Transportation Engineering- II
Lecture 3

Design Control and Criteria

- Selection of the appropriate set of geometric design standards is the first step in the design of any highway
- This is essential because no single set of geometric standards can be used for all highways
- For example, geometric standards that may be suitable for a mountain road with low average daily traffic (ADT) are inadequate for a freeway carrying heavy traffic

Design Control and Criteria

- Design vehicle
- Driver performance and human factors
- Traffic characteristics
  - Design speed
  - Design hourly volume
  - Highway capacity, Pedestrian, Access Management

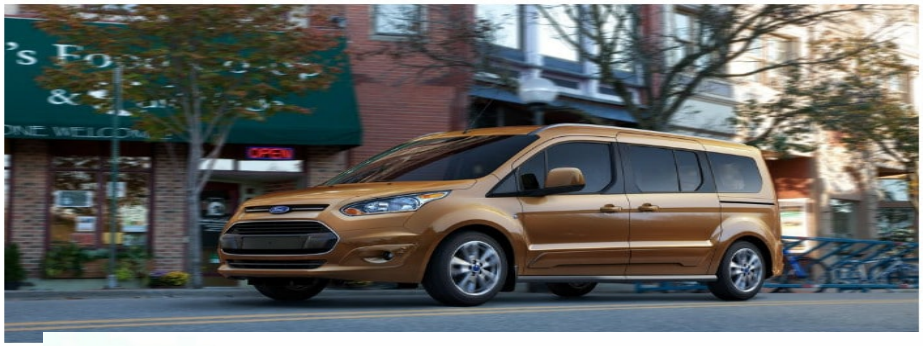
Design Vehicle

- A design vehicle is selected to represent all vehicles on the highway.
- For purposes of geometric design, each design vehicle has larger physical dimensions and a larger minimum turning radius than most vehicles in its class
- The vehicle type selected as the design vehicle is the largest that is likely to use the highway with considerable frequency

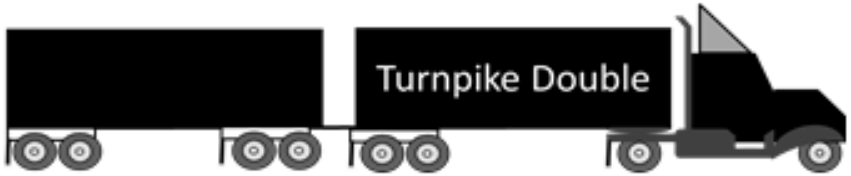
General Guidelines for Selecting a Design Vehicle

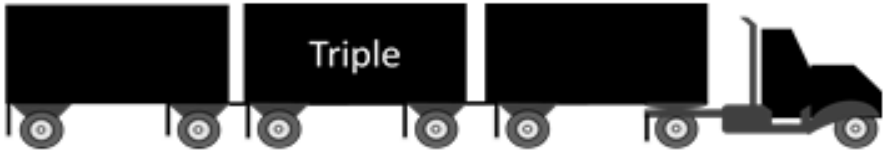
- When a parking lot or a series of ***parking lots*** are the main traffic generators, the ***passenger car*** may be used
- For the design of intersections at ***local streets*** and park roads, a ***single-unit truck*** may be used
- At intersections of ***state highways and city streets*** that serve buses with relatively few large trucks, a ***city transit bus*** may be used

Passenger cars



Single Unit vs Combination Trucks





General Guidelines for Selecting a Design Vehicle

- At intersections of ***highways and low-volume county highways*** or township/local roads with less than 400 ADT, either an ***84-passenger large school bus*** 40 ft long or a ***65-passenger conventional bus*** 36 ft long may be used
- At intersections of ***freeway ramp terminals and arterial crossroads***, and at intersections of state highways and industrialized streets that carry high volumes of traffic, the minimum size of the design vehicle should be ***WB-67***
- The selection of either of these will depend on the expected usage of the facility.

Design Vehicle Dimensions

Design Vehicle Type	Symbol	Dimensions (ft)											
		Overall			Overhang								
		Height	Width	Length	Front	Rear	WB_1	WB_2	S	T	WB_3	WB_4	Typical Kingpin to Center of Rear Tandem Axle
Passenger Car	P	4.3	7.0	19.0	3.0	5.0	11.0	—	—	—	—	—	—
Single-Unit Truck	SU-30	11.0–13.5	8.0	30.0	4.0	6.0	20.0	—	—	—	—	—	—
Single-Unit Truck (three-axle)	SU-40	11.0–13.5	8.0	39.5	4.0	10.5	25.0	—	—	—	—	—	—
Buses													
Intercity Bus (Motor Coaches)	BUS-40	12.0	8.5	40.5	6.3	9.0[a]	25.3	—	—	—	—	—	—
	BUS-45	12.0	8.5	45.5	6.2	9.0[a]	28.5	—	—	—	—	—	—
City Transit Bus	CITY-BUS	10.5	8.5	40.0	7.0	8.0	25.0	—	—	—	—	—	—
Conventional School Bus (65 pass.)	S-BUS 36	10.5	8.0	35.8	2.5	12.0	21.3	—	—	—	—	—	—
Large School Bus (84 pass.)	S-BUS 40	10.5	8.0	40.0	7.0	13.0	20.0	—	—	—	—	—	—
Articulated Bus	A-BUS	11.0	8.5	60.0	8.6	10.0	22.0	19.4	6.2[b]	13.2[b]	—	—	—
Combination Trucks													
Intermediate Semitrailer	WB-40	13.5	8.0	45.5	3.0	4.5[a]	12.5	25.5	—	—	—	—	25.5
Interstate Semitrailer	WB-62*	13.5	8.5	69.0	4.0	4.5[a]	19.5	41.0	—	—	—	—	41.0
Interstate Semitrailer	WB-67**	13.5	8.5	73.5	4.0	4.5[a]	19.5	45.5	—	—	—	—	45.5
"Double-Bottom" Semitrailer/Trailer	WB-67D	13.5	8.5	72.3	2.3	3.0	11.0	23.0	3.0[c]	7.0[c]	22.5	—	23.0
Rocky Mountain Double-Semitrailer/Trailer	WB-92D	13.5	8.5	97.3	2.3	3.0	17.5	40.0	4.5	7.0	22.5	—	40.5
Triple-Semitrailer/Trailers	WB-100T	13.5	8.5	104.8	2.3	3.0	11.0	22.5	3.0[d]	7.0[d]	22.5	22.5	23.0
Turnpike Double-Semitrailer/Trailer	WB-109D*	13.5	8.5	114.0	2.3	4.5[a]	12.2	40.0	4.5[e]	10.0[e]	40.0	—	40.5
Recreational Vehicles													
Motor Home	MH	12.0	8.0	30.0	4.0	6.0	20.0	—	—	—	—	—	—
Car and Camper Trailer	P/T	10.0	8.0	48.7	3.0	12.0	11.0	—	5.0	17.7	—	—	—
Car and Boat Trailer	P/B	—	8.0	42.0	3.0	8.0	11.0	—	5.0	15.0	—	—	—
Motor Home and Boat Trailer	MH/B	12.0	8.0	53.0	4.0	8.0	20.0	—	6.0	15.0	—	—	—

* Design vehicle with 48.0-ft trailer as adopted in 1982 Surface Transportation Assistance Act (STAA).

** Design vehicle with 53.0-ft trailer as grandfathered in with 1982 Surface Transportation Assistance Act (STAA).

[a] This is the length of the overhang from the back axle of the tandem axle assembly.

[b] Combined dimension is 19.4 ft and articulating section is 4.0 ft wide.

[c] Combined dimension is typically 10.0 ft.

[d] Combined dimension is typically 10.0 ft.

[e] Combined dimension is typically 12.5 ft.

- WB_1, WB_2, WB_3, and WB_4 are the effective vehicle wheelbases, or distances between axle groups, starting at the front and working towards the back of each unit.
- S is the distance from the rear effective axle to the hitch point or point of articulation.
- T is the distance from the hitch point or point of articulation measured back to the center of the next axle or the center of the tandem axle assembly.

Minimum Turning Radii of Design Vehicles (ft)

Design Vehicle Type	Pas-senger Car	Single-Unit Truck	Single-Unit Truck (Three Axle)	Intercity Bus (Motor Coach)		City Transit Bus	Conven-tional School Bus (65 pass.)	Large[a] School Bus (84 pass.)	Articu-lated Bus	Inter-mediate Semi-trailer
Symbol	P	SU-30	SU-40	BUS-40	BUS-45	CITY-BUS	S-BUS36	S-BUS40	A-BUS	WB-40
Minimum Design Turning Radius (ft)	23.8	41.8	51.2	41.7	44.0	41.6	38.6	39.1	39.4	39.9
Centerline[b] Turning Radius (CTR) (ft)	21.0	38.0	47.4	37.8	40.2	37.8	34.9	35.4	35.5	36.0
Minimum Inside Radius (ft)	14.4	28.4	36.4	24.3	24.7	24.5	23.8	25.3	21.3	19.3

Design Vehicle Type	Interstate Semi-trailer		"Double Bottom" Combina-tion	Rocky Mtn Double	Triple Semi-trailer/ trailers	Turnpike Double Semi-trail-er/ trailer	Motor Home	Car and Camper Trailer	Car and Boat Trailer	Motor Home and Boat Trailer
Symbol	WB-62*	WB-67**	WB-67D	WB-92D	WB-100T	WB-109D*	MH	P/T	P/B	MH/B
Minimum Design Turning Radius (ft)	44.8	44.8	44.8	82.0	44.8	59.9	39.7	32.9	23.8	49.8
Centerline[b] Turning Radius (CTR) (ft)	41.0	41.0	40.9	78.0	40.9	55.9	36.0	30.0	21.0	46.0
Minimum Inside Radius (ft)	7.4	1.9	19.1	55.6	9.7	13.8	26.0	18.3	8.0	35.0

* Design vehicle with 48-ft trailer as adopted in 1982 Surface Transportation Assistance Act (STAA).

** Design vehicle with 53-ft trailer as grandfathered in with 1982 Surface Transportation Assistance Act (STAA).

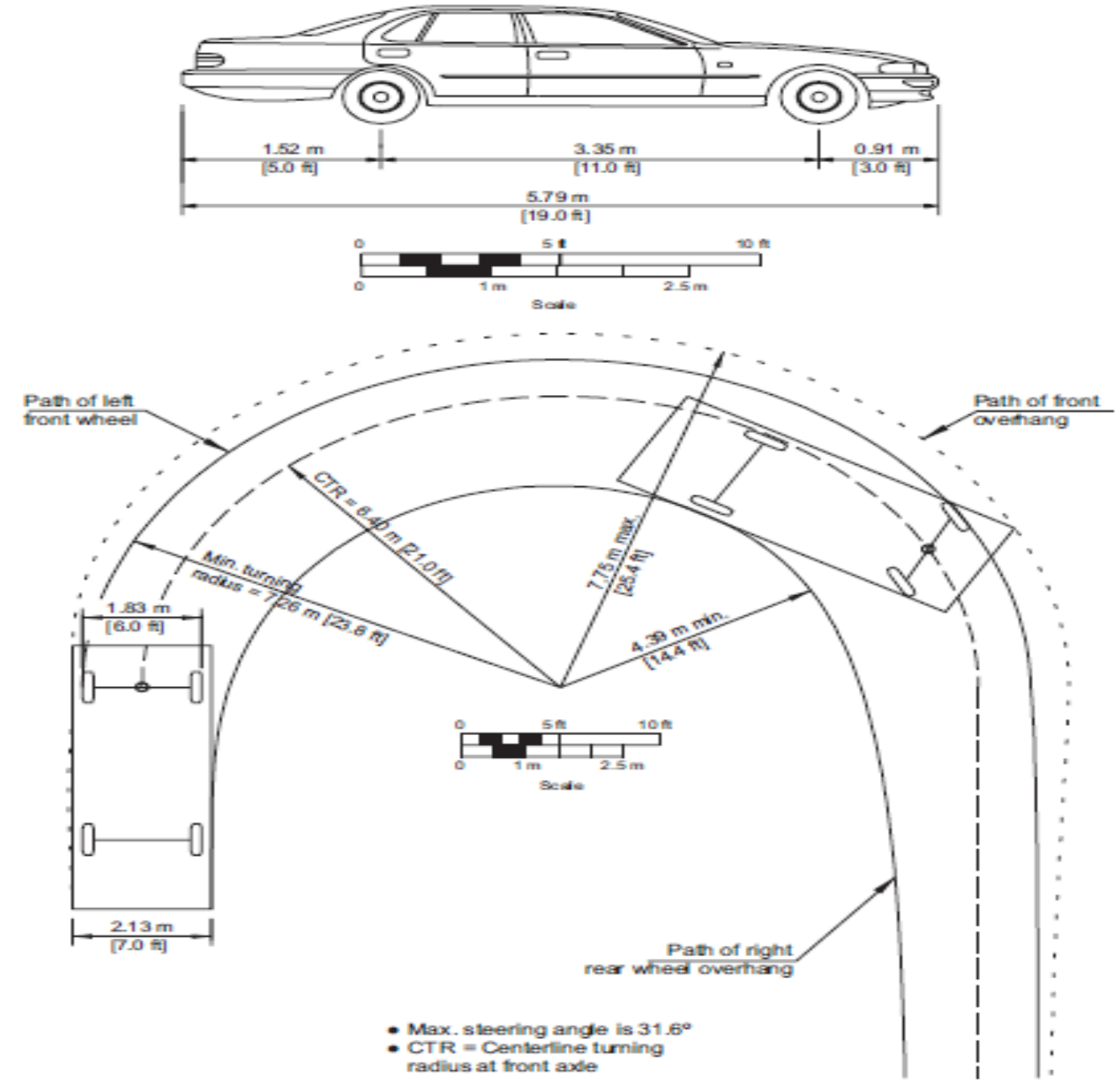


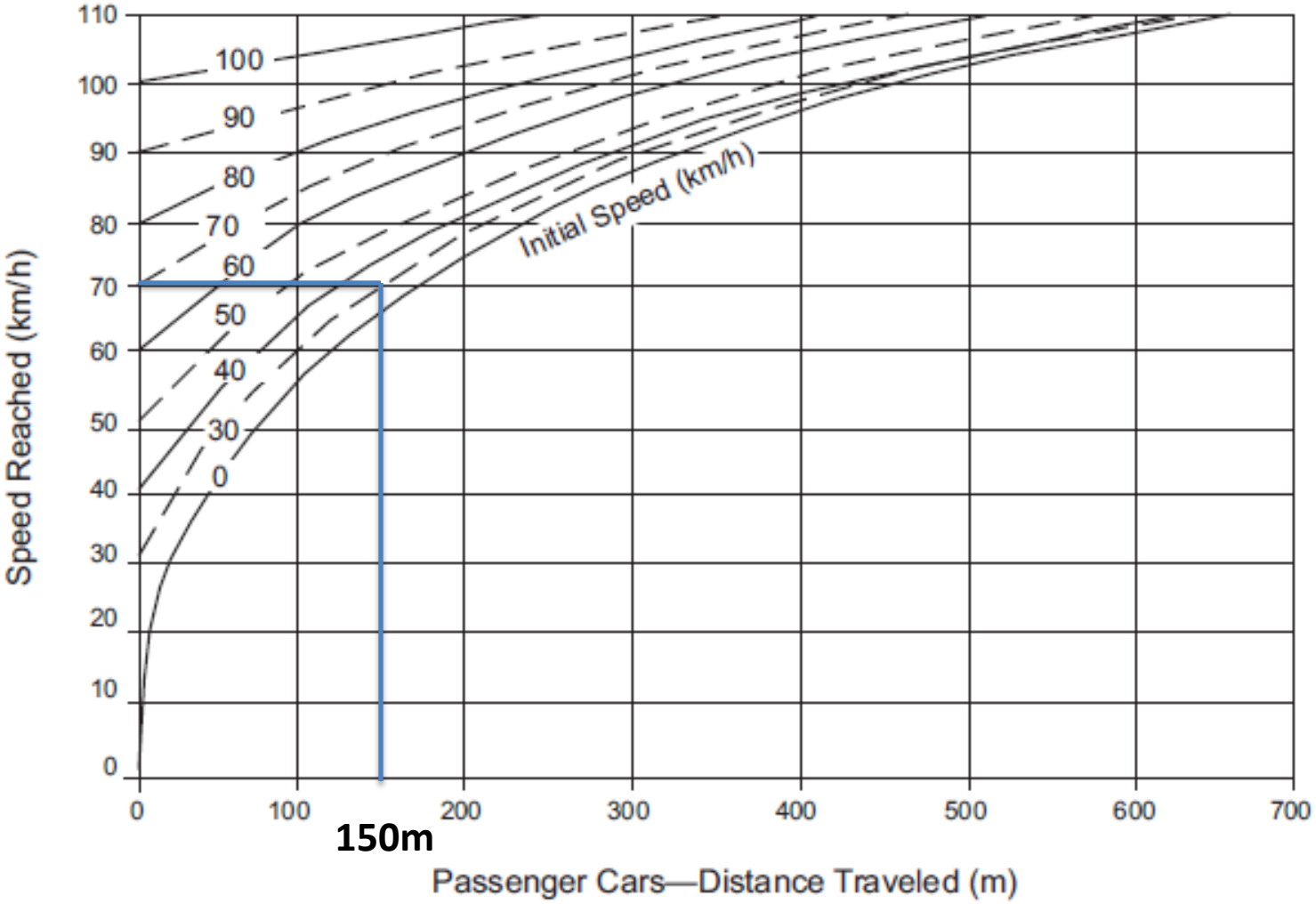
Figure 2-1. Minimum Turning Path for Passenger Car (P) Design Vehicle

Vehicle Performance

- ***Acceleration and deceleration rates of vehicles are often critical parameters in determining highway design***
- These rates often govern the dimensions of such design features:
  - Freeway ramps
  - Climbing or passing lanes
  - Turnout bays for buses
  - Acceleration and deceleration lanes
  - Highway alignment (adequate passing and stopping sight distance)
  - Determine the need for truck climbing lanes (steep grade)

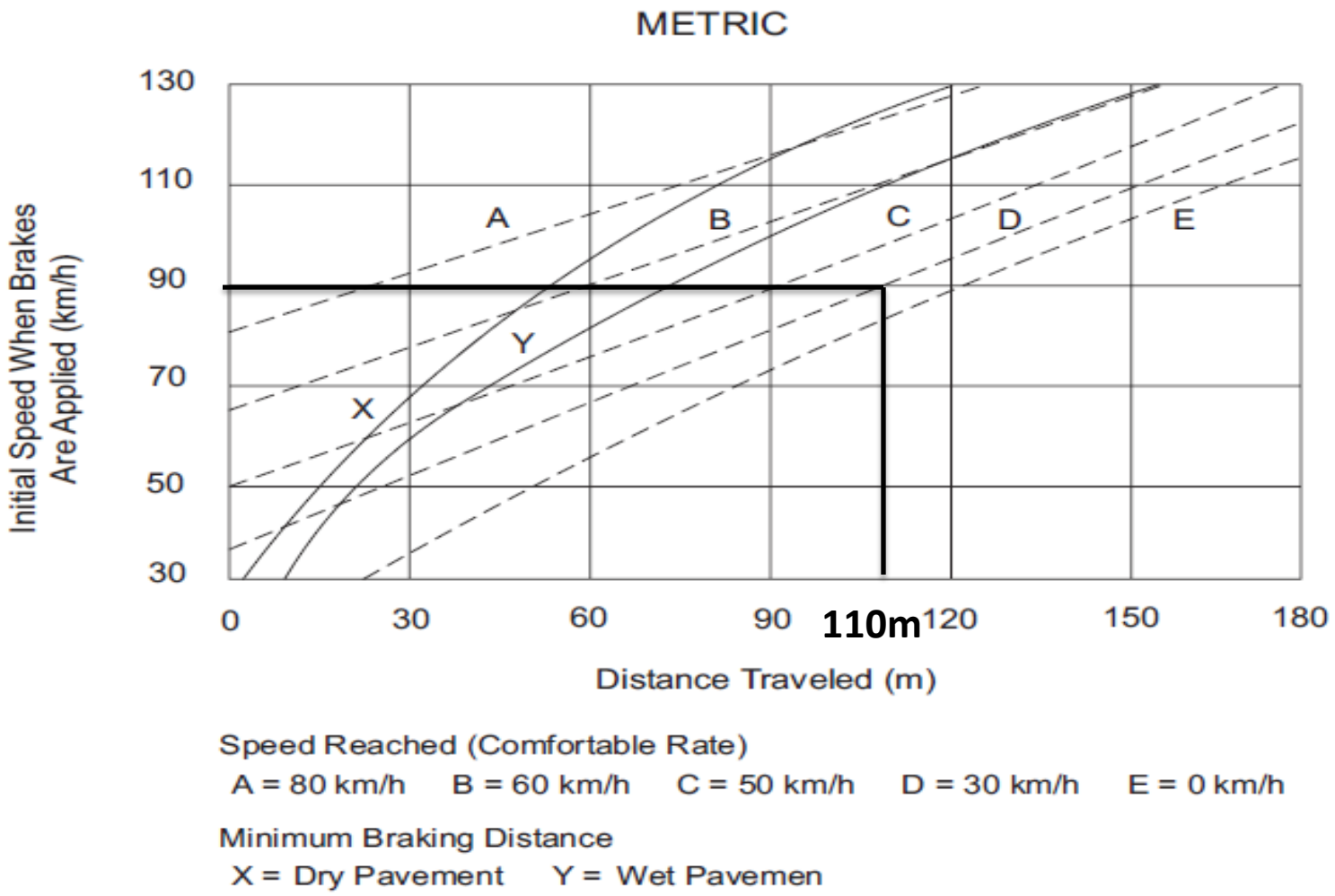
Vehicle Performance

Vehicle Performance



Acceleration of Passenger Cars, Level Conditons

Vehicle Performance



Deceleration Distances for Passenger Vehicles Approaching Intersections

Driver performance and human factors

- Consideration of driver performance is essential to proper highway design and operation
- The suitability of a design rests as much on how effectively drivers are able to use the highway
- When drivers use a highway designed to be compatible with their capabilities and limitations, their performance is aided
- When a design is incompatible with the capabilities of drivers, the chance for driver errors increase, and crashes or inefficient operation may result

Driver performance and human factors

- **Older Drivers**
- Older road users deserve mobility and they should be accommodated in the design of highway facilities to the extent practical
- Older drivers have special needs that should be considered in highway design and traffic control
- For example, for every decade after age 25, drivers need twice the brightness at night to receive visual information
- Hence, by age 75, some drivers may need 32 times the brightness they did at age 25

Driver performance and human factors

- Characteristics of the Older Driver (compared to younger drivers)
  - Slower information processing
  - Slower reaction times
  - Slower decision making
  - Visual deterioration
  - Hearing deterioration
  - Decline in ability to judge time, speed, and distance
  - Limited depth perception
  - Limited physical mobility
  - Side effects from medication

The Information System

- Each element that provides information to drivers is part of the information system of the highway
- Formal sources of information: are the traffic control devices specially designed to display information to drivers.
- Informal sources of information: include such elements as roadway and roadside design features, pavement joints, tree lines, and traffic
- Together, the formal and informal sources provide the information drivers need to drive effectively

The Information System

- Traffic control devices: media by which traffic engineers communicate with drivers
- Traffic control devices provide guidance and navigation information that often is not otherwise available or apparent
- Virtually every traffic law, regulation, or operation instruction must be communicated through the use of devices that fall into three broad categories:
  - Traffic signs
  - Traffic markings
  - Traffic signals

Information Handling

- Needed information should be in the driver's field of view, available when and where needed, available in a usable form, and capable of capturing the driver's attention
- **Reaction Time**
  - Drivers' reaction times increase as a function of decision complexity and the amount of information to be processed.
  - Longer the reaction time, the greater the chance for error
  - For simple, unexpected decision and action, some drivers may take as long as 2.5 s to respond.

Traffic characteristics-Volume

- The design of a highway and its features should explicitly consider traffic volumes and traffic characteristics
- However, traffic volumes can indicate the need for the improvement and directly influence the selection of geometric design features, such as number of lanes, widths, alignments, and grades

Traffic characteristics-Volume

- **Traffic Volume.** Number of vehicles passing a point on a highway during a specified time interval. Units: Simply vehicles or vehicles per unit time (veh/day; veh/hr)
- **Average annual daily traffic (AADT).** The average 24-hour volume at a given location over a full 365-day year (366 days in leap year).
- **Average daily traffic (ADT).** The average 24-hour volume at a given location over a defined time period less than one year; a common application is to measure an ADT for each month of the year

OR

- The ADT is defined as the total volume during a given time period (in whole days), greater than one day and less than one year, divided by the number of days in that time period

Traffic characteristics-Volume

- **Peak-Hour Traffic**
- The reasonableness of 30 HV as a design control is indicated by the changes that result from choosing a somewhat higher or lower volume
- The curve steepens quickly to the left of the point showing the 30th highest hour volume and indicates only a few more hours with higher volumes
- The curve flattens to the right of the 30th highest hour and indicates many hours in which the volume is not much less than the 30 HV

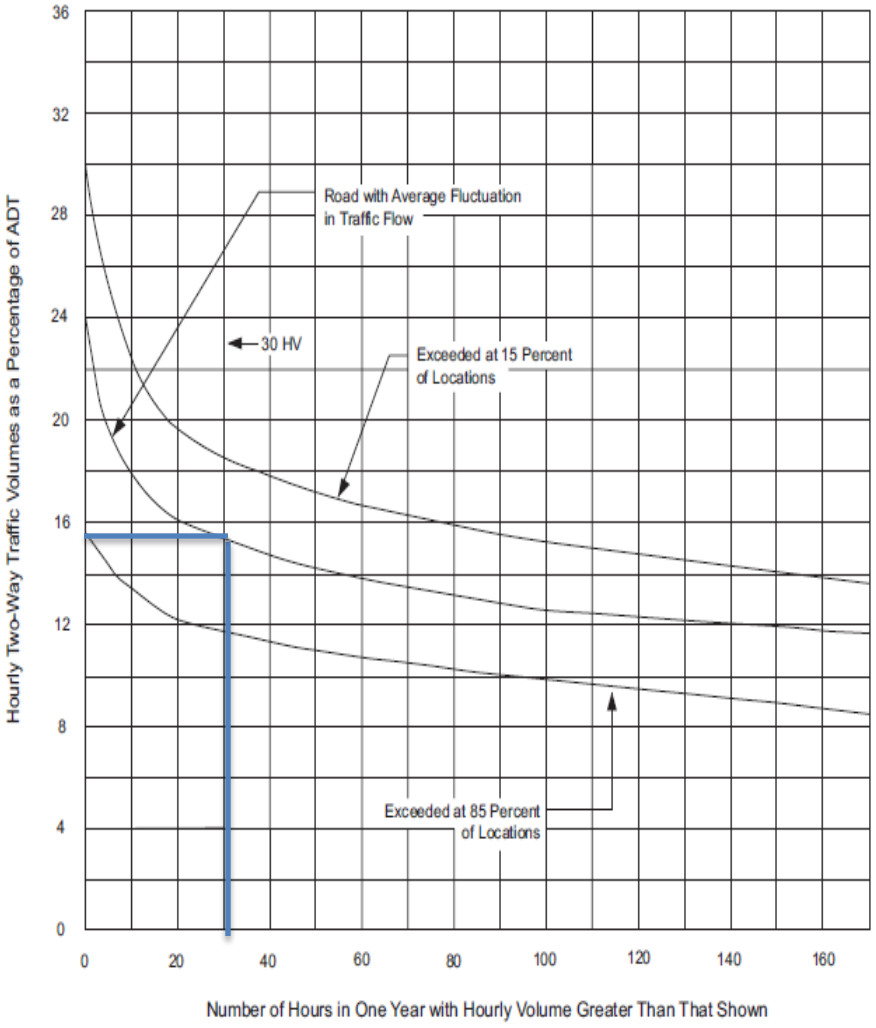


Figure 2-28. Relation between Peak-Hour and Average Daily Traffic Volumes on Rural Arterials

Traffic characteristics-Volume

Peak-Hour Traffic

- On rural roads with average fluctuation in traffic flow, the 30 HV is typically about 15 percent of the ADT
- The maximum hourly volume, which is approximately 25 percent of the ADT on the graph, exceeds 30 HV by about 67 percent.
- Typically, 30HV
  - 15% of AADT in rural areas, and
  - 8-12% in urban areas.

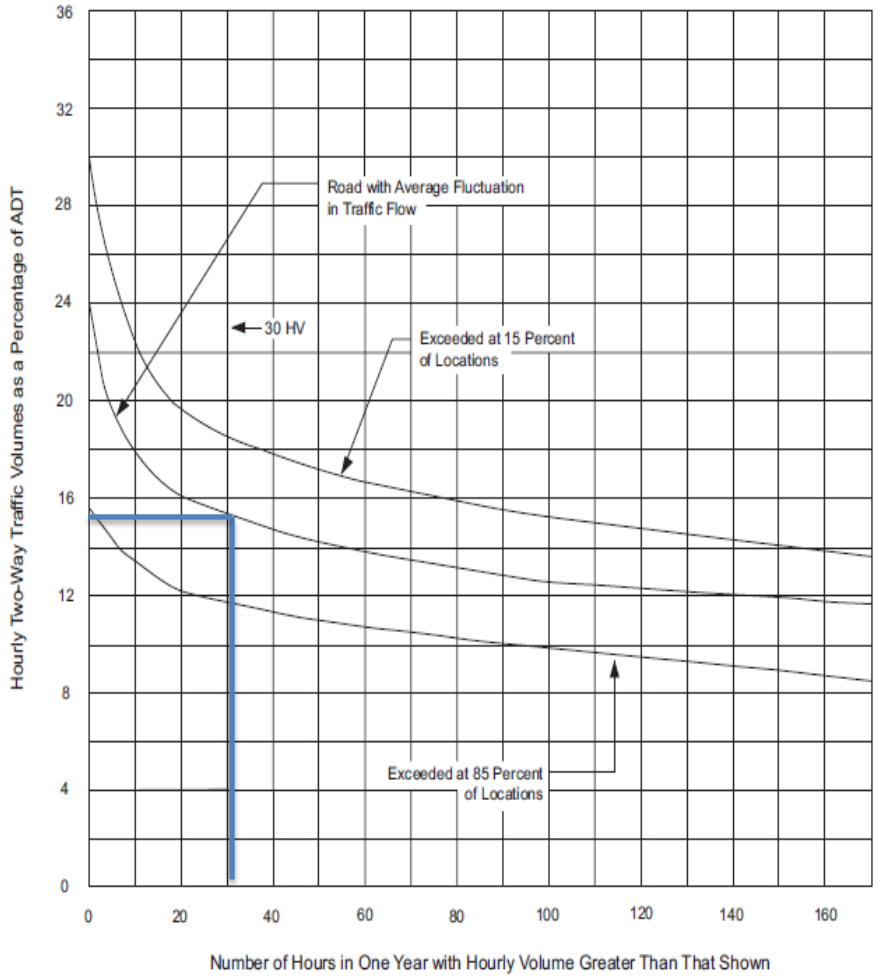


Figure 2-28. Relation between Peak-Hour and Average Daily Traffic Volumes on Rural Arterials


Q
A
Answer