23.3.9. Geometric Design Criteria

The criteria presented within this section are major controlling factors in the design of streets. It is expected that designers will carefully apply, with attention to detail, these criteria to individual design circumstances. Suitable transitional elements must be provided between changes in geometric configuration, pavement, curb, and drainage carrying aspects of the ultimate street design.

In the following section the major criteria governing:

1. General Design Critera
2. Horizontal Alignment
3. Superelevation
4. Vertical Alignment
5. Sight Distance
6. Intersection Design
7. Medians and Turn Lane Design

are presented with explanatory discussions of applications of the criteria followed by the requirements in table form.

The standards contained in the DPM are intended to provide direction in the design of transportation facilities. While most of the design parameters that should be used are provided in the following pages, unusual conditions may occur in some projects.

Where additional guidance and explanation is needed, the designer should refer to the current version of publications from the following sources:

- American Association of State Highway and Transportation Officials (AASHTO)
- Institute of Transportation Engineers (ITE)
- National Association of City Transportation Officials (NACTO)

Specific publications that may be referenced in the design process include:

- Highway Capacity Manual (HCM), Transportation Research Board
- Manual on Uniform Traffic Control Devices (MUTCD), Federal Highway Administration
- Public Right of Way Access Guide (PROWAG)

Note: many of the tables contained in the Geometric Design Criteria section of the DPM are taken from the 6th edition (2011) of the AASHTO publication, “A Policy on Geometric Design of Highways and Streets” (referred to as the AASHTO Green Book). Equivalent tables from updated versions of the AASHTO Green Book should be referenced when they become available.

23.3.9.1. General Design Criteria

Streets shall be designed to avoid long straight segments on residential streets and abrupt, inconsistent changes in either horizontal or vertical alignment. Balance is necessary to avoid hazardous situations and help meet driver expectations.

The fundamental approach to street design is to first identify the design speed for the facility; see Table 1 Street Elements. The nominal vehicle type must also be considered. The design is accomplished by selecting the appropriate characteristics to accommodate the design vehicle at the design speed in a safe and efficient manner at reasonable cost on a durable street.

23.3.9.2. Horizontal Alignment

Normal crown is generally preferred in urban streets to promote control of drainage and nuisance stormwater flows. This preference will lead to the use of longer radius horizontal curves in most major street circumstances.

Table **Error! No text of specified style in document.**-1 provides the minimum centerline radius for a normal road with a 2% crown or 2% cross-slope maximum. Roads with superelevation, cross-slopes greater than 2%, and with design speeds greater than 45 mph refer to the AASHTO Green Book (latest edition).

Table Error! No text of specified style in document.**-1 - Minimum Centerline Radius for a Normal Road**

Design Speed (mph)	Radius[1] (ft)
15	50
20	107[2]
25	198[2]
30	333
35	510
40	762
45	1039

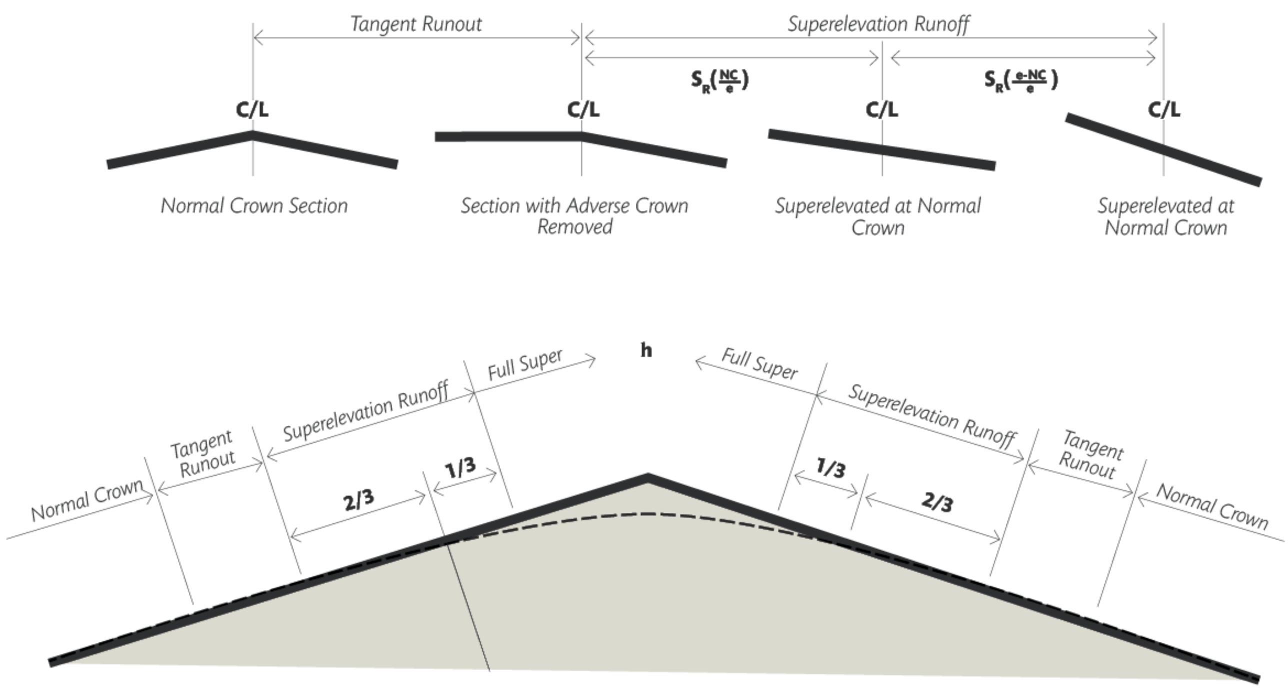
[1] From AASHTO 2011 TABLE 3-13b. Minimum Radii and Superelevation for Low-Speed Urban Streets
[2] A Local residential street with 90^o or near 90^o turns may be designed with a minimum centerline radius of 75' with the approval of the Traffic Engineer.

23.3.9.3. Superelevation

The use of superelevation (i.e., outside edge of pavement higher than inside edge) should be limited in an urban setting due to the lower speeds of the roadways. Superelevation shall not be used on Local Roads. Refer to the current AASHTO *A Policy on Geometric Design of Highways and Streets*, latest edition, for guidance on superelevation rates.

The use of superelevation requires the careful design of transitions leading from normal crown sections to superelevated sections. Designs involving such transitions should show sufficient detail to demonstrate that drainage traps are avoided and to provide sufficient information for adequate construction staking to ensure the desired result. This will normally involve providing special vertical profile lines for all curblines as well as detailed superelevation run-out plans. See Figure 1 for a visual representation of a superelevation runout plan.

Figure Error! No text of specified style in document.**-1 Example Superelevation Runout Plan**



23.3.9.4. Vertical Alignment

Long, flat gradients are undesirable because of poor drainage characteristics. The minimum desirable gradient consistent with acceptable drainage is 0.5 percent and, as such, should be observed as a general design principle. Long, steep gradients are also undesirable since they are difficult for heavier vehicles to negotiate at desirable traffic speeds. See Chapter 22.8 for additional street hydraulic requirements.

Vertical curve criteria stated in Table **Error! No text of specified style in document.**-2 is from the 2011 AASHTO Green Book. In the application of these criteria, the designer will be expected to apply good engineering judgment in combining vertical geometry with horizontal geometry. Extreme vertical undulation is not acceptable. Vertical changes in grade occurring simultaneously with horizontal alignment changes must be carefully considered to preserve the required sight distance consistent with the design speed of the street. Horizontal curvature should not be introduced at or near the top of a crest vertical curve. Intersection sight distances must be maintained in all designs. Intersections on vertical curves should be placed at the crest where visibility in both directions can be maintained.

The values for K shown in the following tables for Crest and Sag Vertical Curves are to be used in determining the minimum length of vertical curve required by the use of the relationship

L = K•A where:

L = Length of vertical curve in feet
A = Algebraic difference in grades expressed in percent
K = Design value indicative of rate of curvature

Lengths of vertical curves longer than the minimums resulting from the use of K values shown should be used wherever possible; however, K should not exceed 167' when curb and gutter is used.

If grade changes without vertical curves are used, as allowed in the following table, a minimum of 50' must be maintained between the vertical point of intersections.

Table Error! No text of specified style in document.**-2 – Design Controls for Vertical Curves**

	Design Speed (MPH)	**MINIMUM LENGTH VERTICAL CURVE (FEET)**	**K VALUE FOR CREST STOPPING SIGHT DISTANCE**	**K VALUE FOR SAG STOPPING SIGHT DISTANCE**	**MAXIMUM GRADE CHANGE ALLOWED WITHOUT VERTICAL CURVE - %**	**MAXIMUM GRADE ALLOWED %**
Arterials/ Collectors	50	150	84	96	0.4	6
	45	135	61	79	0.4	7
	40	135	44	64	0.4	7
	35	100	29	49	0.7	8
Major Local	30	100	19	37	0.8	8
Local Residential	25	75	12	26	1	8
Local Residential: Access Streets, Cul-de-Sacs, Alleys	20	60	7	17	1	12
Local Leg of T Intersection	15	45	3	10	1	12
Local Industrial / Commercial	30	90	19	37	1	8

Source: Tables 3-34 and 3-36 of 2011 AASHTO Green Book