Design Controls and Design Features

DESIGN SPEED

Design speed is the selected speed used to determine various geometric features of the roadway. The design speed should be a logical one with respect to the target speed and existing operating speed (observed speed of cars on the roadway, if existing). In current design practice, the design speed is rarely set to match the posted speed limit, but usually is 5 to 10 mph higher.

The target speed should be the actual operating speed anticipated for the roadway. In current design practice, designers rarely negotiate a target operating speed but rather set it based on 5 to 10 mph higher than the expected posted speed limit. In a Context Sensitive Solutions project, the appropriate target speed is determined early in the project development process in collaboration with the community, and should consider:

- The context of the roadway including adjacent land uses, area type, roadway type, and access control;
- The volume, mix, and safety of facility users; and
- The anticipated driver characteristics and familiarity with the route.

Design speed influences the physical characteristics of the transportation infrastructure. Design elements such as horizontal and vertical curvature, superelevation, and roadside clear zones are directly related to speed. Other features, such as lane and shoulder width, can vary with, but are not a direct function of the design speed.

Since higher operating speeds are desired for freeways and arterials, design speed generally increases as one moves up the functional classification ladder.

LANE WIDTH

The width of travel lanes is selected through consideration of the functional class of the road, volume, choice of design vehicle and to a certain extent, design speed. Wider lanes are generally considered to be "safer," but can also encourage higher speeds, are more difficult for pedestrians and bicyclists to cross, and are more expensive to construct than narrow lanes.

SHOULDER WIDTH

Shoulders are paved and/or graded areas along the travel lanes that serve many purposes---from drainage and pavement support to break down or bike lanes. Uses for shoulders include:

- Drainage of Traveled Way
- Lateral Support of Pavement
- Encroachment of Wide Vehicles
- Off-tracking of Wide Vehicles
- Errant Vehicles
- Bicycle and Pedestrian Use
- Emergency Stopping
- Emergency Travel
- Mail Delivery and Garbage Pickup
- Law Enforcement Operations
- Large Vehicle Emergency Stopping
- Occasional Travel/Detours
- Highway Maintenance

Shoulders do not include on-street parking since the shoulders can not serve the purposes listed if they are occupied by parked cars. During the planning process, the designer should select an appropriate shoulder width given the roadway's context, purpose and need, bicycle and pedestrian accommodation, speed, and transportation demand characteristics. Widths are often given for "usable shoulder" which is composed of both a graded shoulder, and, in some cases, rounding of grade transitions at the edge of the roadway, but not the angled portion of the shoulder at the outer edge.

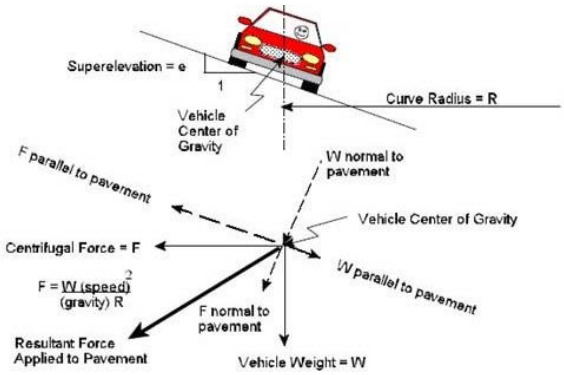
BRIDGE WIDTH

The type of structure best suited to grade separations is one that blends smoothly into the surrounding environment and provides a seamless connection for all users of the transportation facility. The multimodal accommodation and cross-section features found along the adjacent roadway segments should be included on the bridge cross-section. It is not usually necessary for the bridge deck to be substantially wider than the approaching roadway, but the design of the bridge structure should include consideration of possible future widening such as by providing a wider abutment. Generally, the width of the travel way and shoulder lanes should be consistent with the existing or planned future cross section of the adjacent roadway. In terms of additional width, a 2-foot setback from the shoulder or bike lane to bridge rails or parapet walls is required. Additionally or alternatively, approximately 1 to 2 feet of additional sidewalk width is desirable to account for shy distance from the railing or parapet wall when sidewalks are provided.

HORIZONTAL ALIGNMENT

A horizontal curve in a roadway refers to the alignment, and indirectly, is a measure of how “straight” the roadway section is. Roads with no horizontal curves are straight. Horizontal alignment, combined with vertical alignment, can have a substantial effect on how a road fits into its context. Roadways possess vertical and horizontal curves in their alignments to circumvent or be compatible with existing constraints. Alignment constraints typically include topographical variation, natural resource areas, property ownership, land use, cost, and environment.

SUPERELEVATION



Superelevation is the banking of a roadway around a curve. The purpose of employing superelevation of the roadway cross section is to counterbalance the centrifugal force, or outward pull, of a vehicle traversing a horizontal curve. Side friction developed between the tires and the road surface also counterbalances the outward pull of the vehicle. A combination of these two concepts allows a vehicle to negotiate curves safely at higher speeds than would otherwise be possible.

Incorporating superelevation into a roadway's design may help avoid roadside obstacles that might otherwise be impacted by the alignment. In contrast, superelevation may not be desirable for low-speed roadways to help limit excessive speeds or in urban settings to limit impacts to abutting uses or drainage systems and utilities. The maximum useable rate for superelevation is controlled by several factors: climate conditions, terrain conditions, type of area, and the frequency of slow moving vehicles.

VERTICAL ALIGNMENT

A vertical curve refers to a roadway's change in elevation, and indirectly is a measurement of the "flatness" of the roadway. A road with no vertical curves is flat. Vertical curves are defined as either "crest" or "sag", with the former being the top of a hill, and the latter, the bottom. Horizontal alignment, combined with vertical alignment, can have a substantial effect on how a road fits into its context. Roadways possess vertical and horizontal curves in their alignments to circumvent or be compatible with existing constraints. Alignment constraints typically include topographical variation, natural resource areas, property ownership, land use, cost, and environment.

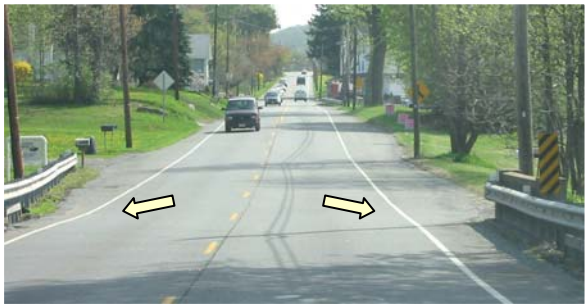
GRADE

Roadway grades have a direct correlation to the uniform operation of vehicles. Vehicle weight and the steepness of the roadway grade have a direct relationship on the ability of the driver to maintain uniform speed. Grades can be an important context consideration in some areas.

STOPPING SIGHT DISTANCE

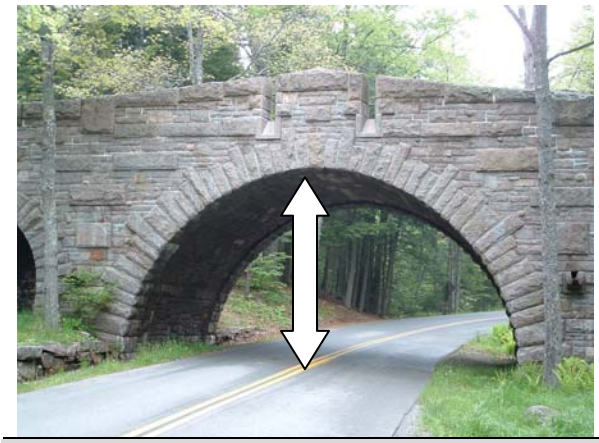
Stopping sight distance is the distance necessary to allow a vehicle traveling at the design speed to stop before reaching a stationary object in its path. It is based on both motorist reaction time plus the physics of actually stopping the vehicle. The sight distance at every point along a roadway should be at least the stopping sight distance. This applies to horizontal and vertical curves, and signalized and unsignalized intersections. Sometimes, features outside the right-of-way such as landscaping and structures can have a major impact on stopping sight distance.

CROSS SLOPE



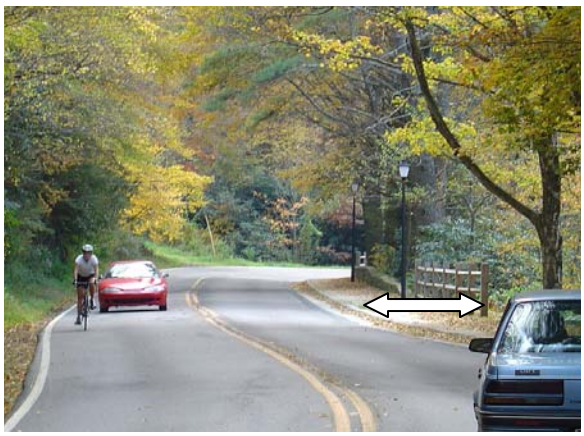
Cross slope is the transversal slope with respect to the horizon, typically having a raised level along the centerline of the road, sloping down in both directions toward the edges of the pavement. Surface cross slopes are necessary on all components of the cross-section to facilitate drainage. This reduces the safety hazards of wet pavements and standing water.

VERTICAL CLEARANCE



The location of the critical vertical clearance generally occurs where the highest point on the pavement of the underpass (crown line and/or runoff line of the road) falls directly under the lowest point of the bottom of the bridge/overpass structure. The context of the facility, including the relative heights of nearby structures and natural features, visual impacts, and mix of vehicles on the road all have an impact on decisions regarding appropriate vertical clearances.

HORIZONTAL CLEARANCE



Horizontal clearance is the lateral offset distance from the edge of the travel lane, shoulder or other designated point to a vertical roadside element. These lateral offsets provide clearance for mirrors on trucks and buses that are in the extreme right lane of a facility and for opening curbside doors of parked vehicles. Curbs, walls, barriers, piers, sign and signal supports, mature trees, landscaping items, and power poles can affect a driver's speed or lane position if located too close to the roadway edge. The context of the surrounding area is a critical element in properly designing these roadside environments.

STRUCTURAL CAPACITY

Structural capacity is the load bearing ability of a structure. The structural capacity is based on bridge type/design, materials, age, and location (weather and seismic conditions). The AASHTO Standard Specifications for Highway Bridges (for rehabilitation and maintenance of older, existing structures) or LRFD (Load and Resistance Factor Design) Bridge Design Specifications (for new/replacement bridge construction) include formulas and specifications for calculating the load that a bridge can carry safely at a given time.