

## CHAPTER 3 DESIGN CONTROLS

### 3.1 DESIGN VEHICLES

Design vehicle is the term generally denoting the vehicle characteristics used in geometric design of highways. The four general classes of vehicles are:

- passenger cars
- buses
- trucks
- recreational vehicles

The passenger car class includes passenger cars of all sizes, sport/utility vehicles, minivans, vans and pick-up trucks. Buses include intercity (motor coaches), city transit, school and articulated buses. The truck class includes single-unit trucks, truck tractor-semitrailer combinations and truck tractors with semitrailers in combination with full trailers. Recreational vehicles include motor homes, cars with camper trailers, cars with boat trailers, motor homes with boat trailers and motor homes pulling cars.

AASHTO further divides these four classes into 19 design vehicle types, as shown in [Figure 3-01](#). The design vehicle represents the largest vehicle in that design class.

The design vehicle is used in defining roadway parameters such as:

- sight distance
- turning radii
- lane width
- capacity

DOTD uses the passenger car (P) vehicle for most geometric design calculations. Exceptions to this would be for calculations to determine radii at intersections, radii for turning roadways (widening on curves), etc., where the single-unit truck (SU) is typically the controlling vehicle. However, the designer should be aware of all potential types of vehicles that will use each part of the facility, and should design for the larger vehicles when appropriate.

The wheel paths of turning vehicles of each type have been determined, as have the overhangs of vehicle bodies during turns. These can be found in Chapter 2 of the AASHTO Green Book. CADD software should be used to determine the turning movement of the design vehicle for intersections, drives and turning roadways.

## 3.2 TRAFFIC CHARACTERISTICS

Traffic volume, distribution per lane, composition and speed are all traffic characteristics used in highway design, as discussed below. Additional discussion is contained in Chapter 2 of the AASHTO Green Book and in Chapter 2 of the Highway Capacity Manual.

The Data Collection and Management Analysis Section will provide traffic data and turning movements for a project upon request.

### 3.2.1 Volume

Average Daily Traffic (ADT) is a term generally used to define the total traffic volume on a highway during a given time period (in whole days) that is greater than one day and less than one year, divided by the number of days in that period. Permanent traffic counters are located at various points along major highways in the state and provide continuous traffic volumes that are used to determine the ADT. At locations where permanent counters are not provided, the ADT is estimated from counts taken by portable units. All traffic counts and estimates are adjusted for seasonal and daily variations.

Establishing ADT for roadways in the state serves several purposes and is a major factor used in the allocation process of highway improvement funds. However, the ADT designated for a particular stretch of highway may vary greatly from the actual volume during certain seasons, months, or days of the week. As a result, the design of a highway is not based on ADT, but on an hourly traffic volume instead. AASHTO and other organizations have determined that the 30<sup>th</sup> highest hourly volume (30 HV) of the year usually provides the most appropriate design for highways. The design hourly volume (DHV) is used by DOTD as the basis for design and is normally the projected 30 HV of the future year that has been selected as the design year. The DHV for a typical rural highway is 12 to 18 percent of the ADT. In urban areas, the DHV is usually 8 to 12 percent of the ADT. This percentage, called the K-value, is part of the standard traffic data supplied for a project. To determine the DHV for a project, the ADT is multiplied by the K-value.

### 3.2.2 Directional Distribution

Directional distribution, expressed as a percentage of the DHV, represents the volume of traffic in a particular direction. It is an essential element in providing an appropriate facility design, especially at critical intersections or where additional lanes are to be provided. The Data Collection and Management Analysis Section provides the directional distribution as part of the traffic data. Directional distribution typically is in the range of 55 percent to 70 percent.

### 3.2.3 Traffic Composition

Another factor in highway design is the composition of traffic using a facility. Since trucks and buses are typically slower and occupy more space, they have a greater effect on the highway capacity. The number of trucks and buses in the design hour (the T-term in the traffic data provided by the Data Collection and Management Analysis Section) is expressed as a percentage of the DHV.

On typical highways, the number of trucks in the design hour is approximately 10 percent of the DHV. DOTD considers a facility to have high truck traffic when T is greater than 12 percent.

### 3.2.4 Future Projection of Traffic Demands

Traffic volumes on a highway typically increase over time. Since a design based on current conditions could be obsolete soon after construction, traffic is projected to a design year using past growth rates and an estimate of the future land use and its impacts on traffic volume. The design year used for most DOTD projects is 20 years beyond the letting date.

### 3.2.5 Speed

The speed of vehicles on a highway usually depends on the combination of:

- driver capabilities
  - vehicle capabilities
  - physical characteristics of the highway and roadsides
  - weather
  - presence of other vehicles
  - speed limitations (either legal or because of control devices)
1. **Operating Speed** – The speed at which drivers are observed operating their vehicles during free-flow conditions (AASHTO).
  2. **Design Speed** – A selected speed used to determine the various geometric features of the roadway. The selected design speed should be a logical one with respect to the anticipated operating speed, topography, the adjacent land use and the functional classification of the highway (AASHTO).
  3. **Running Speed** – The speed at which an individual vehicle travels over a highway section. The running speed is the length of the highway section divided by the running time for the vehicle to travel through the section. The average running speed of all vehicles is the most appropriate speed measure for evaluating level of service and road user costs. The average running speed is the sum of the distances traveled by vehicles on a highway section during a specified time period divided by the sum of their running times (AASHTO).
  4. **Posted Speed** – The enforceable speed limit posted along a route. Posted speeds along rural highways are usually lower than design speeds.

Louisiana statutes set the maximum posted speeds allowed. Further, statutes allow DOTD to analyze locations to determine if additional speed restrictions are appropriate. This is typically done at the District level. Factors considered in this analysis are:

- roadway characteristics (number of lanes, shoulder description, pavement conditions, alignment, sight distance, etc.)
- the 85<sup>th</sup> percentile speed
- roadside development
- safe speeds for curves or hazardous locations within the zone
- parking practices and pedestrian activity

[EDSM VI.1.1.1](#) contains additional guidance on speed zoning.

### 3.3 CAPACITY AND LEVEL OF SERVICE

Capacity, as defined in the Highway Capacity Manual, is the maximum sustainable hourly flow rate at which persons or vehicles reasonably can be expected to traverse a point or a uniform section of a lane or roadway during a given time period under prevailing roadway, environmental, traffic and control conditions. The Highway Capacity Manual contains procedures used to analyze capacity. Capacity analyses are used in developing studies of existing roadways and intersections, and to determine and plan for future needs.

The volume at which a highway operates at capacity is called density at capacity (sometimes referred to as critical density) and the resulting speed is called speed at capacity (often called critical speed). At capacity, there are effectively no gaps in the traffic flow, and any disturbance results in queues developing upstream. For this reason, highways are designed to operate at less than capacity.

Any restriction or interference to normal free flow of a highway is considered congestion. However, congestion does not necessarily mean a complete stoppage of traffic flow. There are acceptable degrees of congestion and the degree to which it should not be exceeded can be assessed by the following:

- Determine the operating conditions that the majority of motorists will accept as satisfactory
- Determine the most extensive highway improvement that the governmental jurisdiction considers practical
- Reconcile the demands of the motorist and the general public with the finances available to meet those demands

There are six levels of service used in highway capacity: A through F. A definition of each level of service (LOS) can be found in the Chapter 2 of AASHTO Green Book.

The designer should strive to provide the highest level of service practical. Based on design year traffic, LOS C is generally the minimum allowable. However, in some

locations, such as urban highways with highly developed land-use, lower LOS may be acceptable.

Traffic Engineering Management performs capacity analyses required for turn lanes, etc., upon request. The Highway Capacity Manual contains discussion and procedures used to determine the level of service for a multitude of situations.

### 3.4 ACCESS CONTROL

Access control is used to regulate points where vehicles enter or leave a facility. Access control is categorized as:

- full control of access
- partial control of access
- driveway and approach regulations

Under full access control, access to the highway is allowed only at selected public roads. Access from such roads is through interchanges, with little effect on the highway through traffic under normal conditions. Distances used for control of access can be found in the DOTD [Control of Access Policy](#).

The right to fully control access is purchased from property owners adjacent to the route through normal right-of-way negotiation procedures. However, where feasible, it may be more economical to provide frontage roads along the route in lieu of property owner compensation.

Under partial control of access, through traffic on the highway is given preference, but some at-grade intersections and private drives may be allowed. Like full access control, the property owner is compensated for the limited access.

Driveway and approach regulations, to a lesser degree, also control access to a highway. This is discussed in more detail in Chapter 6.

Full and partial access control is further discussed in [EDSM III.1.1.14](#).

### 3.5 SAFETY CONSIDERATIONS

Led by DOTD in partnership with the Louisiana State Police (LSP) and the Louisiana Highway Safety Commission (LHSC), the Strategic Highway Safety Plan (SHSP) outlines various ways safety stakeholders from throughout the state can make a difference. Whether it is discouraging drinking and driving, encouraging seatbelt use, educating young and new drivers or improving road safety through improved roadway infrastructure and operations, the SHSP includes effective strategies that can be implemented at the state, regional and local level. The SHSP can be downloaded from the Destination Zero Deaths website.

Three main elements are factors in the cause of crashes. They are:

- the human element
- the vehicle element
- the highway element

The highway is the only element that the designer has some control of, but the designer should be aware of the other factors as well.

Safety in design can be significantly increased by the use of access control. However, this alone does not make for a safe facility and, in many instances, the use of partial or full access control is not possible, practical, or desirable.

DOTD has developed programs that address general safety and safety issues, such as:

- Highway Safety Improvement Program
- Maintenance Hazard Elimination Program
- Transportation Systems Management Program
- Guardrail Upgrade Programs, etc.

In addition, crash types, crash rates for a length of roadway, and rate of crashes at spot locations are considered in the prioritization of major improvement projects and projects at isolated locations. The ultimate goal of these projects and programs is to minimize fatalities and serious injuries on all public roads.

### **3.5.1 Crash Data Analysis**

Crash data contained in crash reports is provided by Louisiana's law enforcement agencies. Through a Memorandum of Agreement with the Department of Public Safety, DOTD is the official repository for all crash data, but does not maintain the official crash reports. The Highway Safety Section, in coordination with LSU's Highway Safety Research Group, conducts quality assurance and quality control on this information and produces a corrected crash database. This corrected crash database, in conjunction with roadway data elements, is used to conduct statewide network screening for all public roads. Access to crash data can be obtained with a written request to the Highway Safety Administrator or his/her representatives. While data for the previous ten years is kept on file, a three-year period is often sufficient for analysis. The data can be provided in various formats by searching with different parameters, such as:

- day/night crashes
- run-off-the-road crashes
- wet weather crashes, etc.

In addition to the uses of crash data previously mentioned, the designer can use crash data to help determine if design exceptions are warranted. The use of total crashes in analyzing an intersection or spot location is not recommended. A careful study of the type of crashes is essential in determining if a specific roadway improvement will provide a significant reduction in the number or severity of crashes. The Highway Safety Section is available for technical assistance.

### 3.5.2 Safety Improvement Projects

The Highway Safety Improvement Program policy and procedures are contained in HSIP Project Selection Guide (currently in development). It also establishes priorities for implementation of safety improvement projects. Safety improvement projects at high crash locations can be funded through a variety of sources.

## 3.6 ENVIRONMENTAL CONSIDERATIONS

To the extent practical, a highway should be designed to complement its environment, to minimize impacts to its environment, and in some cases, to serve as a catalyst to improve the surrounding environment. Such factors to be considered in highway design include:

- landscaping
- alignments that complement the surrounding terrain, while causing as little disruption to the surrounding environment and nature as possible
- noise abatement measures
- pollution impacts
- location of historical structures, trees, Indian mounds, cemeteries or other significant sites, etc.

In addition, the design should address other environmental concerns, such as underground storage tanks (USTs), sewer effluent, etc. The DOTD policy on sewer effluent can be found in [EDSM I.1.1.6](#).

## 3.7 VALUE ENGINEERING

Value Engineering (VE) is a systematic process using a team from a variety of disciplines to improve the value of a project through the analysis of its functions. The VE process incorporates, to the extent possible, the values of design; construction; maintenance; the contractor; state, local and federal approval agencies; other stakeholders; and the public.

The primary objective of the Value Engineering process is value improvement. The value improvements might relate to scope definition, functional design, constructability, coordination (both internal and external), or the schedule for project development. Other possible value improvements are reduced environmental impacts, reduced public (traffic) inconvenience, or reduced project cost.

Projects with a total estimated cost over \$50 million and any bridge project over \$40 million are required by FHWA and by [EDSM I.1.1.18](#) to have a VE Study performed. This total estimated cost includes preliminary engineering, construction, right of way, utilities, and mitigation costs.

Value Engineering can be applied during any stage of a project's development. The greatest benefits and resource savings are most likely to be achieved when performed earliest as possible in project development and should be performed no later than plan-in-hand.

Additional guidelines concerning VE can be found in [EDSM I.1.1.18](#).