Arterial Profiles Part A & B

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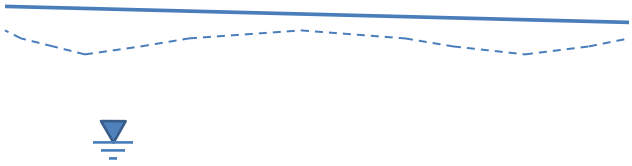
Objective

- Consider the following when developing an urban roadway profile:
  - Critical features
  - Criteria

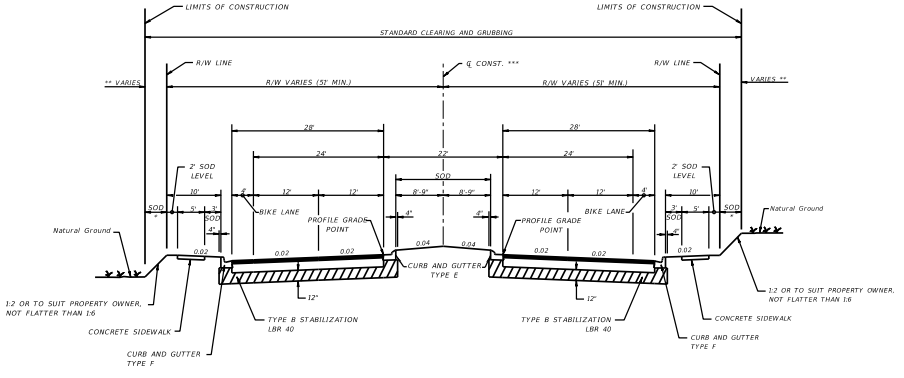


Typical Section

- Urban, Suburban or Rural
- Design Speed
- Divided or Undivided
- Number of Lanes
- Lane Widths
- Bicycle Lanes
- Sidewalk Width

Typical Section

- 4-lane Divided Urban

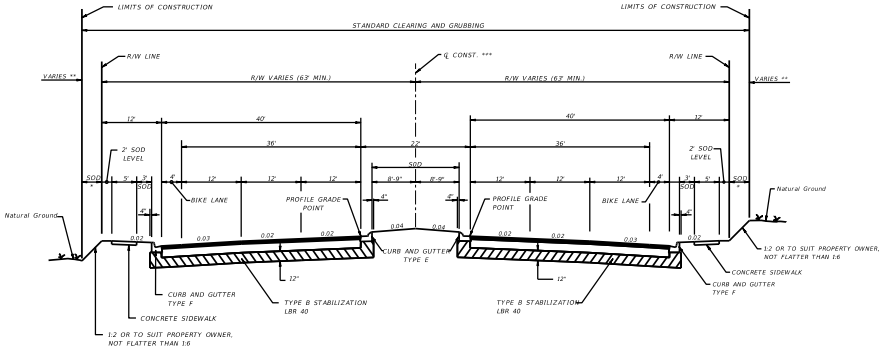


4-Lane Divided Urban

This is Mahan Drive (SR 10/US 90) in Tallahassee.

Typical Section

- 6-lane Divided Urban



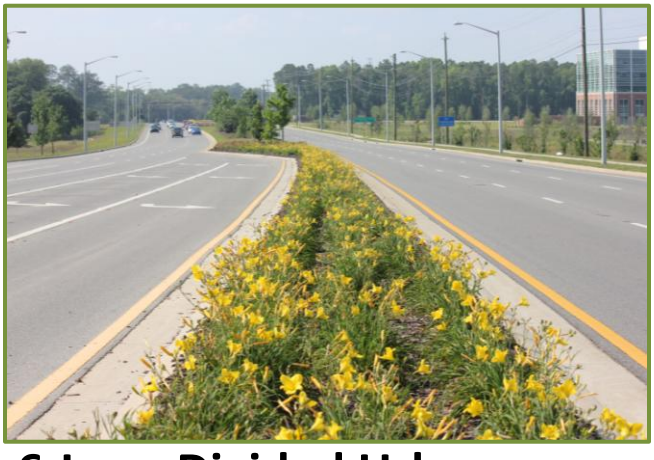
FIHS/SIS Design Speed

Table 1.9.2 Minimum Design Speed
FIHS/SIS

Facility		Minimum Design Speed (mph)
Interstate and Freeways	Rural and Urban*	70
	Urbanized*	60
Arterials	Rural*	65
	Urban and Urbanized*	50**

* Terms based on definitions contained in ***FIHS Procedure (Topic No. 525-030-250)***

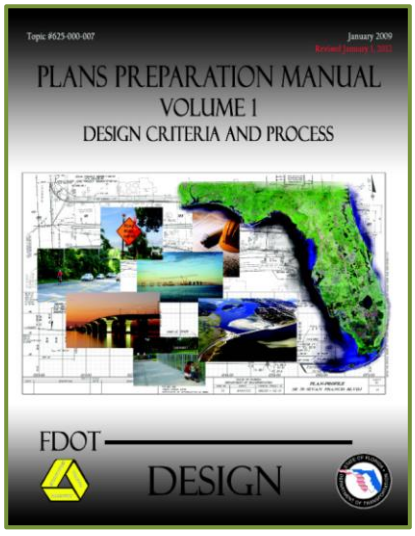
** For curb and gutter facilities where existing posted speed is 45mph or less and Access Management Class 3 is proposed, a design speed of 45mph may be used.



6-Lane Divided Urban

This is SE Capital Circle (SR 261/US 319) in Tallahassee. This is a six lane divided urban road with bicycle lanes and sidewalks. The posted speed is 45 mph.

PPM Vol. I Profile Criteria



PPM Vol. I Profile Criteria

- Chapter 2 Design Geometrics and Criteria
  - New Construction
  - Major Reconstruction

Table 2.6.1

- Table 2.6.1

Table 2.6.1 Maximum Grades

MAXIMUM GRADES IN PERCENT

TYPE OF HIGHWAY	AREA	DESIGN SPEED (mph)											
		FLAT TERRAIN						ROLLING TERRAIN					
		30	40	45	50	60	70	30	40	45	50	60	70
FREEWAYS [1]	Rural	----	----	4	4	3	3	----	----	----	5	4	4
	Urban	----	----	4	4	3	3	----	----	----	5	4	4
ARTERIALS [2]	Rural	8	7	6	6	5	----	9	8	7	7	6	----
	Urban	8	7	6	6	5	----	9	8	7	7	6	----
COLLECTORS [3]	Rural	7	7	7	6	5	4	9	8	8	7	6	5
	Urban	9	9	8	7	6	5	11	10	9	8	7	6
	Industrial [2]	4	4	4	3	3	----	5	5	5	4	4	----
FRONTAGE ROADS	Require same criteria as Collectors.												

RAMPS	DESIGN SPEED (mph)	< 20	25 to 30	35 to 40	45 to 50
	GRADES (%)	8	7	6	5

One-way descending grades on Ramps may be 2% greater, in special cases.

1. Interstate designed to 70 mph will be restricted to 3% maximum grade.
2. Areas with significant (10% or more) heavy truck traffic.
3. On 2-lane highways critical length of upgrades shall not be exceeded. Critical lengths are those which reduce the speeds of 200 lb/hp trucks by more than 10 mph.

Table 2.6.2 & 2.6.3

- Table 2.6.2 Maximum Change in Grade Without Vertical Curves

Table 2.6.2 Maximum Change in Grade Without Vertical Curves

DESIGN SPEED (mph)	20	30	40	45	50	60	65	70
MAXIMUM CHANGE IN GRADE IN PERCENT	1.20	1.00	0.80	0.70	0.60	0.40	0.30	0.20

- Table 2.6.3 Criteria for Grade Datum

Table 2.6.4

- Table 2.6.4 Grade Criteria for Curb and Gutter Sections

Table 2.6.4 Grade Criteria for Curb and Gutter Sections

GRADES ON CURB AND GUTTER SECTIONS	
Minimum Distance Required between VPI's	250 ft.
Minimum Grade (%)	0.3 %

Table 2.8.5

Table 2.8.5 Minimum Lengths of Crest Vertical Curves Based on Stopping Sight Distance

K VALUES FOR CREST CURVES		
Design Speed (mph)	**Interstate**	**All Other Facilities**
15	----	5
20	----	10
25	----	19
30	----	31
35	----	47
40	----	70
45	----	98
50	----	136
55	245	185
60	313	245
65	401	313
70	506	401

Length, L = KA

Where: L = Minimum Length (feet)
K = Constant
A = Algebraic Difference In Grades (percent)

K values for crest vertical curves are based on an eye height of 3.5' and an object height of 6".

Interstates:	Lengths of crest vertical curves on Interstate mainlines are not to be less than 1000 ft. for open highways and 1800 ft. within interchanges.
Service Interchanges:	K values for ramp crest vertical curves at interstate terminals are not to be less than the Interstate K values. K values for other ramp crest vertical curves are not to be less than the K values for All Other Facilities.
System Interchanges:	K values for all crest vertical curves on systems interchanges are not to be less than the K values of the higher system.
Arterials and Collectors:	The minimum lengths of crest vertical curves for highways with design speeds of 50 mph or greater are as follows:

Design Speed (mph)	50	55	60	65	70
Minimum Length (ft.)	300	350	400	450	500

All Facilities: The lengths of crest vertical curves are not to be less than 3 times the design speed (mph) expressed in feet.

Table 2.8.6

Table 2.8.6 Minimum Lengths of Sag Vertical Curves Based on Stopping Sight Distance and Headlight Sight Distance

K VALUES FOR SAG CURVES		
Design Speed (mph)	Interstate	All Other Facilities
15	----	10
20	----	17
25	----	26
30	----	37
35	----	49
40	----	64
45	----	79
50	----	96
55	136	115
60	157	136
65	181	157
70	206	181

Length, L = KA
Where: L = Minimum Length (feet)
K = Constant
A = Algebraic Difference In Grades (percent)

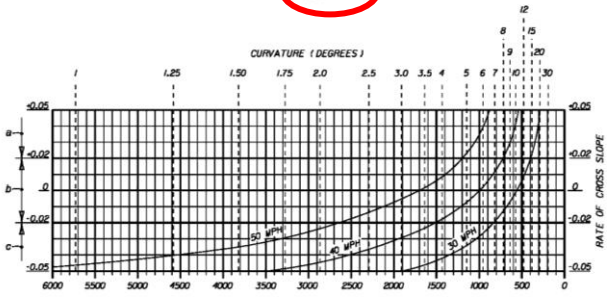
Interstates:	Lengths of sag vertical curves on Interstate mainlines are not to be less than 800 ft.
Service Interchanges:	K values for ramp sag vertical curves at interstate terminals are not to be less than the interstate K values. K values for other ramp sag vertical curves are not to be less than the K values for All Other Facilities.
System Interchanges:	K values for all sag vertical curves on systems interchanges are not to be less than the K values of the higher system.
Arterials and Collectors:	The minimum lengths of sag vertical curves for highways with design speeds of 50 mph or greater are as follows:

Design Speed (mph)	50	55	60	65	70
Minimum Length (ft.)	200	250	300	350	400

All Facilities:	The lengths of sag vertical curves are not to be less than 3 times the design speed (mph) expressed in feet.

Figure 2.9.2

Figure 2.9.2 Superelevation Rates for Urban Highways and High Speed Urban Streets (e_{max} = 0.05)



a. When the speed curves and the degree of curve lines intersect above this line, the pavement is to be superelevated (positive slope) at the rates indicated at the lines intersecting points.

b. When the speed curves and the degree of curve lines intersect between these limits, the pavement is to be superelevated at the rate of 0.02 (positive slope).

c. When the speed curves and the degree of curve lines intersect below this line, the pavement is to have normal crown (typically 0.02 and 0.03 downward slopes).

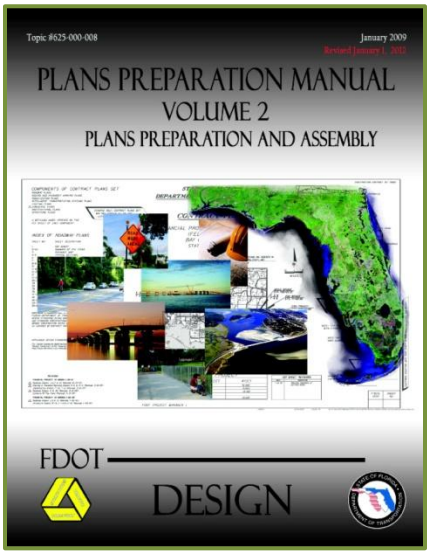
Table 2.9.2 & Section 2.10

- Table 2.9.2 Superelevation Rates for Urban Highways and High Speed Urban Streets (e_{max} = 0.05)
- Section 2.10 Vertical Clearance

PPM Profile Criteria

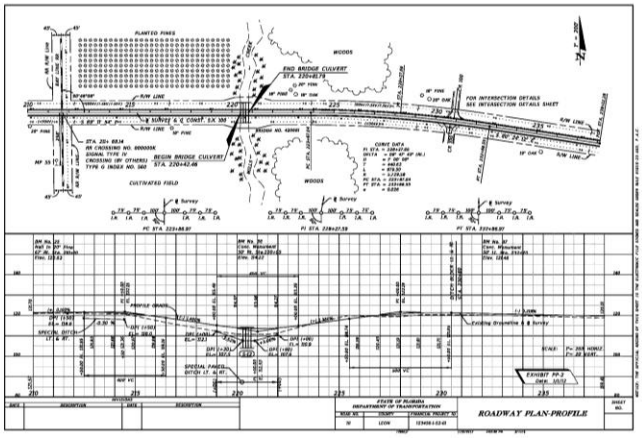
- Chapter 6 Railroad Crossing
- Chapter 8 Pedestrian, Bicycle and Public Transit Facilities
- Chapter 12 Right of Way
- Chapter 21 Transportation Design for Livable Communities
- Chapter 30 Retaining Walls

PPM Vol. II



PPM Vol. II

- Chapter 6 Typical Sections
- Chapter 10 Roadway Plan, Roadway Profile, and Roadway Plan-Profile
- Chapter 11 Special Profiles
- Chapter 12 Back-of-Sidewalk Profiles
- Chapter 18 Roadway Cross Sections
- Chapter 22 Miscellaneous Structures Plans



Plan and Profile Sheet

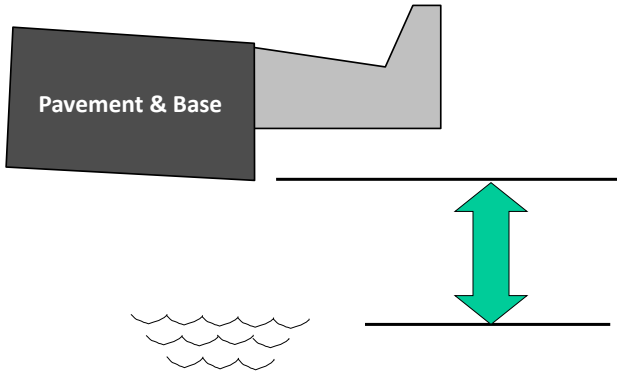
Critical Features in Part A

- Base Clearance
- Drainage
- Back of Sidewalk

Critical Features in Part B

- Driveways
- Intersections
- Paved Parking Areas
- Building Floor Elevations
- Vertical Clearance for Bridges

Base Clearance



High Water

Base Clearance

- High Water
  - Design High Water (DHW)
  - Seasonal High Water (SHW)
- Type of Facility
  - Freeways and Rural Multilane Mainline
  - Ramps
  - Low Point on Ramps at Cross Roads
  - Rural Two-lane with Design year ADT Greater than 1500 VPD
  - All Other Facilities Including Urban

Base Clearance

- Required Clearance (PPM Table 2.6.3 Criteria for Grade Datum)

Table 2.6.3 Criteria for Grade Datum

CLEARANCE FOR THE ROADWAY BASE COURSE ABOVE THE BASE CLEARANCE WATER ELEVATION	
TYPE FACILITY	**REQUIRED CLEARANCE**
Freeways and Rural Multilane Mainline	3 ft.
Ramps (proper)	2 ft. [1]
Low Point on Ramps at Cross Roads	1 ft. [1]
Rural Two-lane with Design Year ADT Greater than 1500 VPD	2 ft. [1]
All Other Facilities Including Urban	1 ft. [1]

1. This clearance requires a reduction in the design resilient modulus (see the ***Flexible Pavement Design Manual***). Notify the Pavement Design Engineer that the clearance is less than 3 feet.

Base Clearance

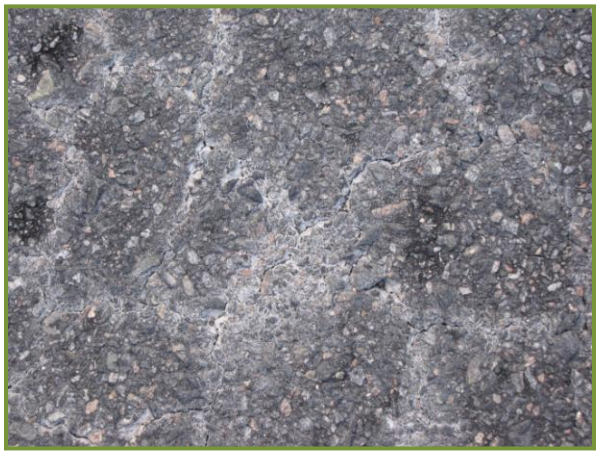
- Resilient Modulus (Flexible Pavement Design Manual Section 5.2.2)
  - Base Clearance < 3 ft. Reduce Design Resilient Modulus
    - 2 ft. clearance modulus reduced 25%
    - 1 ft. clearance modulus reduced 50%
      - Thicker pavement structure
      - Significant construction problems
      - Dewatering to achieve compaction

Avoid inadequate base clearance

Alligator cracking due to insufficiently designed pavement. This will include inadequate base clearance without a reduction in resilient modulus.

Avoid inadequate base clearance

Alligator cracking with fines bleeding though to the surface.



Avoid inadequate base clearance

An up-close view of alligator cracking with fines bleeding though to the surface.

Some things can't be avoided.

This is an example of a sink hole.

Drainage

- Minimum Grade
- Spread
- Curb Returns
- Driveways
- Back of Sidewalk
- Basin Divides

Minimum Grade

- **Minimum longitudinal gutter grade is 0.3%** (Drainage Manual Section 3.8.1)

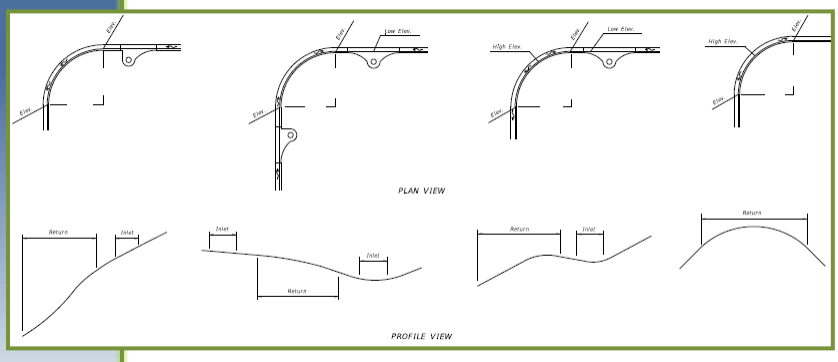
What to avoid

Bird bath created by insufficient profile and construction issues. The cost of a drainage system to fix these minor locations is significantly more costly than a proper profile.

Spread

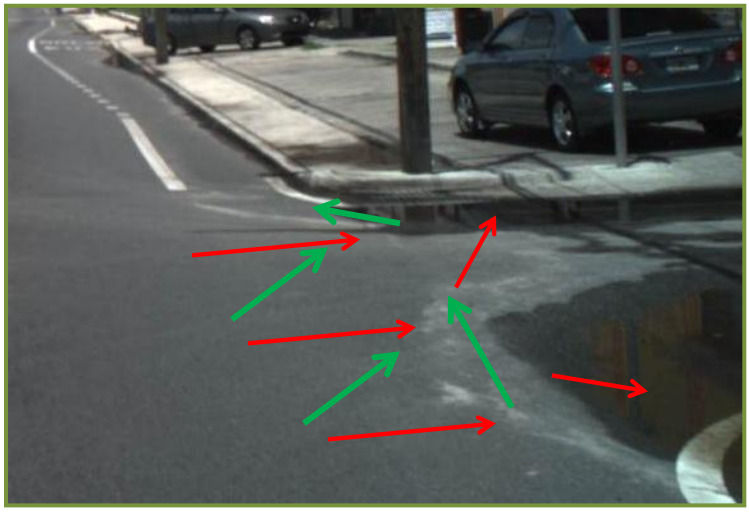
- Spread limits established by design speed and typical section
  - Based on 4 in/hr rainfall intensity
  - Maximum inlet spacing
- Bridge ends with shoulder gutter
  - Require 10 yr design frequency check

Curb Returns



- Curb Return Profiles Index 303
- Limit water flowing to and from our roadway
- Apply flow patterns to driveways as well

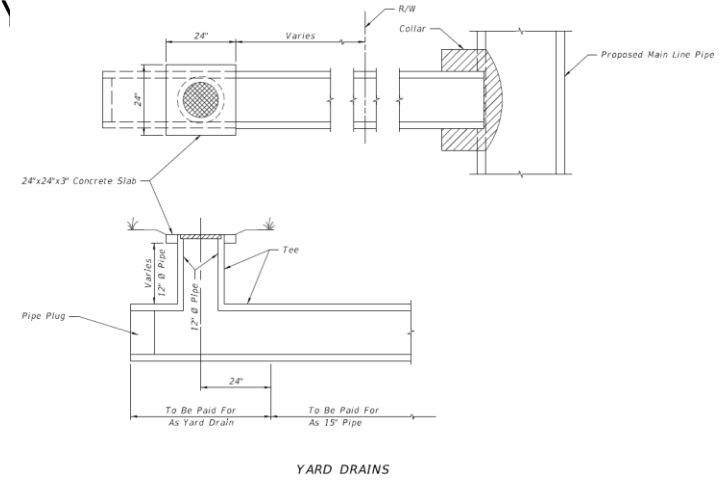

NORTH
45
411 PAIN



Back of Sidewalk Drainage (Index 282)

- Back of sidewalk Inlets
  - Used for significant offsite flow towards roadway

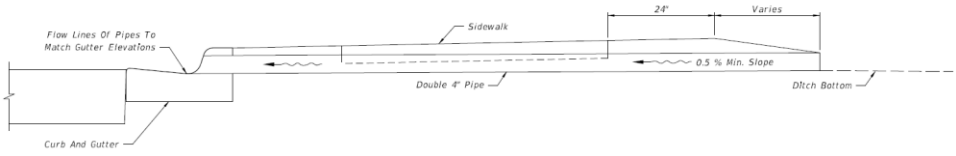
Back of Sidewalk Drainage (Index 282)



YARD DRAINS

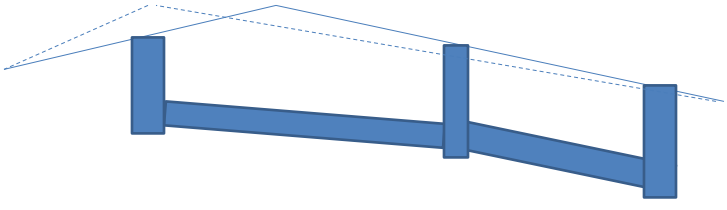
Back of Sidewalk Drainage (Index 282)

- Dual 4” pipes through sidewalk
  - Consider maintenance before using



Basin Divides

- Does not need to correlate to roadway profile high points



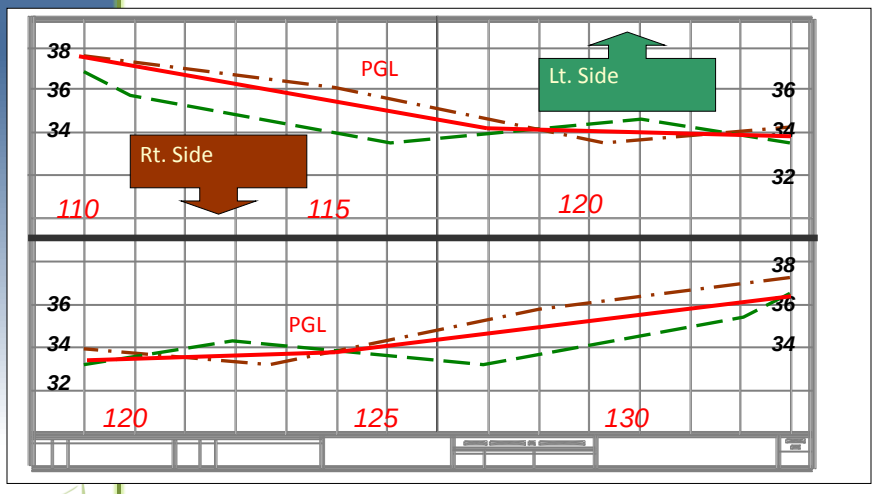
Back of Sidewalk

- Establish profile grade
- Minimize disturbance or rework of adjoining properties
- Constructability
- Checking of stormwater trapped behind the sidewalks

Back of Sidewalk

- PPM Volume II Chapter 12
  - Optional
  - Right and Left Sidewalk

Back of Sidewalk



Back of Sidewalk

Summary of Part A

Covered typical section, profile criteria and the following critical features for developing an urban roadway profile:

- Base Clearance
  - High Water (DHW and SHW)
  - Type of Facility
  - Required Clearance (Table 2.6.3 Criteria for Grade Datum)
  - Base Clearance < 3 ft. Reduce Design Resilient Modulus

Summary of Part A

- Drainage
  - Minimum Grade
  - Spread
  - Curb Returns
  - Driveways
  - Back of Sidewalk

Summary of Part A

- Back of Sidewalk
  - Establish profile grade
  - Minimize disturbance or rework of adjoining properties
  - Constructability
  - Checking of stormwater trapped behind the sidewalk

Questions?

Arterial Profiles Part B

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Part A

Covered typical section, profile criteria and the following critical features for developing an urban roadway profile:

- Base Clearance
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  - Type of Facility
  - Required Clearance (Table 2.6.3 Criteria for Grade Datum)
  - Base Clearance < 3 ft. Reduce Design Resilient Modulus

Part A

- Drainage
  - Minimum Grade
  - Spread
  - Curb Returns
  - Driveways
  - Back of Sidewalk

Part A

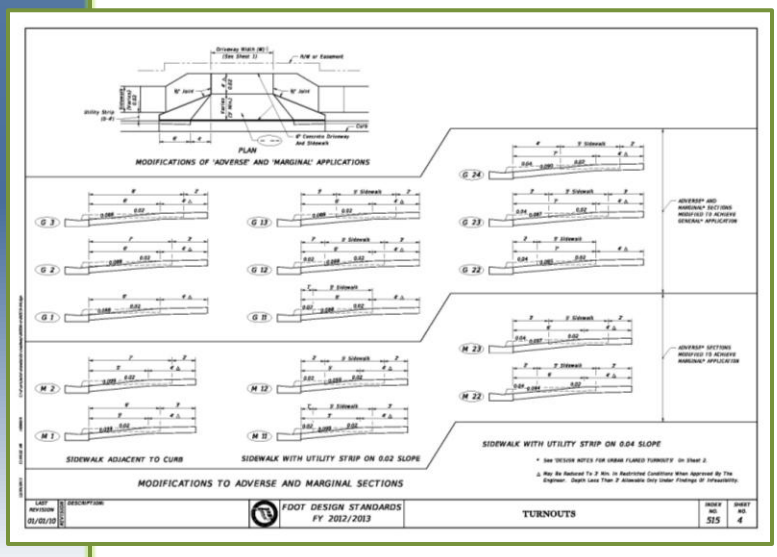
- Back of Sidewalk
  - Establish profile grade
  - Minimize disturbance or rework of adjoining properties
  - Constructability
  - Checking of stormwater trapped behind the sidewalk

Critical Features in Part B

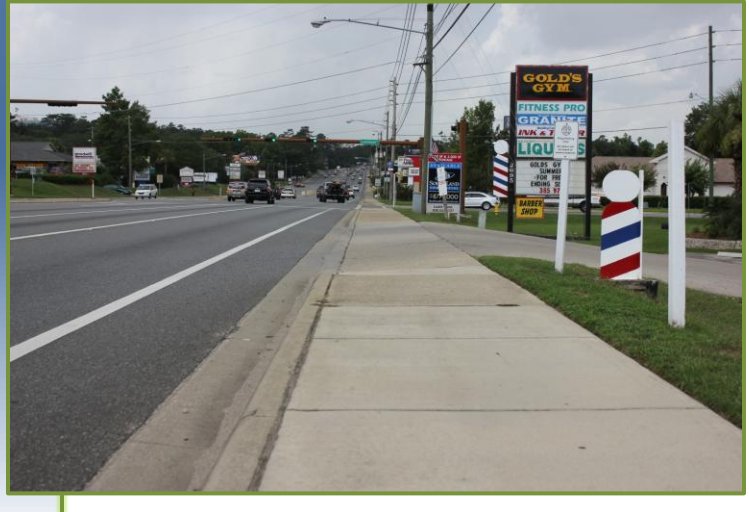
- Driveways
- Intersections
- Paved Parking Areas
- Building Floor Elevations
- Vertical Clearance for Bridges

Driveways

- Standard Index 515
- PPM
- Driveway Information Guide



Index 515



Don't forget about Pedestrians

Avoid steep driveways

Intersections

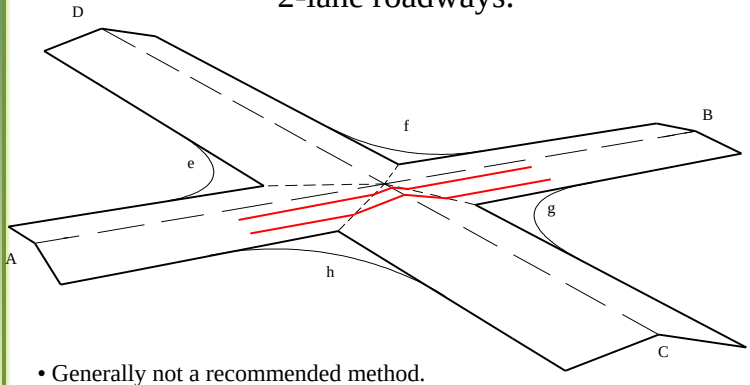
- Major Roads
- Minor Roads
- Railroad

Intersection Profile Methods for Intersecting Roads

- Intersect Crowned Roads
- Major Roadway Controls
- Warp Crowns into a Plane
- Plateauing

Intersect Crowned Roads

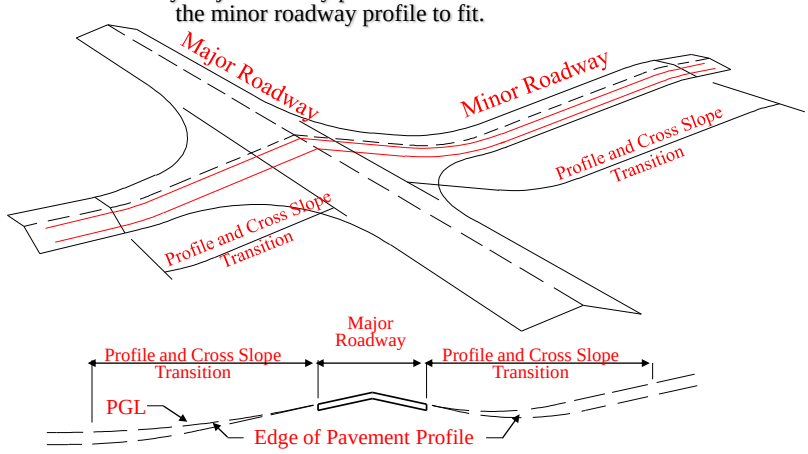
Intersect both crowned roadways, adjusting PGL's to intersect and the edges of pavement to intersect. Generally used at intersections of 2-lane roadways.



- Generally not a recommended method.
- Rider comfort may be an issue at higher speeds.

Major Roadway Controls

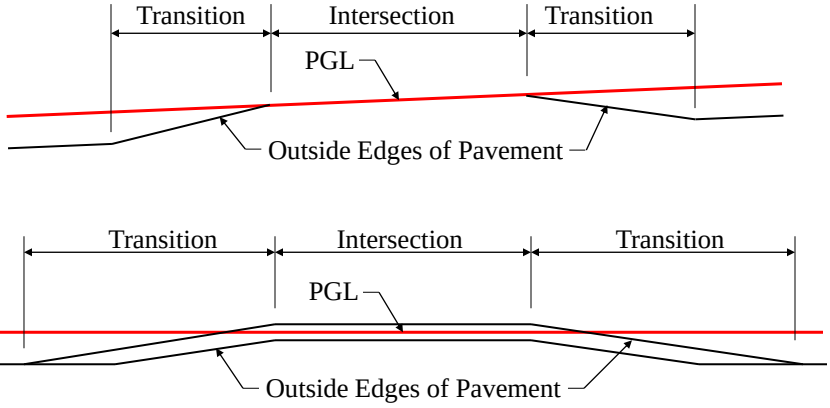
Carry major roadway profile and section thru the intersection and transition the minor roadway profile to fit.



- 'STOP' and Signal controlled intersections.
- Must verify sight distance for Crossing movement.
- Rider comfort may be an issue at higher speeds.
- Highly applicable when improving minor roadway, minimizes impacts in major roadway.

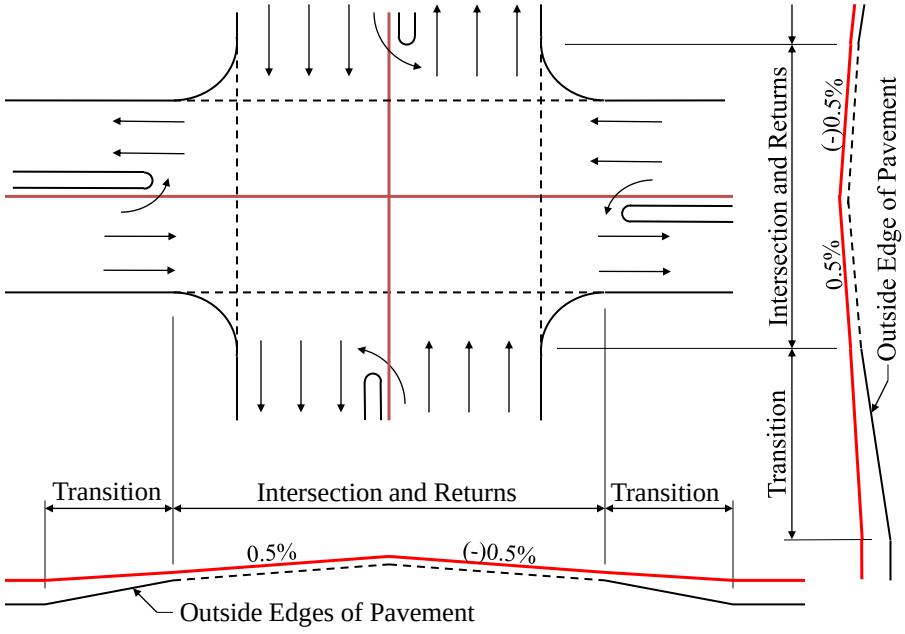
Warp Crowns into a Plane

Warp the crowns of both roads into a plane at the intersection.

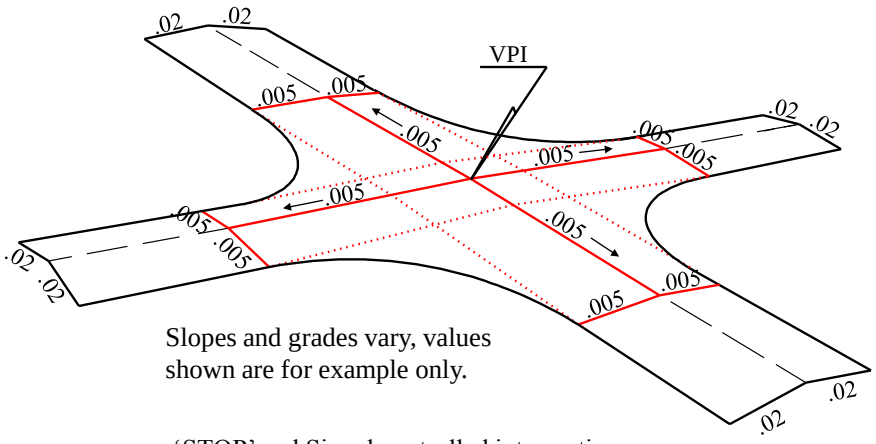


- 'STOP' and Signal controlled intersections.
- Applicable to both 2L/2W and Multi Lane Divided intersections.
- 'Plane' must have enough slope for drainage.

Plateauing



Plateauing



Slopes and grades vary, values shown are for example only.

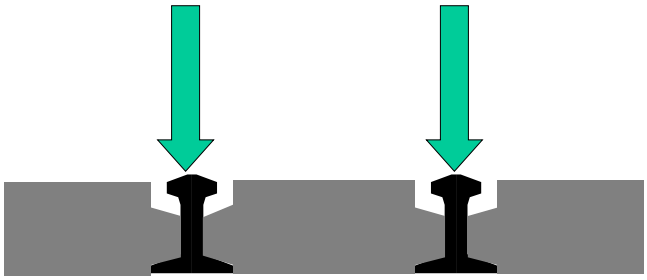
- 'STOP' and Signal controlled intersections.
- Can be applied to 2L/2W Roadways.
- Provides positive drainage.

Intersecting Roads

- PPM
- Intersection Design Guide
- Highway Capacity Manual

Railroad Crossings

- PPM
- Manual on Uniform Traffic Control Devices (MUTCD)
- Florida Greenbook Chapter 7 and 9
- Design Standards Index 560, 600, 635, 700, 17346, 17347,17881, and 17882
- Rail Handbook
  - http://www.dot.state.fl.us/rail/publications.shtm



Railroad Crossing

Railroad at Grade Crossing

Maintenance of Traffic

- Constructability
- Traffic at Intersections

Paved Parking Areas

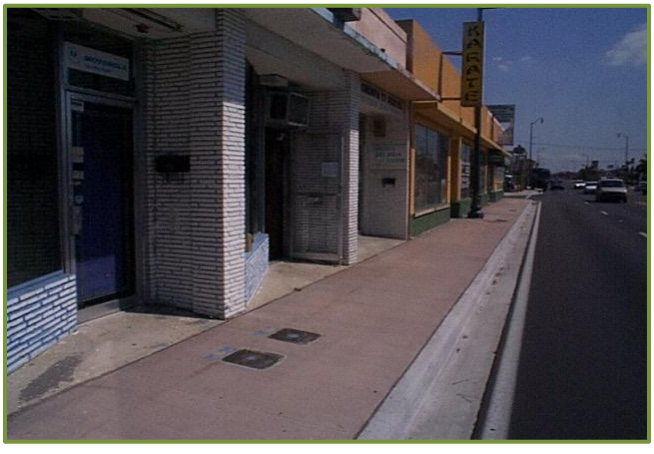
- ADA
- Elevation Differences

Building Floor Elevations

- ADA
- Elevation Differences

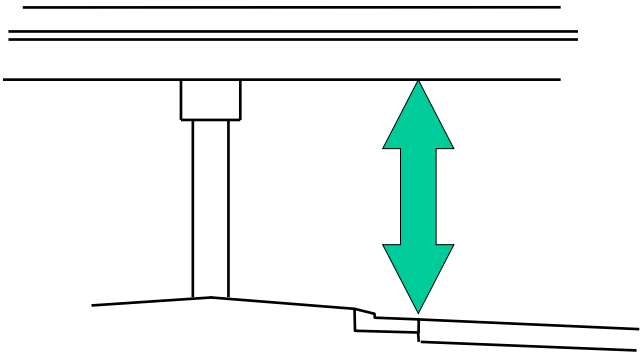
This is downtown Tallahassee.

This is on Calle Ocho in Miami



Vertical Clearance for Bridges

- PPM Volume 1 Chapter 2 Section 2.10 Vertical Clearance



Vertical Clearance

The vertical clearance varies for bridges depending on the type of traffic it serves (pedestrians, railroad, or automobiles).

Railroad Over Roadway

This bridge goes over South Monroe Street, just south of the Capital.

Roadway Over Roadway

This an I-95 bridge over West Granada Boulevard (SR 40) near Ormond Beach.

Pedestrian Over Roadway

This pedestrian bridge goes over Conner Boulevard in Tallahassee.

Roadway Over Railroad

This is North East Capital Circle (SR 319) over a rail road track.

Table 2.10.1

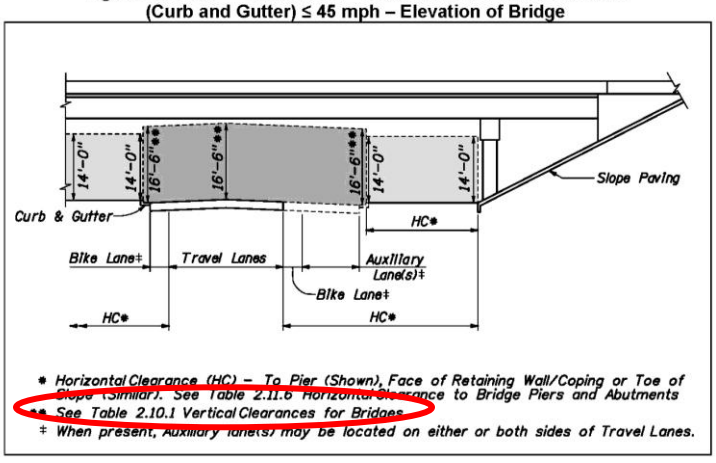
Table 2.10.1 Vertical Clearances for Bridges

FACILITY TYPE	CLEARANCE [1, 4, 6] (FEET)			
	Roadway or Railroad Over Roadway [2]	Roadway Over Railroad [3, 4, 5]	Pedestrian Over Roadway [2]	Pedestrian Over Railroad [3]
Freeways, Arterials Collectors & Others	16'-6"	23'-6"	17'-6"	23'-6"

1. Clearance Measurement:
   The least vertical distance between the bridge structure and the surface of the roadway (traffic lanes and shoulders) or the top of the highest rail.
2. Includes Future Underpass Resurfacing:
   6" over pavements.
3. Includes Rail Resurfacing (Track Raised):
   12" for conventional railroads.
   Others-see footnotes No. 4 and 5, and ***Section 6.3.5*** of this volume.
4. Over High Speed Rail Systems:
   See Department guidelines and specifications for Intermediate Class Rail Operations entitled ***Standard Specifications for the Design and Construction of Railways***.
5. Over Electrified Railroad:
   The minimum vertical clearance shall be 24 feet 3 inches. This provision is based on FDOT Policy for 25 KV service: ***South Florida Rail Corridor Clearance (Topic No. 000-725-003)***.
6. Clearance Over Waterways:
   See Department ***Drainage Manual, Topic No. 625-040-002, Chapter 4*** and ***Section 2.10.1*** of this volume.

Figure 2.10.4.A

Figure 2.10.4.A Clearances – Urban Arterials and Collectors (Curb and Gutter) ≤ 45 mph – Elevation of Bridge



Summary Part A & B

After selecting a typical section consider critical features for developing an urban roadway profile.

- Base Clearance
  - High Water (DHW and SHW)
  - Type of Facility
  - Required Clearance (Table 2.6.3 Criteria for Grade Datum)
  - Base Clearance < 3 ft. Reduce Design Resilient Modulus

Summary Part A & B

- Drainage
  - Minimum Grade
  - Spread
  - Curb Returns
  - Driveways
  - Back of Sidewalk

Summary Part A & B

- Back of Sidewalk
  - Establish profile grade
  - Minimize disturbance or rework of adjoining properties
  - Constructability
  - Checking of stormwater trapped behind the sidewalk
- Driveways

Summary Part A & B

- Intersections
  - Intersection Profile Methods for Intersecting Roads
  - Railroad Crossings
  - MOT
    - Constructability
    - Traffic at Intersections

Summary Part A & B

- Paved Parking Areas
- Building Floor Elevation
- Vertical Clearance for Bridges
  - Section 2.10 Vertical Clearance
  - Table 2.10.1 Vertical Clearances for Bridges

Questions?