CE 380

Highway and Traffic Engineering

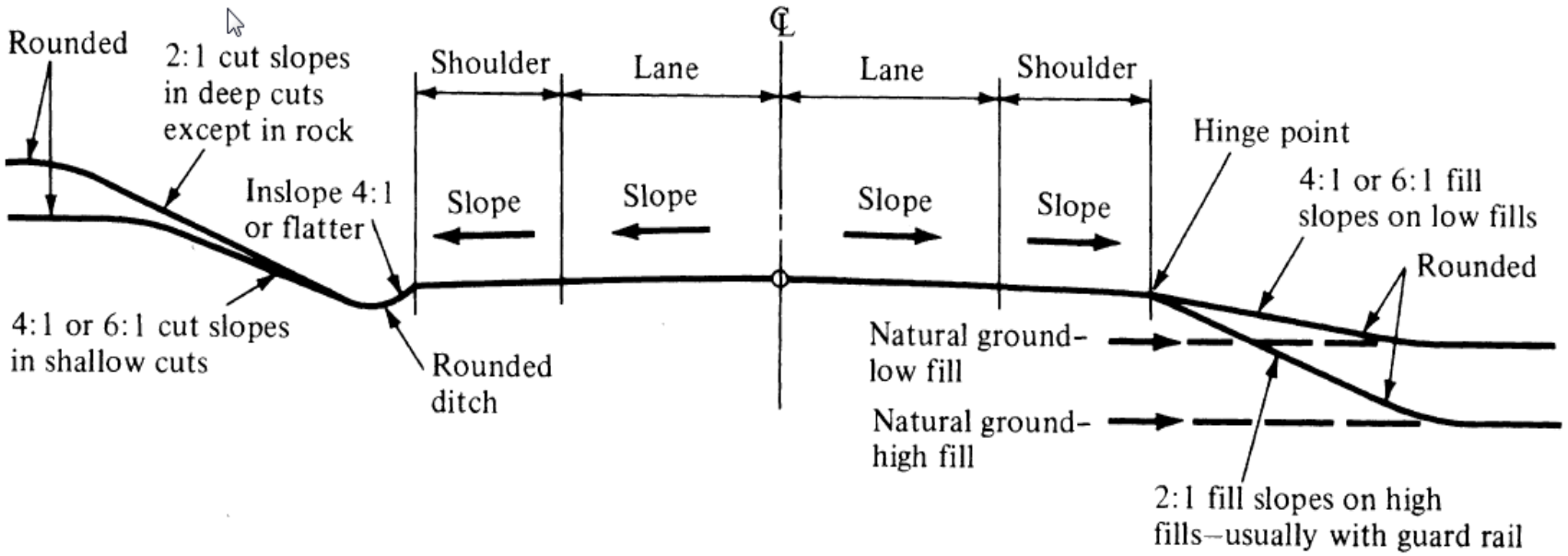
Lec-2

Road Cross-Section Design

Dr. Mahmoud Owais

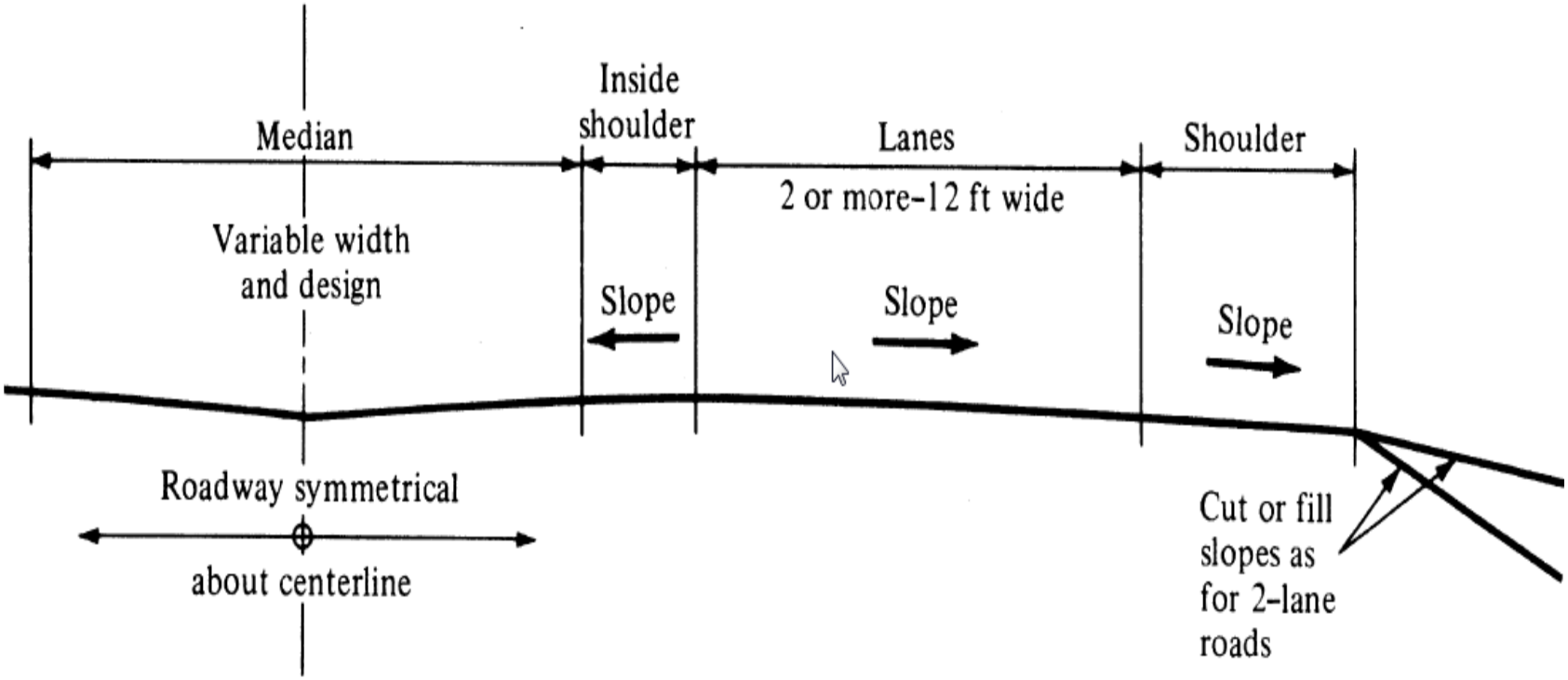
Cross-Section Elements

The principal elements of a highway cross section consist of the travel lanes, shoulders, and medians (for some multilane highways). Marginal elements include median and roadside barriers, curbs, guard rails, sidewalks, and side slopes.



Typical Cross Section for Two-Lane Highways

Cross-Section Elements



Typical Cross Section for Multilane Highways (half section)

Basic physical elements of a highway

The basic features of a highway are the carriageway itself, expressed in terms of the number of lanes used, the central reservation or median strip and the shoulders (including verges). Depending on the level of the highway relative to the surrounding terrain, side-slopes may also be a design issue.

Main carriageway

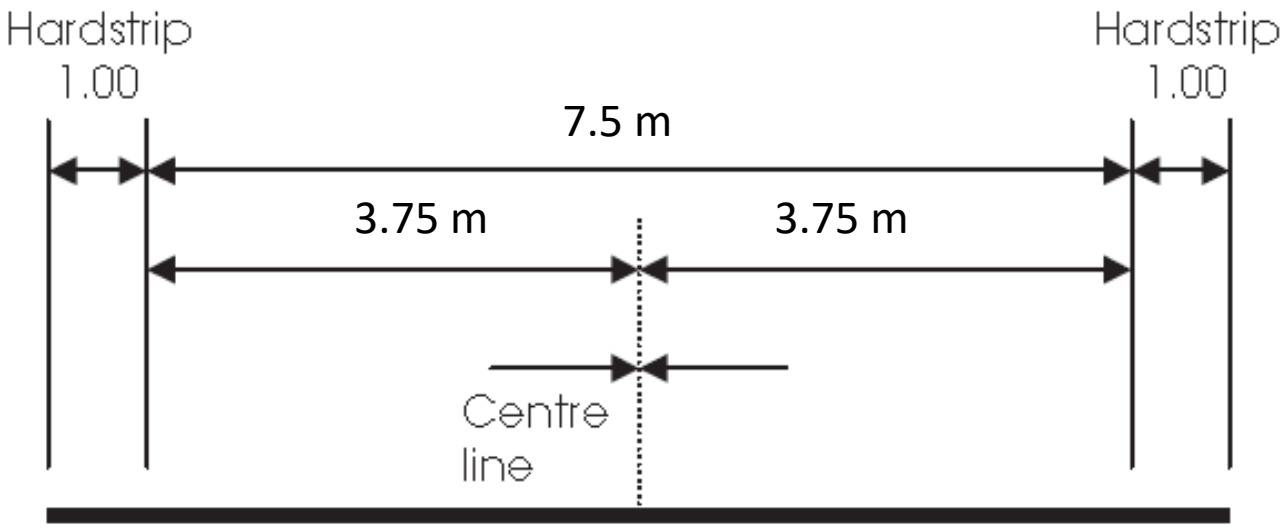
The chosen carriageway depends on a number of factors, most notably the volume of traffic using the highway, the quality of service expected from the installation and the selected design speed. In most situations a **lane width of 3.75 m** is used, making a standard divided or undivided 2-lane carriageway **7.5 m** wide in total.

Standard carriageway widths

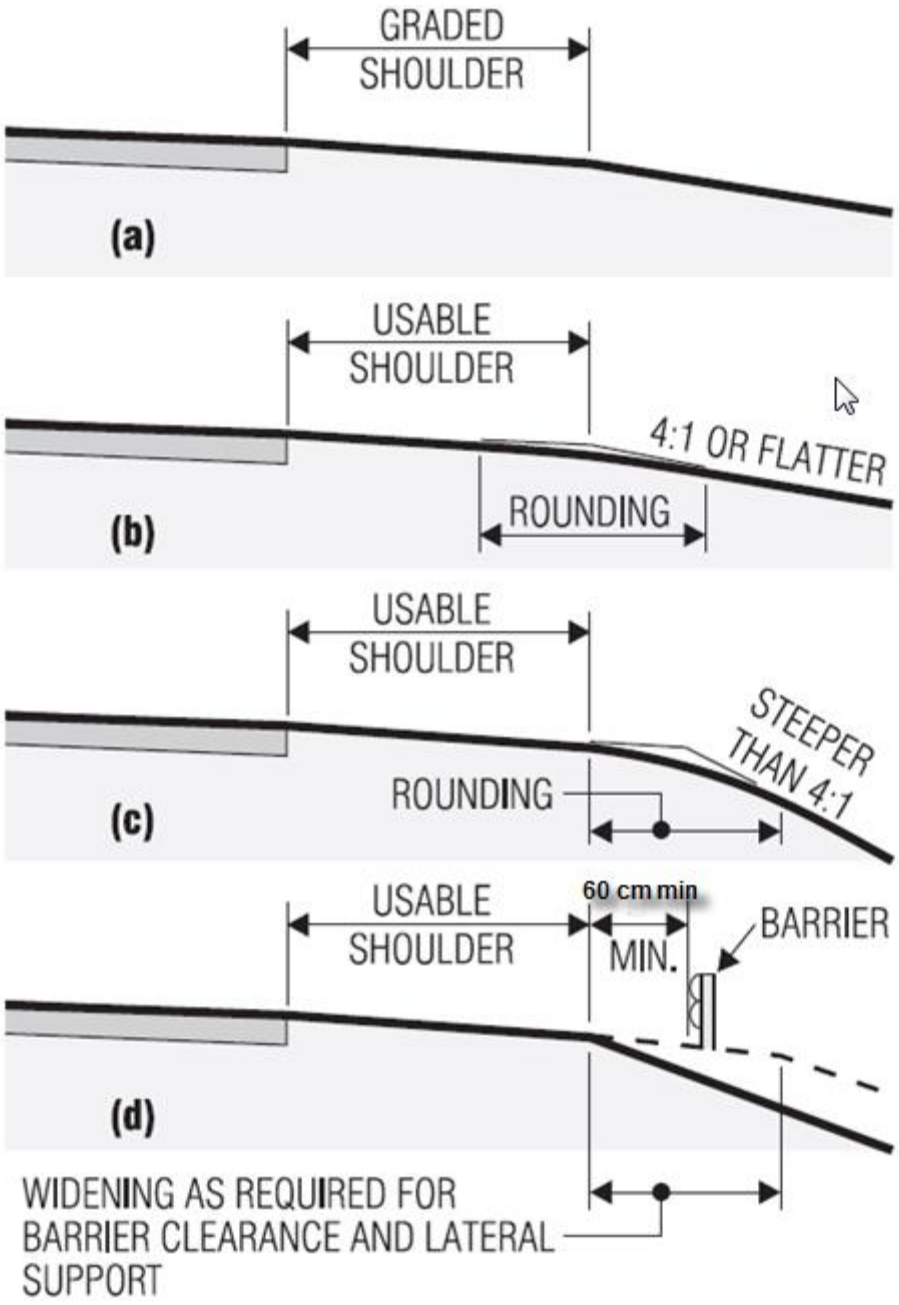
Road description	Carriageway width (m)
Urban/rural 4-lane dual	…….
Urban/rural 3-lane dual	……
Urban/rural single/dual 2-lane (normal)	…….
Rural single 2-lane (wide)	…….

Shoulders:

On single carriageway roads (normal and wide), a 1m wide hard strip and a 2.5m wide grassed verge is employed on the section of roadway immediately adjacent to the main carriageway on each side. On rural 2 and 3-lane motorways, a Hard shoulder of 3.3 m and a verge of 1.5 m are the recommended standard. On rural 2/3-lane dual carriageways, the 1m wide hard strip and 2.5 m wide verge is detailed on the nearside with a 1m hard strip on the offside. For urban motorways the verge dimension varies while the hard shoulder is set at 2.75m wide.

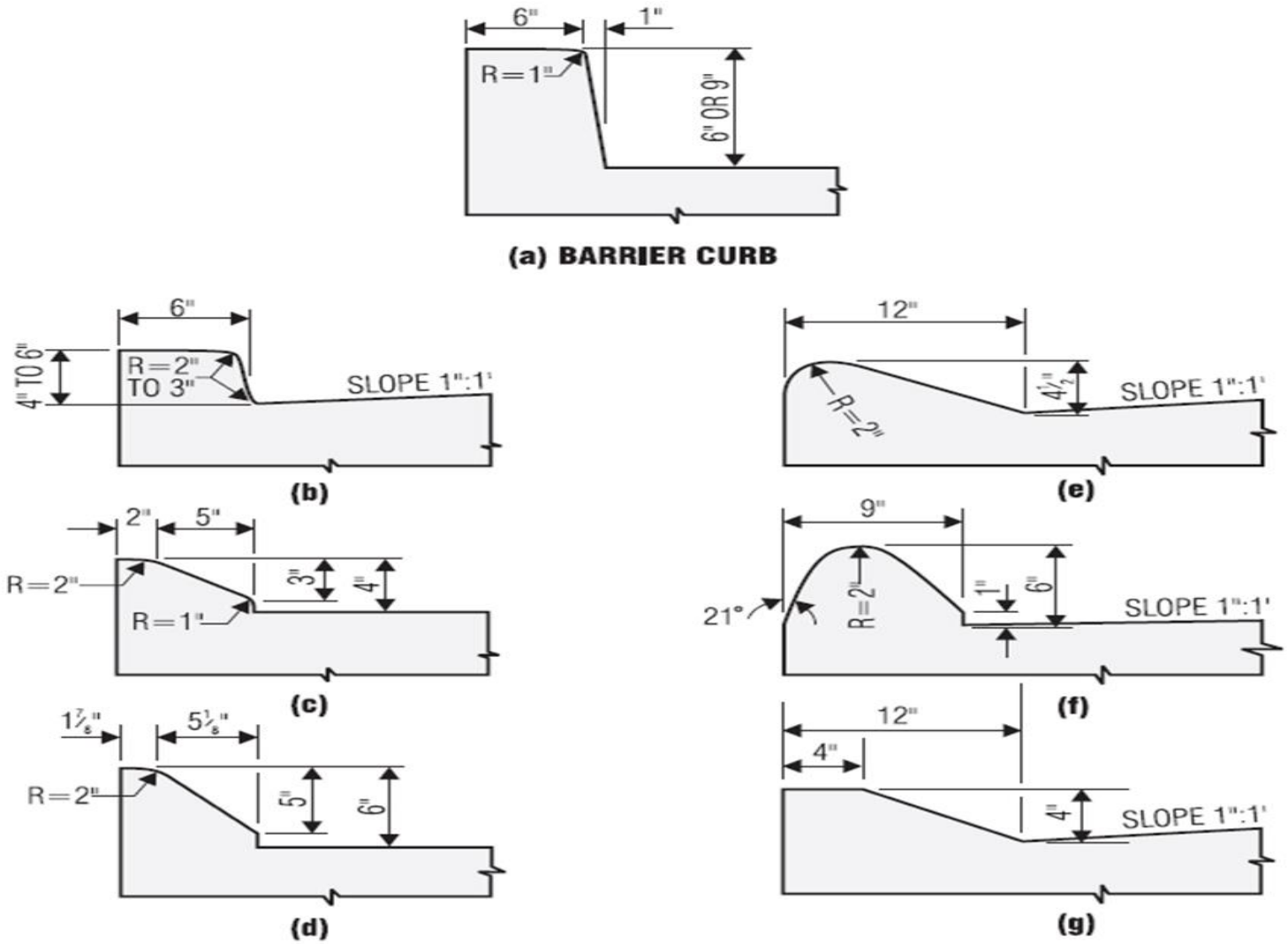


Single 7.5 meter all- purpose roadway


GRADED
SHOULDER
(a)
USABLE
SHOULDER
4:1 OR FLATTER
ROUNDING
(b)
USABLE
SHOULDER
STEEPER
THAN 4:1
ROUNDING
(c)
USABLE
SHOULDER
60 cm min
MIN.
BARRIER
(d)
WIDENING AS REQUIRED FOR
BARRIER CLEARANCE AND LATERAL
SUPPORT

Curbs

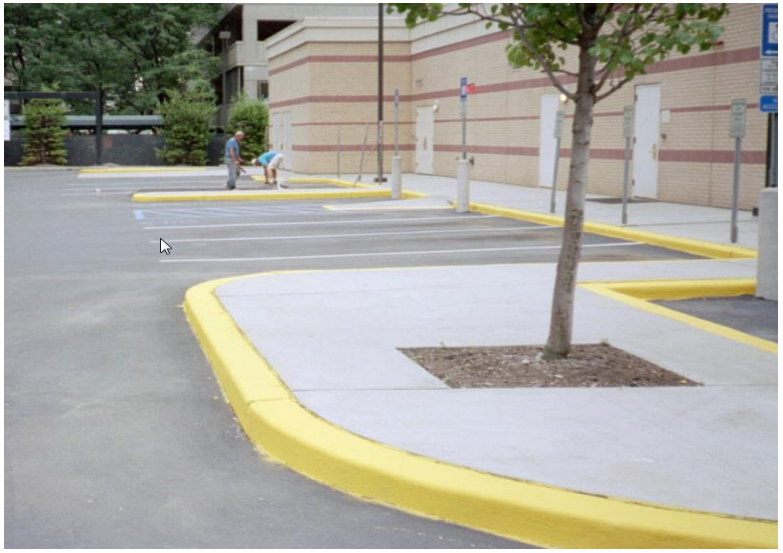
A curb is a raised element that is used, among other things, to denote the edge of a roadway. Curbs can be made of Portland cement or bituminous concrete, granite, or some other hard material. In addition to pavement delineation, curbs provide drainage control, right-of-way reduction, enhanced appearance, delineation of pedestrian walkways, and reduction of maintenance operations. To facilitate drainage, curbs can be combined with a gutter to create a combined curb-gutter section. There are two general classifications of curbs: barrier and mountable.



Typical highway curbs.

(a) Barrier curb used to prevent vehicles from leaving the roadway.

(b) to (g) Mountable curbs that permit vehicles to cross when necessary. Slopes of curb faces and rounding vary.



Medians

A median is the section of a divided highway that separates the lanes in opposing directions. The width of a median is the distance between the edges of the inside lanes, including the median shoulders. The functions of a median include:

- Providing a recovery area for out-of-control vehicles
- Separating opposing traffic
- Providing stopping areas during emergencies
- Providing storage areas for left-turning and U-turning vehicles
- Providing refuge for pedestrians
- Reducing the effect of headlight glare
- Providing temporary lanes and cross-overs during maintenance operations

Medians Types

1-Raised medians are frequently used in urban arterial streets because they facilitate the control of left-turn traffic at intersections by using part of the median width for left-turn-only lanes.

2- Depressed medians are generally used on freeways and are more effective in draining surface water. A side slope of 6:1 is suggested for depressed medians, although a slope of 4:1 may be adequate.

Guard Rails

Guard rails are longitudinal barriers placed on the outside of sharp curves and at sections with high fills. Their main function is to prevent vehicles from leaving the roadway.

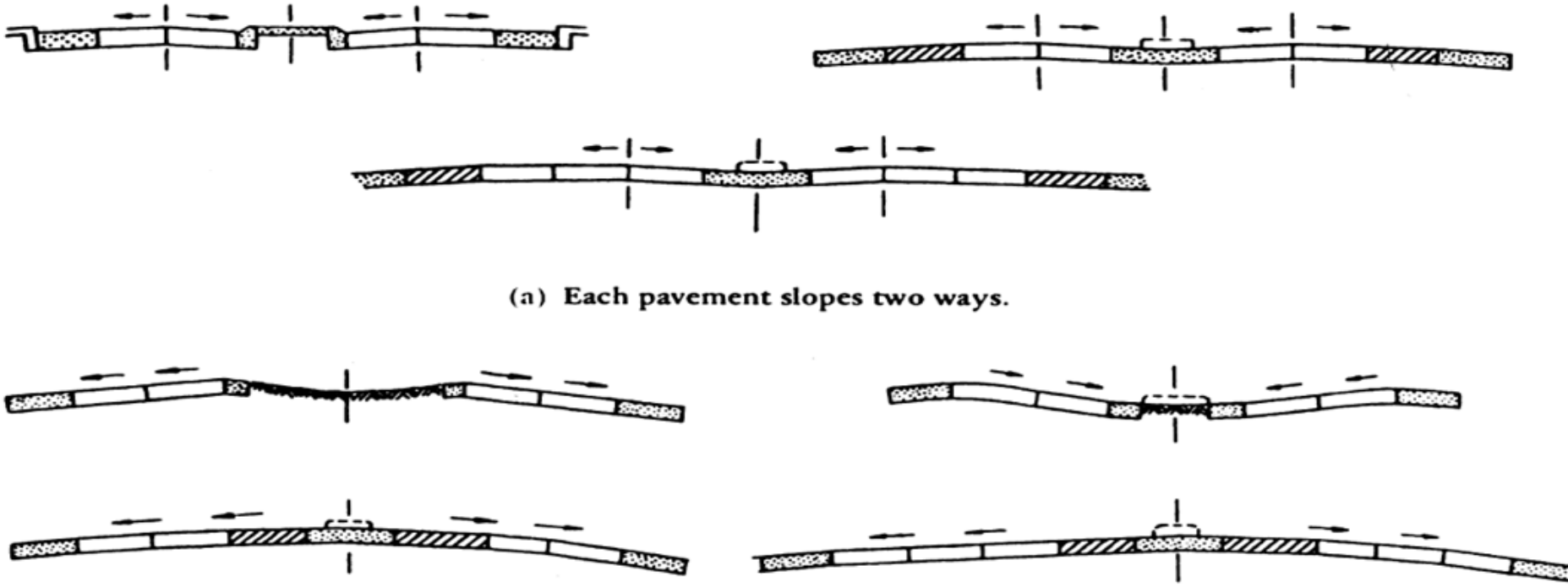
Median barriers can be composed of cable or post and beam systems or concrete.

Median widths vary from a minimum of 1.2m to 24m or more.

Cross Slopes

Pavements on straight sections of two-lane and multilane highways without medians are sloped from the middle downward to both sides of the highway, resulting in a transverse or cross slope, with a cross section shape that can be curved, plane or a combination of the two. A parabola is generally used for curved cross sections, and the highest point of the pavement (called the crown) is slightly rounded, with the cross slope increasing toward the pavement edge.

Cross Slopes



(a) Each pavement slopes two ways.

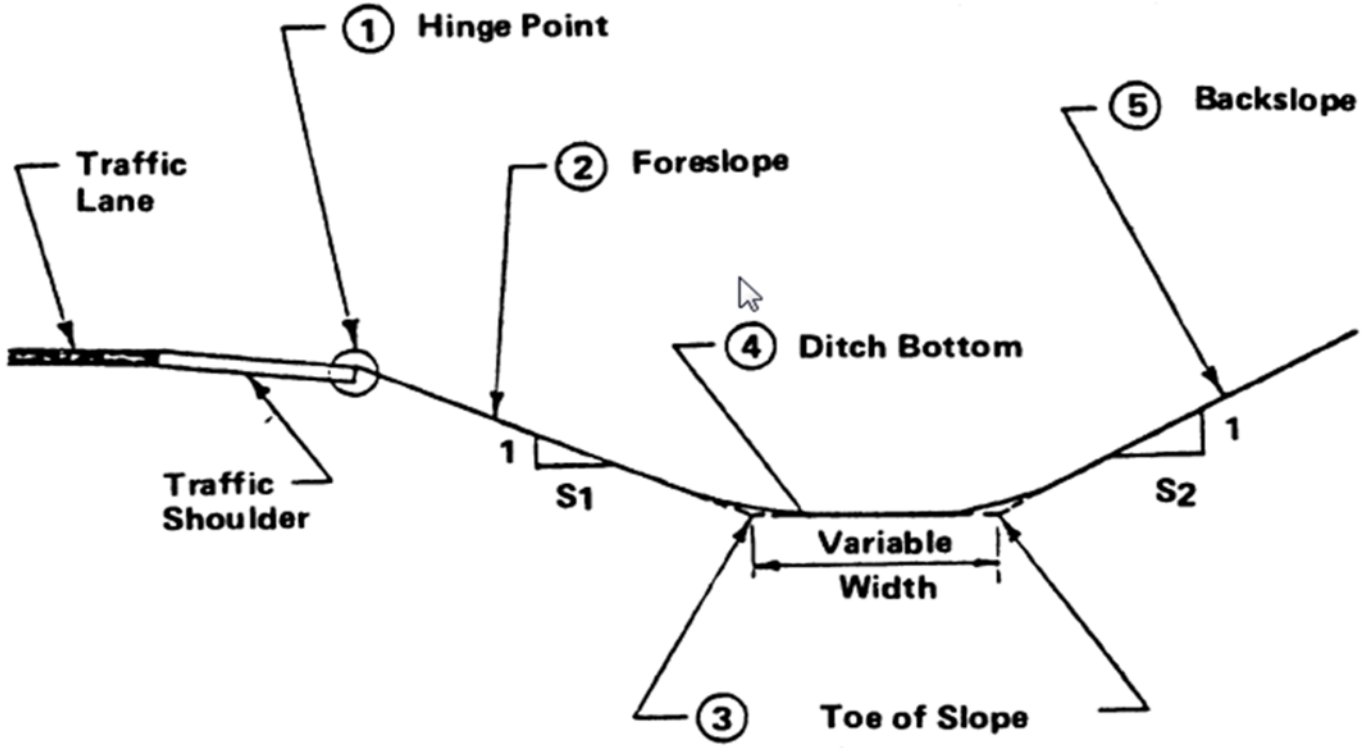
(b) Each pavement slopes one way.

Basic Cross Slope Arrangements for Divided Highways

Side Slopes.

Side slopes are provided on embankments and fills to provide stability for earthworks. They also serve as a safety feature by providing a recovery area for out-of-control vehicles. When being considered as a safety feature, the important sections of the cross slope are the hinge point, the fore slope, and the toe of the slope.

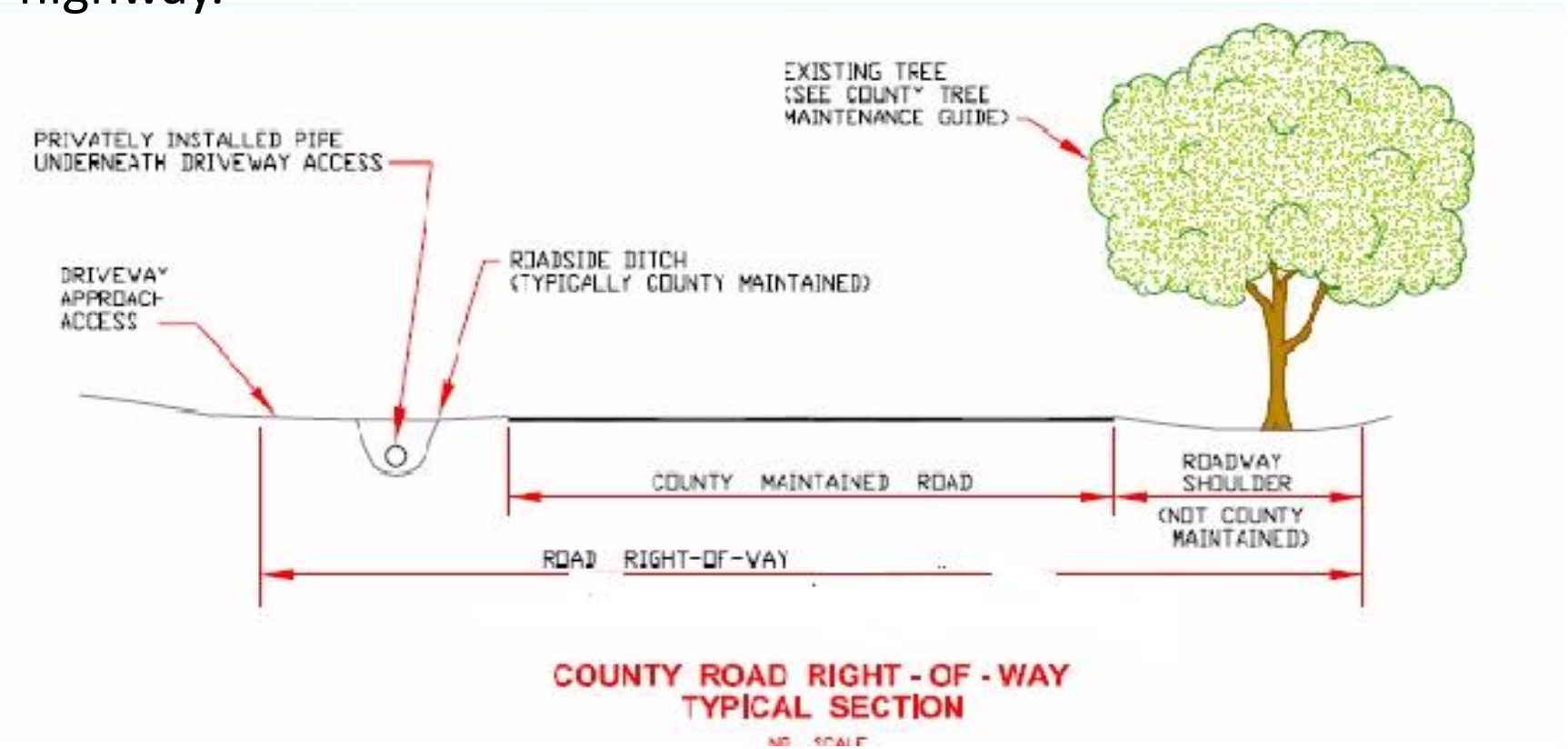
Side Slopes.



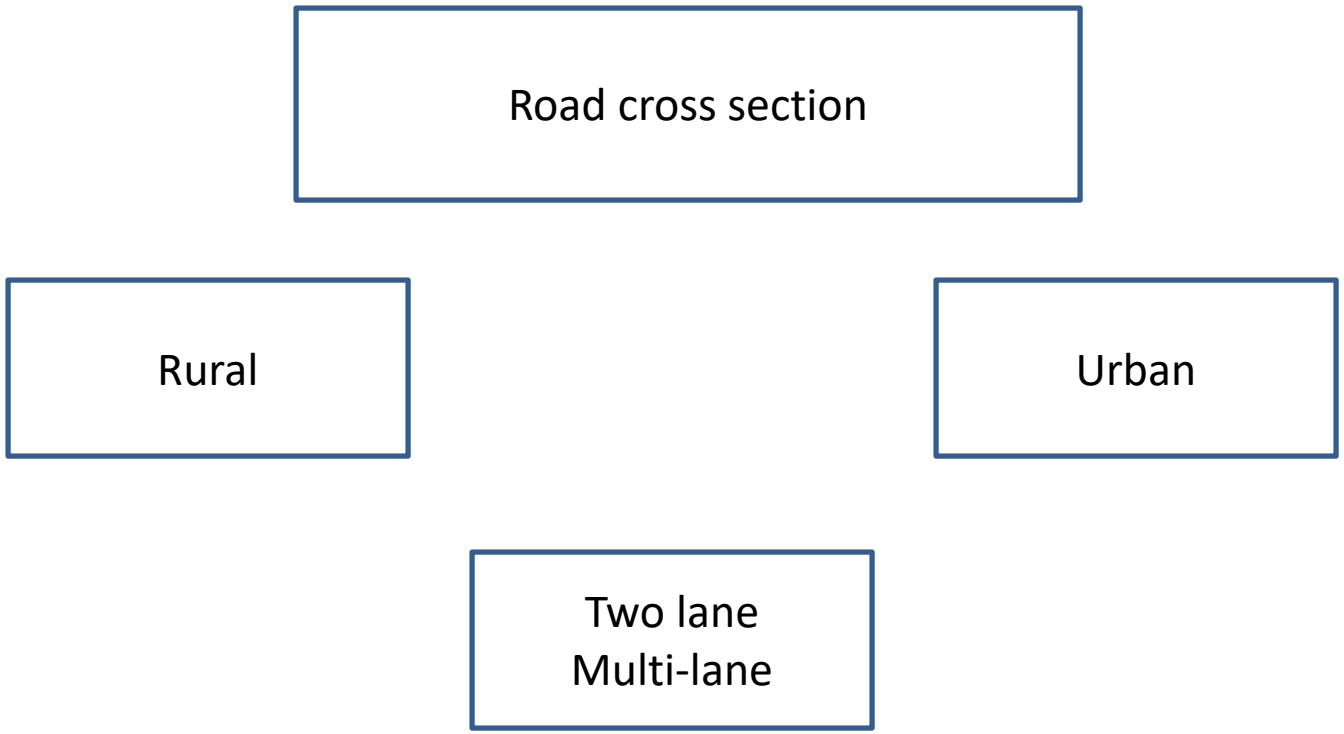
Designation of Roadside Regions

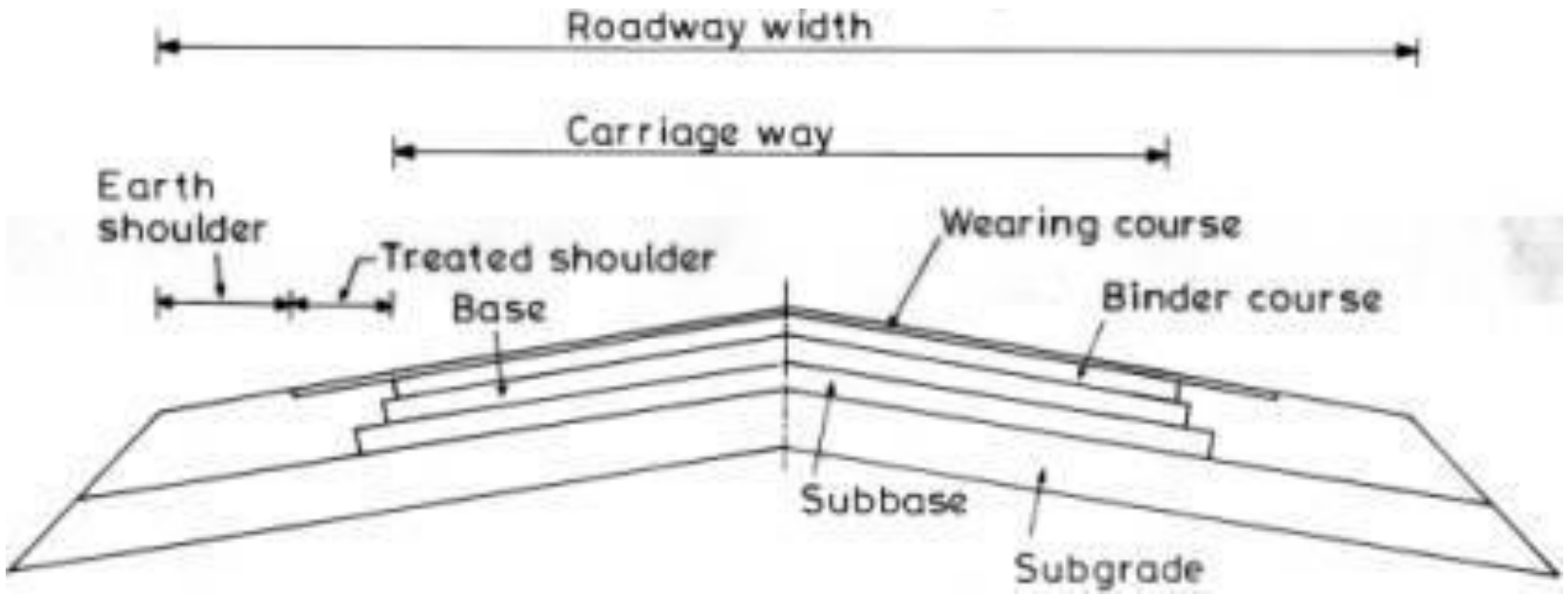
Right of Way

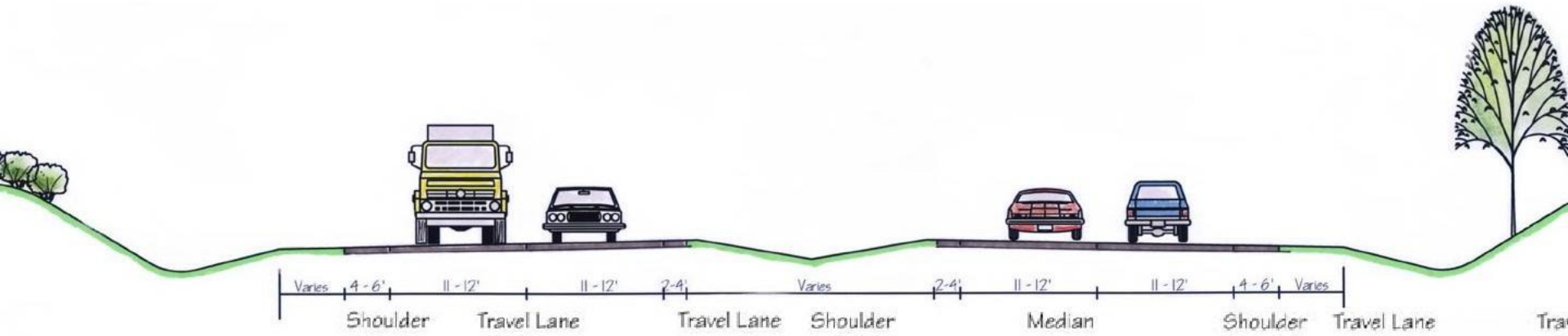
The right of way is the total land area acquired for the construction of a highway. The width should be sufficient to accommodate all the elements of the highway cross section, any planned widening of the highway, and public-utility facilities that will be installed along the highway.



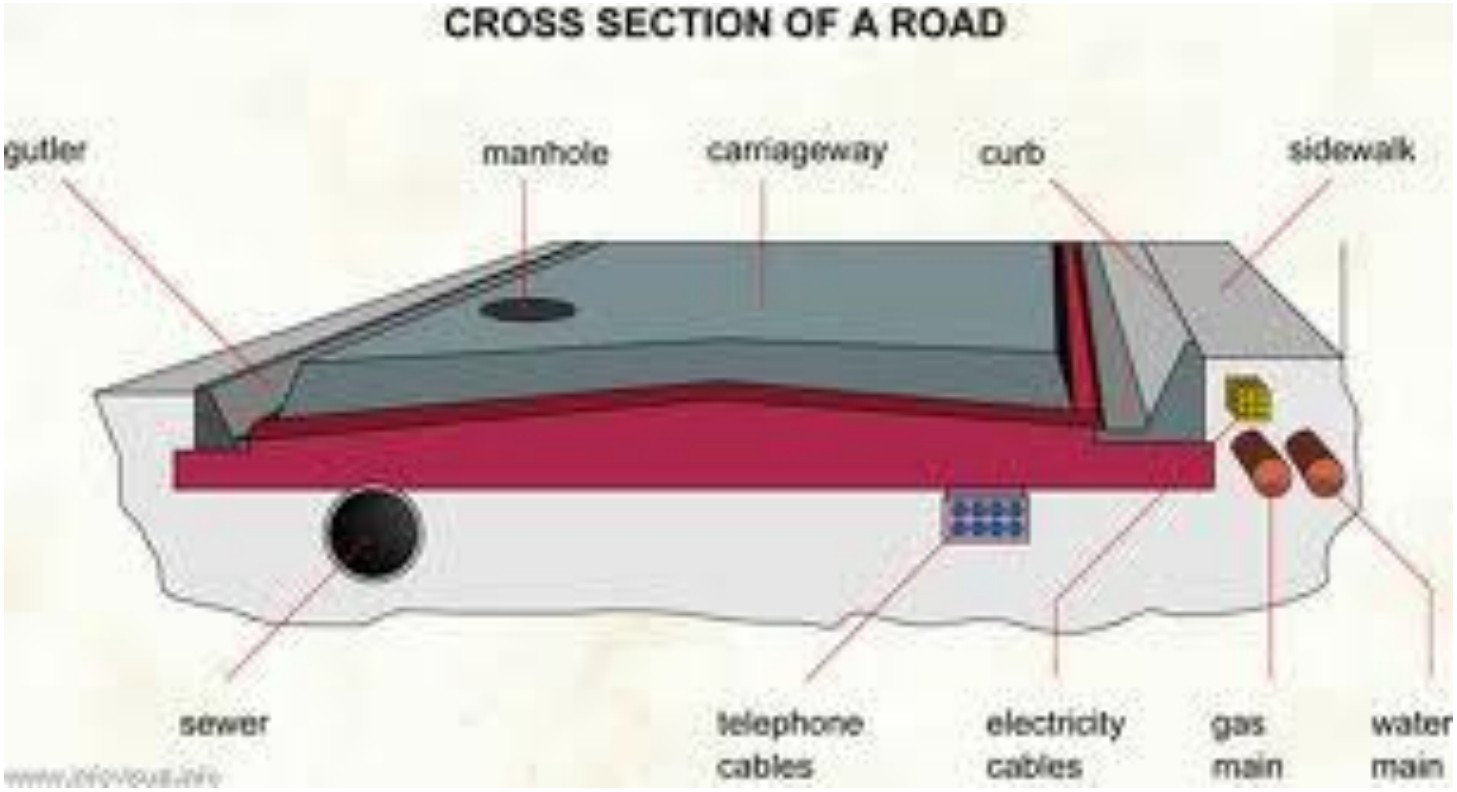
Road Cross Section Design


Road cross section
Rural
Urban
Two lane
Multi-lane


Roadway width
Carriage way
Earth shoulder
Treated shoulder
Base
Wearing course
Binder course
Subbase
Subgrade



Four Lane Divided Roadway


CROSS SECTION OF A ROAD
gutter
manhole
carriageway
curb
sidewalk
sewer
telephone cables
electricity cables
gas main
water main


Context
Streetside
Traveled Way
Streetside
Context

Design Controls and Criteria

The physical design of a new highway is controlled by many factors which are:-

- **Design Speed**

Design speed is the maximum safe speed that can be maintained over a specified section of a highway when conditions are so favorable that the design features of the highway govern.

It determines lane capacity (veh/hr/lane)

Traffic Volume

The traffic engineer's measure or indicator of traffic volume is the average daily traffic (ADT). The ADT is the volume that results from dividing a traffic count obtained during a given time period by the number of days in that time period (usually 7 days).

Another commonly used measure of traffic volume is the annual average daily traffic (AADT), which is determined by dividing a count of the total yearly traffic volume by 365.

Traffic Volume in design year

- $ADT_{\text{in design year}} = ADT\,(1+r)^n$

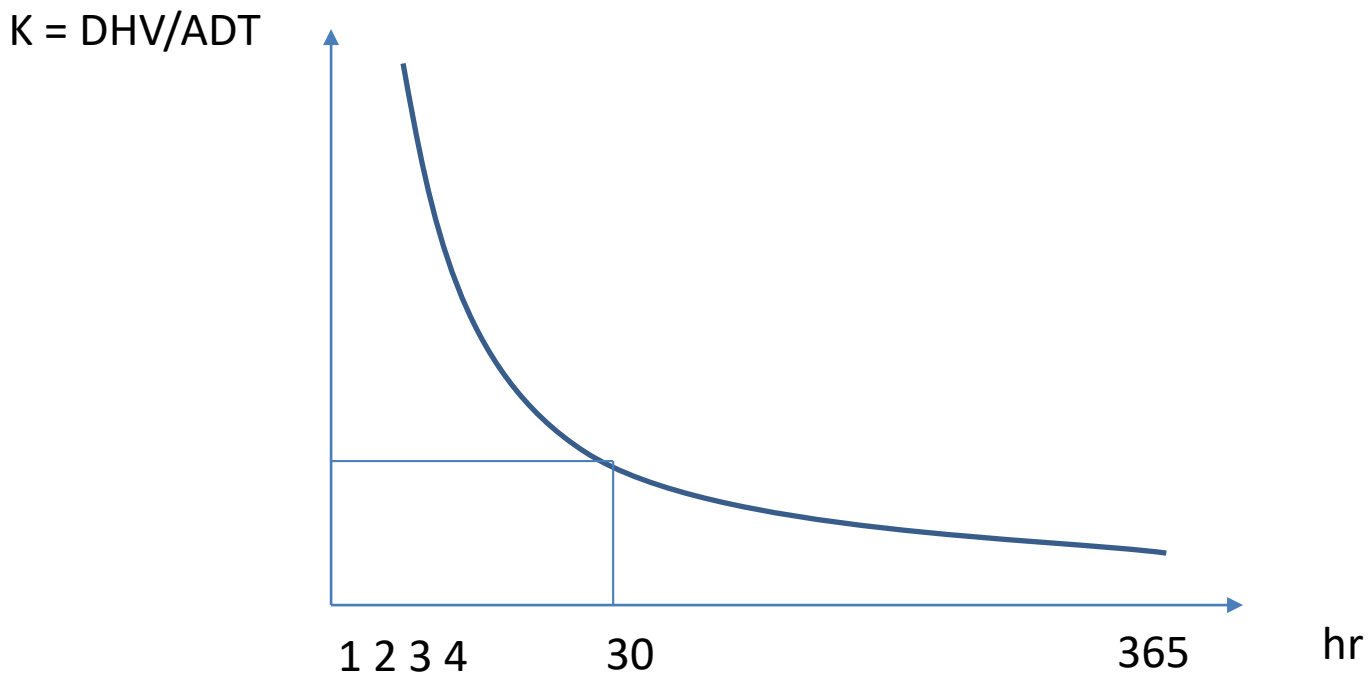
ADT : Average Daily Traffic Veh/day

r: vehicle growth factor

n: Target Year – Base year

Design Hour Factor (K)

K factor : it is used to turn ADT from veh/day to veh/hr



- **Design Hour Volume**

The DHV is a two-way traffic volume that is determined by multiplying the ADT by a percentage called the K-factor. Values for K typically range from 8 to 12% for urban facilities and 12 to 18% for rural facilities. Neither the AADT nor the ADT indicate the variations in traffic volumes that occur on an hourly basis during the day, specifically high traffic volumes that occur during the peak hour of travel.

Directional Design Hour Volume

The directional design hour volume (DDHV) is the one-way volume in the predominant direction of travel in the design hour, expressed as a percentage of the two-way DHV.

DDHV = ADT (or AADT)*K*D.

D is the directional distribution factor