2-03 DESIGN CONTROLS

2-03.1 General

The location and geometric design of highways are affected by numerous factors and controlling features. These may be considered in two broad categories as follows:

1. Primary Controls
    - Highway Classification
    - Topography and Physical Features
    - Traffic
2. Secondary controls
    - Design Speed
    - Design Vehicle
    - Capacity

2-03.2 Primary Controls

1. Highway Classification

Separate design standards are appropriate for different classes of roads, since the classes serve different types of trips and operate under different conditions of both speed and traffic volume. The design of streets and highways on the State highway system should conform to the guidelines as indicated in this manual. In special cases of restrictive or unusual conditions, it may not be practical to meet these guide values. For detailed descriptions of the various guide values, please refer to the appropriate Sections of this Manual.

2. Topography and Physical Features

The location and the geometric features of a highway are influenced to a large degree by the topography, physical features, and land use of the area traversed. The character of the terrain has a pronounced effect upon the longitudinal features of the highway, and frequently upon the cross sectional features as well. Geological conditions may also affect the location and the geometrics of the highway. Climatic, soil and drainage conditions may affect the profile of a road relative to existing ground.

Man-made features and land use may also have considerable effect upon the location and the design of the highway. Industrial, commercial, and residential areas will each dictate different geometric requirements.

3. Traffic

The traffic characteristics, volume, composition and speed, indicate the service for which the highway improvement is being made and directly affects the geometric features of design.

The traffic volume affects the capacity, and thus the number of lanes required. For planning and design purposes, the demand of traffic is generally expressed in terms of the design-hourly volume (DHV), predicated on the design year. The design year for new construction and reconstruction is to be 20 years beyond the anticipated date of Plans, Specifications and Estimate (PS&E), and 10 years beyond the anticipated date of PS&E for resurfacing, restoration and rehabilitation projects.

The composition of traffic, i.e., proportion of trucks and buses, is another characteristic which affects the location and geometrics of highways. Types, sizes and loadpower characteristics are some of the aspects taken into account.

The following definitions apply to traffic data elements pertinent to design.

ADT Average daily traffic. The total volume during a given time period greater than one day but less than one year divided by the number of days actually counted.

AADT Average annual daily traffic. The total yearly volume in both directions of travel divided by 365 days.

DHV The design-hourly volume. Normally estimated as the 30th highest hour two-way traffic volume for the design year selected.

K Ratio of DHV to ADT, expressed as a percent.

D The directional distribution of traffic during the design hour. It is the one-way volume in the predominant direction of travel expressed as a percentage of DHV.

T The proportion of trucks, exclusive of light delivery trucks, expressed as a percentage of DHV.

V The design speed in mph.

2-03.3 Secondary Controls

1. Design Speed

"Design Speed" is a selected speed used to determine the various design features of the roadway.

The assumed design speed should be a logical one with respect to topography, anticipated operating speed, the adjacent land use, and the functional classification of the highway. Except for local streets where speed controls are frequently included intentionally, every effort should be made to use as high a design speed as practicable to attain a desired degree of safety, mobility and efficiency within the constraints of environmental quality, economics, aesthetics and social or political impacts. Once the design speed is selected, all of the pertinent features of the highway should be related to it to obtain a balanced design. Above minimum design values should be used, where practical. Some design features, such as curvature, superelevation, and sight distance are directly related to and vary appreciably with, design speed. Other features, such as widths of lanes and shoulders, and clearances to walls and rails, are not directly related to design speed, but they affect vehicle speeds. Therefore, wider lanes, shoulders, and clearances should be considered for higher design speeds. Thus, when a changes is made in design speed, many elements of the highway design will change accordingly.

Since design speed is predicated on the favorable conditions of climate and little or no traffic on the highway, it is influenced principally by:

- Character of the terrain;
- Extent of man-made features;
- Economic considerations (as related to construction and right-of-way costs).

These three factors apply only to the selection of a specific design speed within a logical range pertinent to a particular system or classification of which the facility is a part.

The design speed (mph) as it relates to the posted speed (mph) is shown below:

Table 2-1
Design Speed vs. Posted Speed

	Design Speed	
Posted Speed	**Existing Highways**	**New Highways or Alignment**
20 mph	**25 mph**	**30 mph**
25 mph	**30 mph**	**35 mph**
30 mph	**35 mph**	**40 mph**
35 mph	**40 mph**	**45 mph**
40 mph	**45 mph**	**50 mph**
45 mph	**50 mph**	**55 mph**
50 mph	**55 mph**	**60 mph**
55 mph	**60 mph**	**65 mph**

*Generally, for freeways and the Interstate system, the design speed shall be 70 mph for either column shown in Table 2-1. But in certain urban areas, the Interstate highway or freeway was designed at 60 mph. Therefore, the design speed shall be 60 mph in either column for these areas.

2. Design Vehicle

The physical characteristics of vehicles and the proportions of the various size vehicles using the highways are positive controls in geometric design. A design vehicle is a selected motor vehicle, the weight, dimensions and operating characteristics of which are used to establish highway design controls to accommodate vehicles of a designated type. The symbols and dimensions of design vehicles are shown in Table 2.2.

Table 2-2
Design Vehicles
(Dimensions in feet*)

Design Vehicle			Overhang		Overall	
Type	Symbol	Wheel Base	Front	Rear	Length	Width
Passenger Car	P	11	3	5	19	7
Single Unit Truck	SU	20	4	6	30	8
Single Unit Bus	BUS-40	24	6	6.3	40	8.5
Articulated Bus	A-BUS	22 + 19.4 = 41.4	8.6	10	60	8.5
Semitrailer Intermediate	WB-40	12.5 + 27.5 = 40	3	2.5	45.5	8
Semitrailer Large	WB-50	14.6 + 35.4 = 50	3	2	55	8.5
Semitrailer Interstate	WB-62	21.6 + 40.4 = 62	4	2.5	68.5	8.5
"Double Bottom" Semitrailer	WB-67D	11 + 23 + 10 + 23 = 67	2.33	3	72.3	8.5

Source: *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2001

* Design vehicle dimensions are intended for use in the design of roadways and do not define the legal vehicle dimensions in the State.

c. Service Volume

For highway design purposes, the service volume is related to the "Level of Service" selected for the proposed facility. (No service volumes are defined for Level of Service F). Service volume is defined as the maximum rate of flow which may be accommodated under prevailing traffic and roadway conditions while still maintaining a quality of service appropriate to the indicated Level of Service. The service volume varies with a number of factors, including:

(1) Level of service selected;
(2) Width of lanes;
(3) Number of lanes;
(4) Presence or absence of shoulders;
(5) Grades;
(6) Horizontal alignment;
(7) Operating speed;
(8) Lateral clearance;
(9) Side friction generated by parking, driveways, intersections, and interchanges;
(10) Volumes of trucks, buses, and recreational vehicles;
(11) Spacing and timing of traffic signals.

The objective in highway design is to create a highway of appropriate type with dimensional values and alignment characteristics such that the resulting service volume will be at least as great as the design volume, but not much greater as to represent extravagance or waste. More detailed data on service volume are available in the *Highway Capacity Manual*, Transportation Research Board, 2000 and *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2001.