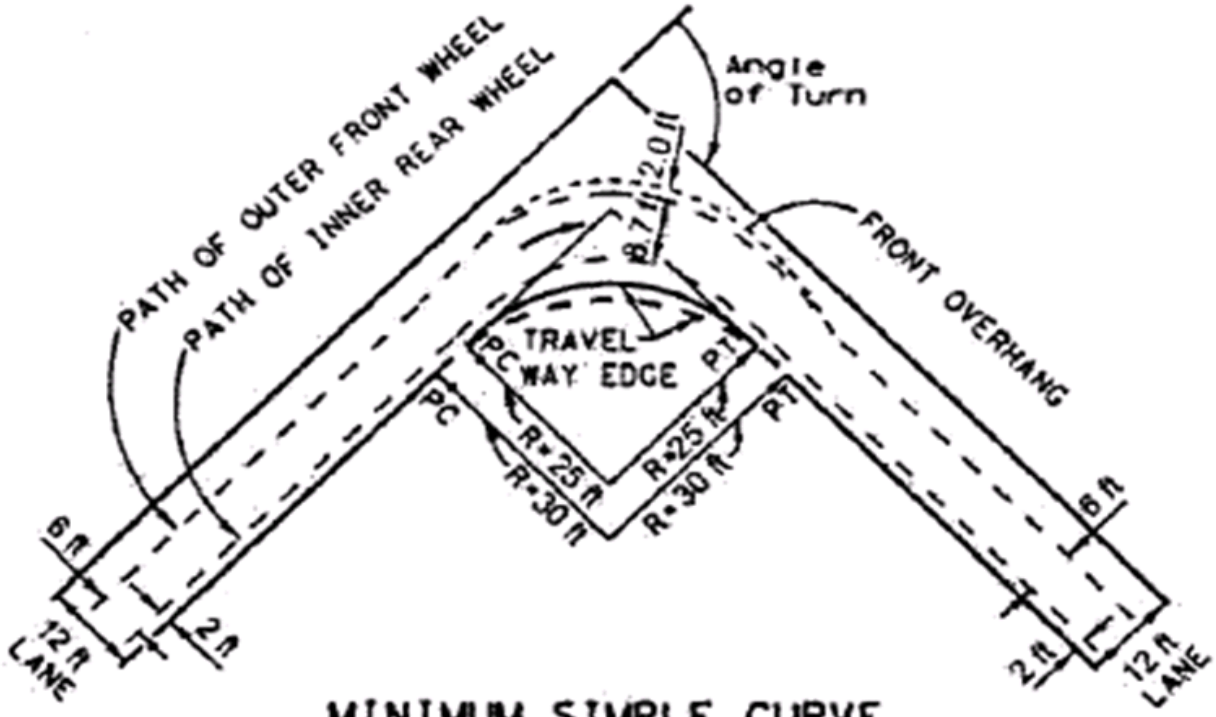
Source: www\fhwa\Flexibility in Highway Design - Chapter 8 - FHWA.htm



US Customary

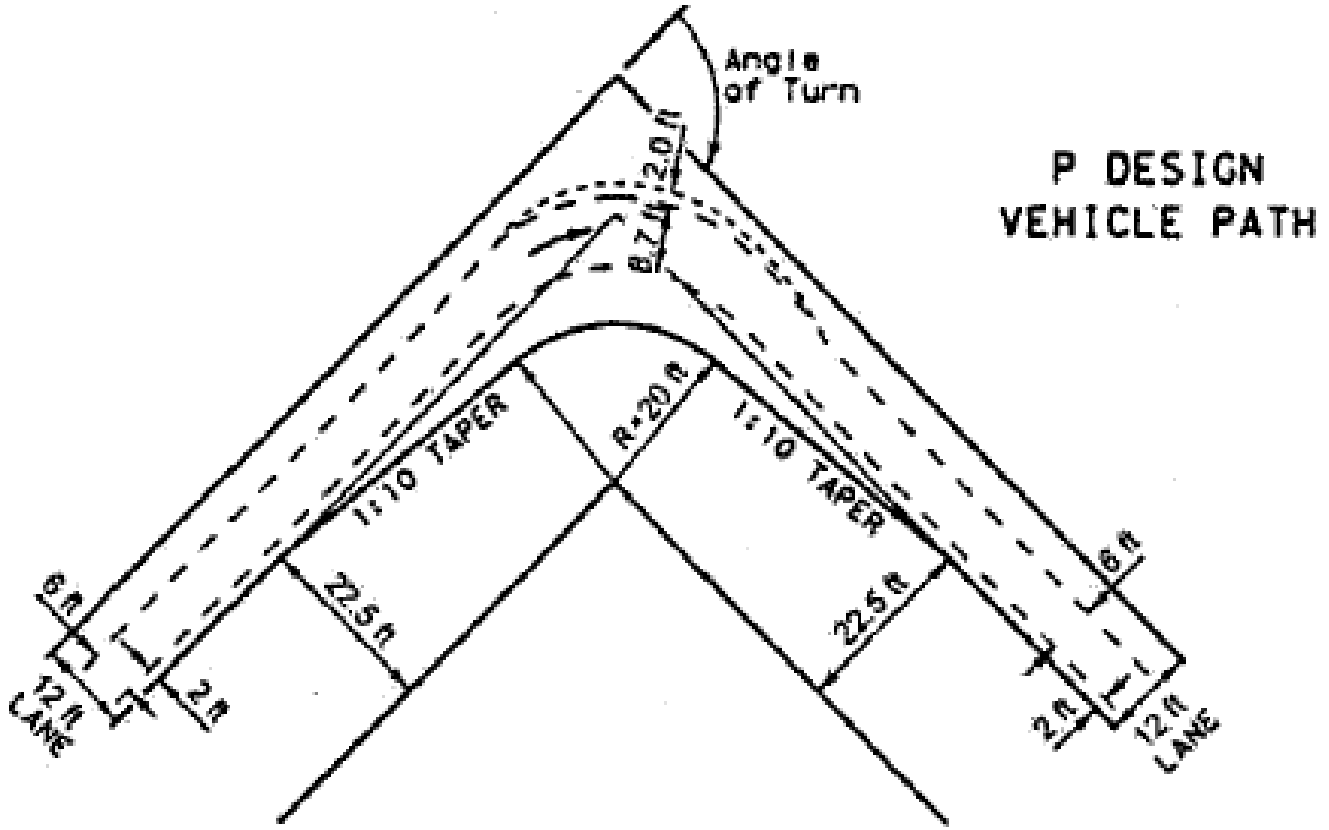
Exhibit 9-29. Effect of Curb Radii on Right Turning Paths of Various Design Vehicles

Simple Curve (passenger car template)



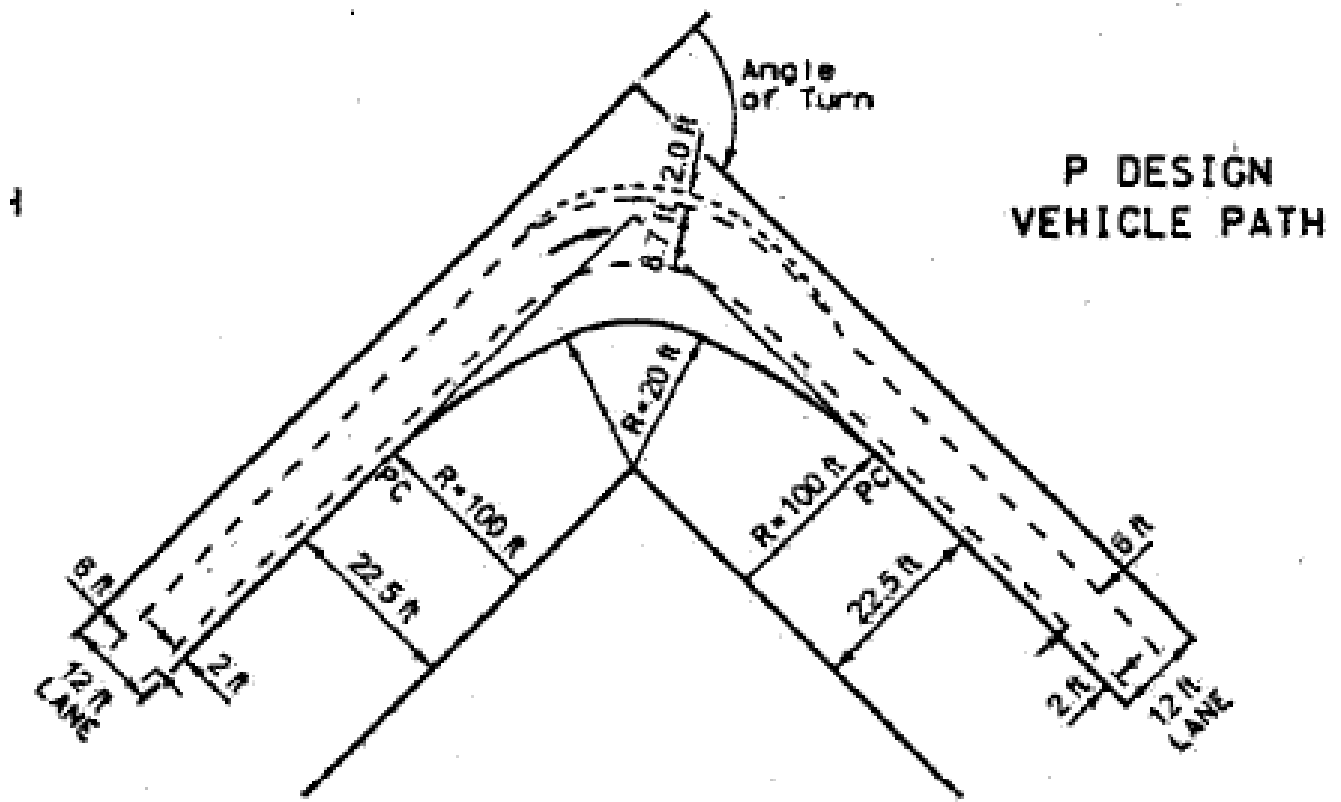
MINIMUM SIMPLE CURVE
25 ft OR 30 ft RADIUS
-A-

Simple Curve with Taper (passenger car template)



MINIMUM SIMPLE CURVE WITH TAPER 20 ft RADIUS, OFFSET 2.5 ft

Compound curves (passenger car template)



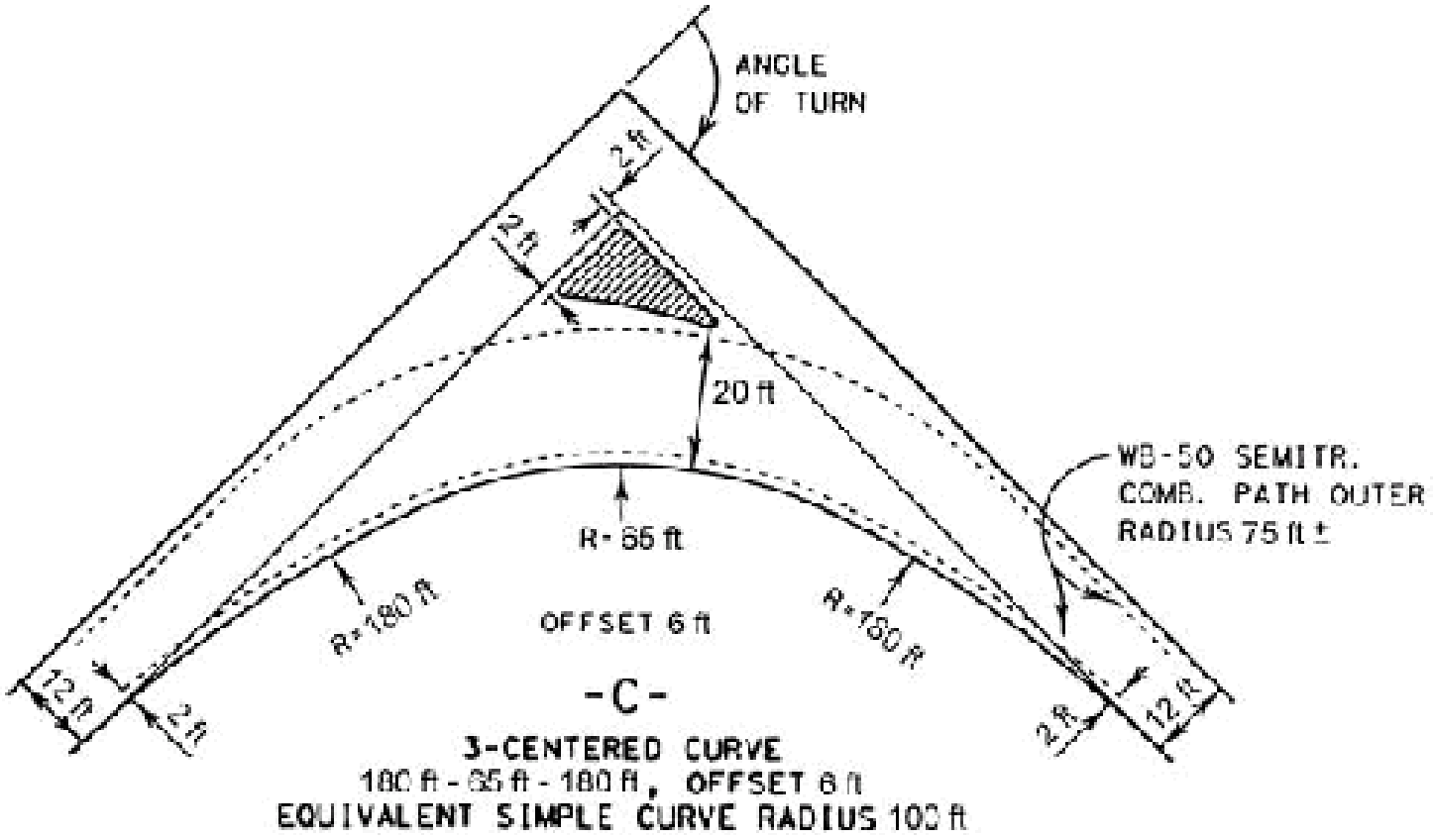
3 CENTERED COMPOUND CURVE WITH
100 ft - 20 ft - 100 ft RADII; OFFSET 2.5 ft

Metric						US Customary					
Angle of turn (degrees)	Design vehicle	Simple curve radius (m)	Simple curve radius with taper			Angle of turn (degrees)	Design vehicle	Simple curve radius (ft)	Simple curve radius with taper		
			Radius (m)	Offset (m)	Taper H:V				Radius (ft)	Offset (ft)	Taper H:V
75	P	11	8	0.6	10:1	75	P	35	25	2.0	10:1
	SU	17	14	0.6	10:1		SU	55	45	2.0	10:1
	WB-12	–	18	0.6	15:1		WB-40	–	60	2.0	15:1
	WB-15	–	20	1.0	15:1		WB-50	–	65	3.0	15:1
	WB-19	–	43	1.2	20:1		WB-62	–	145	4.0	20:1
	WB-20	–	43	1.3	20:1		WB-67	–	145	4.5	20:1
	WB-30T	–	26	1.0	15:1		WB-100T	–	85	3.0	15:1
	WB-33D	–	42	1.7	20:1		WB-109D	–	140	5.5	20:1
90	P	9	6	0.8	10:1	90	P	30	20	2.5	10:1
	SU	15	12	0.6	10:1		SU	50	40	2.0	10:1
	WB-12	–	14	1.2	10:1		WB-40	–	45	4.0	10:1
	WB-15	–	18	1.2	15:1		WB-50	–	60	4.0	15:1
	WB-19	–	36	1.3	30:1		WB-62	–	120	4.5	30:1
	WB-20	–	37	1.3	30:1		WB-67	–	125	4.5	30:1
	WB-30T	–	25	0.8	15:1		WB-100T	–	85	2.5	15:1
	WB-33D	–	35	0.9	15:1		WB-109D	–	115	2.9	15:1
105	P	–	6	0.8	–	105	P	–	20	2.5	–
	SU	–	11	1.0	–		SU	–	35	3.0	–
	WB-12	–	12	1.2	–		WB-40	–	40	4.0	–
	WB-15	–	17	1.2	15:1		WB-50	–	55	4.0	15:1
	WB-19	–	35	1.0	15:1		WB-62	–	115	3.0	15:1
	WB-20	–	35	1.0	15:1		WB-67	–	115	3.0	15:1
	WB-30T	–	22	1.0	15:1		WB-100T	–	75	3.0	15:1
	WB-33D	–	28	2.8	20:1		WB-109D	–	90	9.2	20:1

Exhibit 9–19. Edge-of-Traveled-Way Designs for Turns at Intersections (Continued)

Metric						US Customary					
Angle of turn (degrees)	Design vehicle	3-centered compound Curve radii (m)	Symmetric offset (m)	3-centered compound Curve radii (m)	Asymmetric (m)	Angle of turn (degrees)	Design vehicle	3-centered compound Curve radii (ft)	Symmetric offset (ft)	3-centered compound Curve radii (ft)	Asymmetric (ft)
75	P	30-8-30	0.6	–	–	75	P	100-75-100	2.0	–	–
	SU	36-14-36	0.6	–	–		SU	120-45-120	2.0	–	–
	WB-12	36-14-36	1.5	36-14-60	0.6–2.0		WB-40	120-45-120	5.0	120-45-195	2.0–6.5
	WB-15	45-15-45	2.0	45-15-69	0.6–3.0		WB-50	150-50-150	6.5	150-50-225	2.0–10.0
	WB-19	134-23-134	4.5	43-30-165	1.5–3.6		WB-62	440-75-440	15.0	140-100-540	5.0–12.0
	WB-20	128-23-128	3.0	61-24-183	0.3–3.0		WB-67	420-75-420	10.0	200-80-600	1.0–10.0
	WB-30T	76-24-76	1.4	30-24-91	0.5–1.5		WB-100T	250-80-250	4.5	100-80-300	1.5–5.0
	WB-33D	213-38-213	2.0	46-34-168	0.5–3.5		WB-109D	700-125-700	6.5	150-110-550	1.5-11.5
90	P	30-6-30	0.8	–	–	90	P	100-20-100	2.5	–	–
	SU	36-12-36	0.6	–	–		SU	120-40-120	2.0	–	–
	WB-12	36-12-36	1.5	36-12-60	0.6–2.0		WB-40	120-40-120	5.0	120-40-200	2.0–6.5
	WB-15	55-18-55	2.0	36-12-60	0.6–3.0		WB-50	180-60-180	6.5	120-40-200	2.0–10.0
	WB-19	120-21-120	3.0	48-21-110	2.0–3.0		WB-62	400-70-400	10.0	160-70-360	6.0–10.0
	WB-20	134-20-134	3.0	61-21-183	0.3–3.4		WB-67	440-65-440	10.0	200-70-600	1.0–11.0
	WB-30T	76-21-76	1.4	61-21-91	0.3–1.5		WB-100T	250-70-250	4.5	200-70-300	1.0–5.0
	WB-33D	213-34-213	2.0	30-29-168	0.6–3.5		WB-109D	700-110-700	6.5	100-95-550	2.0–11.5
105	P	30-6-30	0.8	–	–	105	P	100-20-100	2.5	–	–
	SU	30-11-30	1.0	–	–		SU	100-35-100	3.0	–	–
	WB-12	30-11-30	1.5	30-17-60	0.6–2.5		WB-40	100-35-100	5.0	100-55-200	2.0–8.0
	WB-15	55-14-55	2.5	45-12-64	0.6–3.0		WB-50	180-45-180	8.0	150-40-210	2.0–10.0
	WB-19	160-15-160	4.5	110-23-180	1.2–3.2		WB-62	520-50-520	15.0	360-75-600	4.0–10.5
	WB-20	152-15-152	4.0	61-20-183	0.3–3.4		WB-67	500-50-500	13.0	200-65-600	1.0–11.0
	WB-30T	76-18-76	1.5	30-18-91	0.5–1.8		WB-100T	250-60-250	5.0	100-60-300	1.5–6.0
	WB-33D	213-29-213	2.4	46-24-152	0.9–4.6		WB-109D	700-95-700	8.0	150-80-500	3.0–15.0

Exhibit 9-20. Edge of Traveled Way for Turns at Intersections (Continued)



US Customary

Exhibit 9-41. Minimum Turning Roadway Designs With Corner Islands at Urban Locations (Continued)

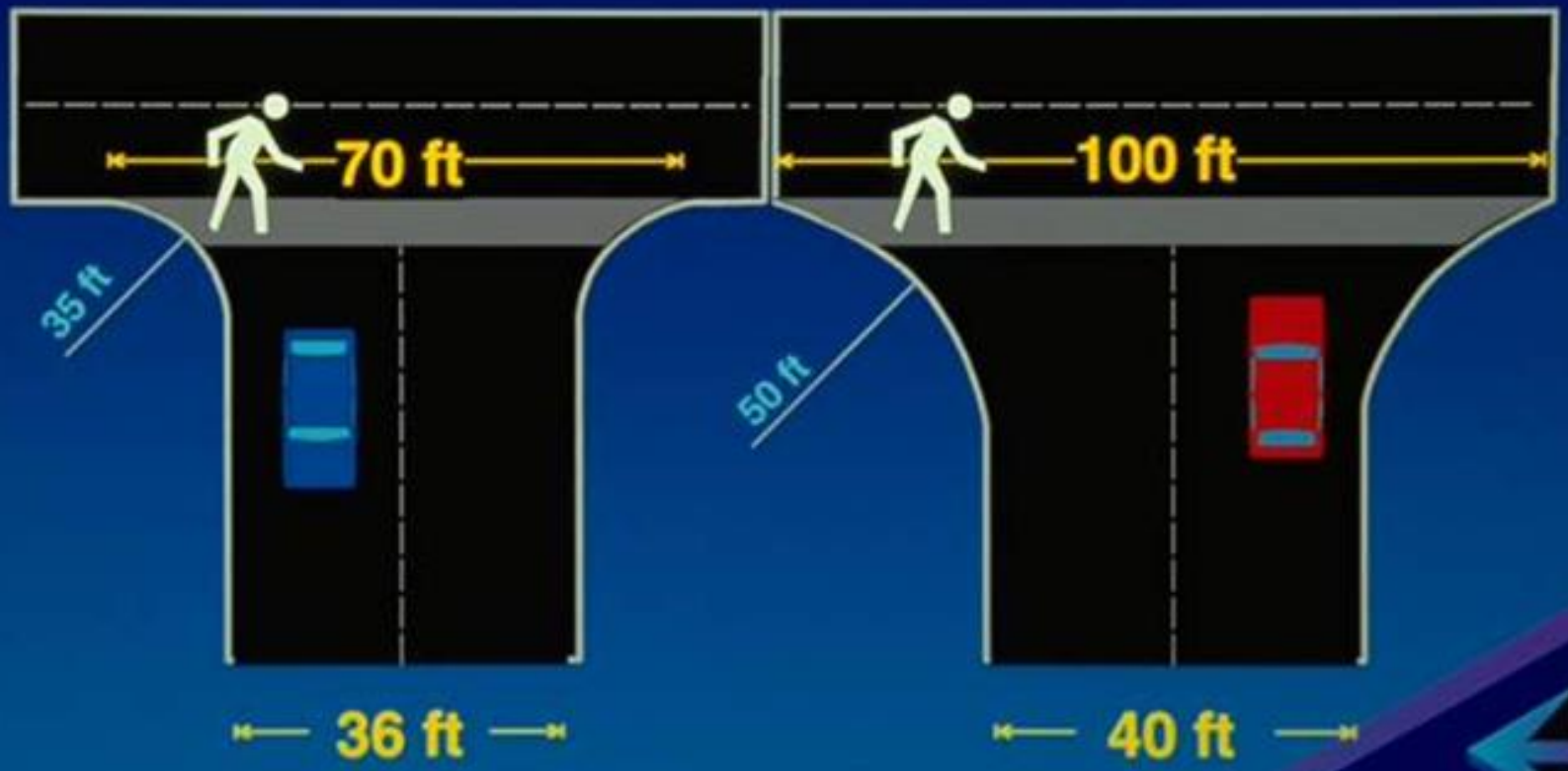
Higher Speed Turns

US Customary								
Design (turning) speed, V (mph)	10	15	20	25	30	35	40	45
Side friction factor, f	0.38	0.32	0.27	0.23	0.20	0.18	0.16	0.15
Assumed minimum superelevation, e/100	0.00	0.00	0.02	0.04	0.06	0.08	0.09	0.10
Total e/100 + f	0.38	0.32	0.29	0.27	0.26	0.26	0.25	0.25
Calculated minimum radius, R (ft)	18	47	92	154	231	314	426	540
Suggested minimum radius curve for design (ft)	25	50	90	150	230	310	430	540
Average running speed (mph)	10	14	18	22	26	30	34	36
Note: For design speeds greater than 45 mph, use values for open highway conditions.								

Exhibit 3-43. Minimum Radii for Intersection Curves

Intersection Design Considerations for Pedestrians

Pedestrian exposure due to very large radii



Provide median refuge to provide crossing in stages



Provision of crosswalks



Intersections on High Speed Rural Divided Expressways


ONE WAY
STOP
DIVIDED
HIGHWAY
YIELD


650TH AV
DO NOT
ENTER





High speed expressway intersections

- Iowa DOT is building many rural expressways
- At-grade intersections can be very dangerous
- Don't use traffic signals as a safety measure (in most cases) - leave as 2-way stop or replace with interchange
- There are alternate measures …

Alternate measures

- Double yellow center line and stop bars in the median
  - maintain and replace frequently
- More and longer left and right turn lane
  - Offset!
- Paved shoulders near the intersections
- "T" intersections
- Offset "T" intersections
  - much fewer conflict points
- Restricted median
  - allow lefts in and rights in and out
  - prohibit lefts out and cross traffic

Alternate measures

- Education about proper process via media (print or electronic)
  - stop, look left only and enter into the median
  - stop in the median
  - look right and then cross or turn left onto the expressway
- Advisory speed limit 10-mph below the posted speed
  - Signs on both sides (where fast aggressive drivers operate)
  - In low volumes, traffic may not slow down
  - In peak hours one slows – everyone slows



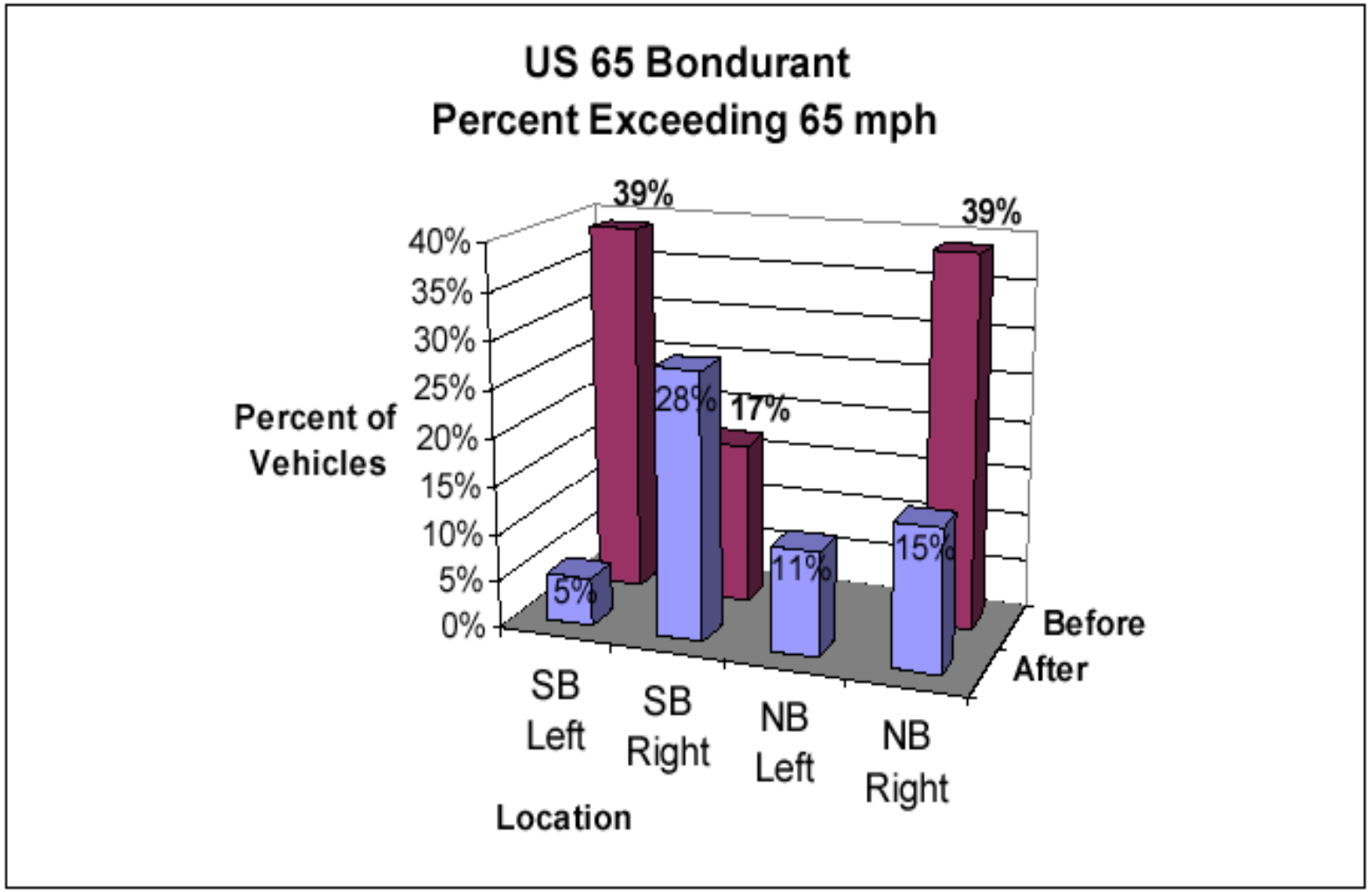
Picture showing advance advisory signs with flashing beacons on both sides of US 65 near Bondurant.



Close-up picture of sign installation on US 65 near Bondurant.

US 65 Bondurant Example

- Speed study done before and after
  - Some problems with the speed plates
  - Intense enforcement during the before and after period
  - Data show promise



Comparison of percent of vehicles exceeding 65 mph before and after the January 2002 installation of advance advisory 45 mph speed signs were posted with flashing yellow beacons. Before data for NB Left was not recorded.

Another idea …

- median sign west on Boone on US-30
- Initially solar powered strobe light above the sign to draw attention
- was distracting to drivers on US- 30



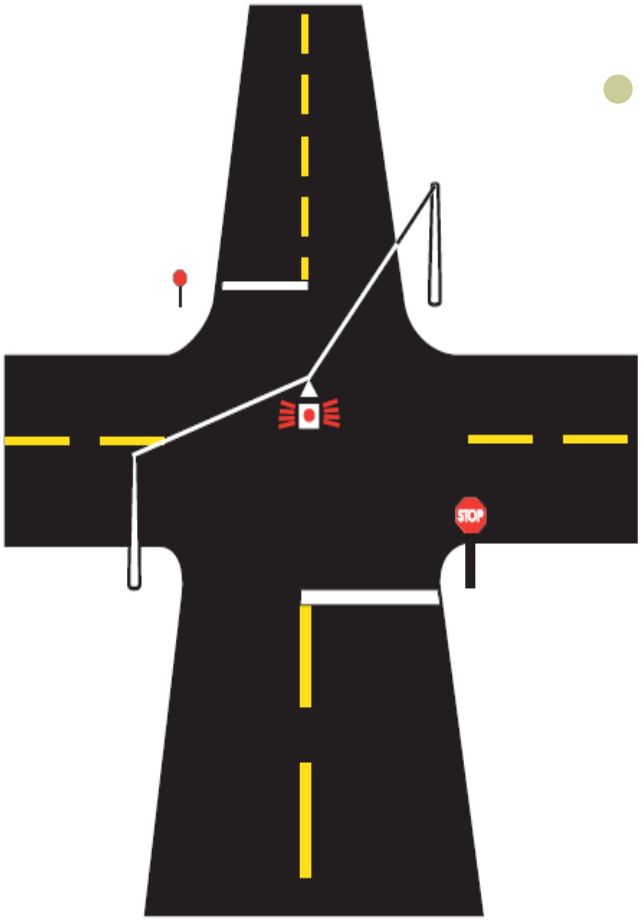
Median signing. US 30 west of Boone.

Change Blindness

- A psychological phenomenon
- Lots of roadside items = ease of estimating speed
- Clean roadside = not so easy
- Gray/white/blue sky – lots of glare
- Older drivers



Overhead intersection beacons?



Typical intersection control beacon installation

- Recent research in Minnesota
  - ineffective
  - confuse motorists (drivers may think the flashing red beacon means 4-way stop)
  - now removing over head flashing intersection beacons in favor of red beacon on the stop sign



Another Idea

- Overhead lighting

Circular Intersections

- Rotaries: large diameter > 300 ft, allows speeds > 30 mph with minimum horizontal deflection of the path of through traffic
- Neighborhood traffic circle: small diameter, for local streets, traffic calming
- Roundabout
  - Yield control at each approach
  - Separation of conflicting movements
  - Speed < 30 mph (typically)







DuPont Circle, Washington, D.C. (Google Earth image)

Urbandale



- Image – Google Earth

A6 Motorway near Crooklands



- Image – Google Earth