TABLE 5.11 Effect of Grade on Stopping-Sight Distance

Design speed, mi/h	Increase for downgrade, ft, %			Assumed speed, mi/h	Decrease for upgrade, ft, %		
—	3	6	9	—	3	6	9
30	10	20	30	28	—	10	20
40	20	40	70	36	10	20	30
50	30	70	—	44	30	50	—
70	70	160	—	58	40	70	—

Adapted from AASHTO, 1994.

even on relatively flat surfaces. Intersections and horizontal curves should be designed to provide drivers with a clear vision of oncoming traffic and pedestrian activity. The *sight triangle* is used to determine the clear, obstruction-free area required at an intersection (Fig. 5.16). Many local ordinances include sight triangle design requirements. Figure 5.16 illustrates the sight triangle parameters recommended by the American Association of State Highway and Transportation Officials (AASHTO). In the figure *d* is the distance traveled by a vehicle moving at the design speed during the time required for a stopped vehicle to get underway and cross the intersection or make a turn.

Vertical curves

The vertical design of cartways must also be considered. The vertical curve is actually a parabola as opposed to a circular curve. In most instances the vertical curve is designed from the centerline of the cartway. The following formula presumes the vertical curve is symmetrical. Designing a vertical curve begins with selecting the *point of vertical intersection* (PVI) by extending the opposing slopes to a point of intersection. The PVI is identified as a particular station along the centerline and the grades. Once the PVI and the grades for the proposed curve are known, the designer can set the curve length. The length of the vertical curve (L) is the distance of the tangent from the *point of vertical curve* (PVC) to the *point of vertical tangent* (PCT). Elevations are taken from the profile sheet. With this information the vertical curve can be calculated as follows.

Step 1. Determine the slopes for the respective tangents:

$$\text{Tangent PVC-PVI} = \frac{\text{elevation of PVI} - \text{elevation of PVC}}{L/2 \times 100 = \text{percent slope}}$$

$$\text{Tangent PVT-PVI} = \frac{\text{elevation of PVT} - \text{elevation of PVI}}{L/2 \times 100 = \text{percent slope}}$$