Roadway Geometric Design 2

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PDH: 3

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INTRODUCTION

Geometric design is the assembly of the fundamental three-dimensional features of the highway that are related to its operational quality and safety. Its basic objective is to provide a smooth-flowing, crash-free facility. Geometric roadway design consists of three main parts: **cross section** (lanes and shoulders, curbs, medians, roadside slopes and ditches, sidewalks); **horizontal alignment** (tangents and curves); and **vertical alignment** (grades and vertical curves). Combined, these elements provide a three-dimensional layout for a roadway.

This course is the **second** in a series of five volumes that summarizes and highlights the geometric design process for modern roads and highways. Subjects covered include: *vertical alignments (grades, curves, design controls); and roadway cross-sections (lanes, shoulders, curbs, slopes).* The contents of this document are intended to serve as guidance and not as an absolute standard or rule. The course objective is to give engineers and designers an in-depth look at the principles to be considered when selecting and designing roads.

The *American Association of State Highway and Transportation Officials (AASHTO)* publishes and approves information on geometric roadway design for use by individual state transportation agencies. For this course, AASHTO's **A Policy on Geometric Design of Highways and Streets** (also known as the "Green Book") will be used primarily for fundamental geometric design principles. This text is considered to be the primary guidance for U.S. roadway geometric design.

OFFTRACKING

Offtracking occurs when a vehicle's rear wheels do not precisely follow the same path as the front wheels when turning or traveling through a horizontal curve. Offtracking is dependent on curve/turn radii, number and location of articulation points, and vehicle wheelbase lengths.

Curve without superelevation (low speed)> rear wheels track inside front wheels

Superelevated curve> rear wheels may track inside front wheels (more or less)

High speeds> rear wheels may track outside front wheels

The amount of widening on horizontal curves for offtracking depends on curve radius design vehicle characteristics (track width for passing, lateral vehicle clearance, width of inner lane vehicle front overhang, rear overhang width, curve difficulty allowance width). This amount increases with design vehicle size and decreases with increasing curve radii.

Traveled-Way Widening on Horizontal Curves

Sometimes, roadways with horizontal curves need to be widened in order to obtain operational conditions similar to tangent sections. The primary reasons for widening on certain curves are:

1. Design vehicle offtracks (rear wheels track inside front wheels) when traversing horizontal curves
2. Drivers difficulty in maintaining vehicles in center of lane

The traveled-way width is dependent on many of the same variables as for offtracking: *track width for passing/meeting vehicles; lateral vehicle clearance; width of inner lane vehicle front overhang;* and *curve difficulty allowance width.*

Normally, the design vehicle should be a truck since offtracking is much greater for them versus passenger cars – **WB-62** is considered appropriate for two-lane open highways.

AASHTO recommends a minimum widening of **2.0 feet** due to economic reasons. Widening on a two-lane, one-way riding surface of a divided highway should be equivalent to a two-lane, two-way highway.

Traveled-way widening on horizontal curves should produce gradual transitions to the curve for smooth alignments of the roadway edges and fit the paths of entering /exiting vehicles. The following guidelines are for both ends of highway curves:

- Widening should be only on the inside edge for simple curves.
- For curves with spirals, widening should be applied to the inside edge or equally divided by the centerline.
- Curve widening transitions should be gradual and sufficient for the traveled way to be fully usable.
- Changes in width are transitioned over a distance of 100 to 200 feet.
- The edge of traveled way should have a smooth and graceful appearance throughout the widening transition.
- For roadways without spirals, one-half to two-thirds of the transition length should be based along the tangent section. For roads with spirals, the width increase is distributed along the spiral length.
- Widening sections may be fully detailed on the roadway construction plans.

Turning Roadway Width Criteria (Intersections)

- Vehicle type: based on size and frequency of vehicle expected
- Curve radii: in addition to vehicle track width determine roadway width
- Expected speed

Turning roadways are classified by: *number of lanes; opportunity for passing;* and *one-way or two-way.*

Design Methods for Turning Roadways

Case I One-lane, one-way operation – no passing provision

Used for minor turning movements, moderate turning volumes, short connecting roadway

Remote chance of vehicle breakdown

Case II One-lane, one-way operation – passing provision

Widths are sufficient for all turning movements of moderate to heavy traffic volumes within capacity of single-lane connection

For breakdowns, low traffic can be maintained

Case III Two-lane, either one or two-way

Two lanes needed for traffic volume

Traffic Conditions for Turning Roadway Widths

Traffic Condition A	Predominantly Passenger Car (P) vehicles, some Single-Unit Trucks (SU-30)
Traffic Condition B	Majority of Single-Unit Trucks (SU-30), some tractor-semitrailer combination trucks (WB-40) 5 to 10%
Traffic Condition C	Predominantly tractor-semitrailer combination (WB-40)

For turning roadways, their width includes shoulders or lateral clearance outside the traveled way. Shoulder widths may vary from none (curbed urban streets) to 2 feet or more (highways). For roadways without curbs or with sloping curbs, adjacent shoulders should match those of the approaches.

Table 3-30. Range of Usable Shoulder Widths or Equivalent Lateral Clearances Outside of Turning Roadways, Not on Structure

Turning Roadway Condition	Metric: Shoulder Width or Lateral Clearance Outside of Traveled-Way Edge (m)		U.S. Customary: Shoulder Width or Lateral Clearance Outside of Traveled-Way Edge (ft)	
	Left	Right	Left	Right
Short length, usually within channelized intersection	0.6 to 1.2	0.6 to 1.2	2 to 4	2 to 4
Intermediate to long length or in cut or on fill	1.2 to 3.0	1.8 to 3.6	4 to 10	6 to 12

Note: All dimensions should be increased, where appropriate, for sight distance.

If roadside barriers are present, shoulder widths should be measured to the face of barrier (additional graded width of 2.0 feet). For other than low-volume roadways, right shoulders should be stabilized a minimum of 4.0 feet.

Sight Distance – Horizontal Curves

Sight distance across the inside of curves is a crucial design control for any roadway horizontal alignment. For horizontal alignments, the sight line is a chord of the curve. The **stopping sight distance** is along the centerline of the curve's inside lane.

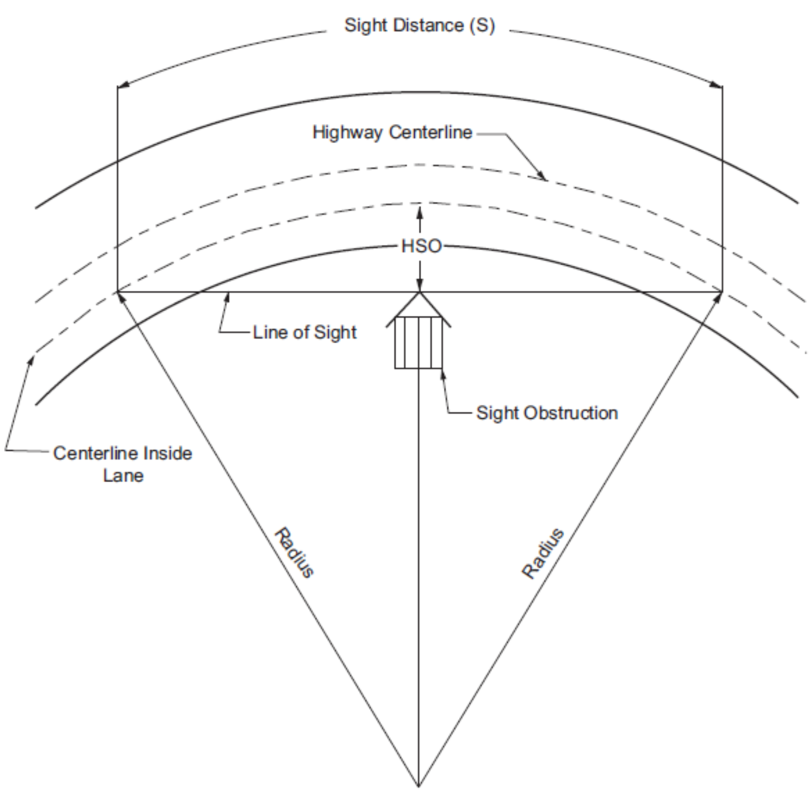

Figure 3-23. Diagram Illustrating Components for Determining Horizontal Sight Distance

Eye Height:	3.50 feet	
Object Height:	2.00 feet	Stopping sight distance
	2.75 feet	Midpoint of sight line where cut slope obstructs sight

Equation 3-36 can be used for circular curve lengths greater than the sight distance for the particular design speed.

$$HSO = R\left[1 - \cos\left(\frac{28.65S}{R}\right)\right]$$

where:

HSO = Horizontal sight line offset, ft

S = Stopping sight distance, ft

R = Radius of curve, ft

At locations where adequate stopping sight distance is not available, the following alternatives may be used: *increase offset to sight obstructions; increase curve radii; or reduce design speed.*

Minimum values for **passing sight distance** (two-lane road) are approximately twice the minimum stopping sight distance.

Eye Height:	3.50 feet	
Object Height:	3.50 feet	Passing sight distance

Due to differences in sight line and stopping sight distance, design for passing sight distance should be limited to tangents and flat curves.

GENERAL CONTROLS

- Any roadway alignment should be directional as possible.
- Minimum radius values should be avoided whenever possible.
- Consistent roadway alignment is desirable.
- Horizontal curves should be long enough for aesthetic purposes.
- Sharp curves should be avoided on lengthy high embankments.

Purchase this course to see the remainder of the technical materials.