Contents

3 Chapter 03 Sight Distance (SD)

3.1 Objectives

1. describe various types of sight distance
2. determine sight distance requirements for stopping and passing maneuvers

3.2 key component of SD

1. PRT: the perception-reaction time required to initiate a maneuver (pre-maneuver phase)
2. MT: the time requried to safely complete a maneuver

driver's eye - 3.5ft high
Hazard - 2ft high

3.3 Sight Distance Types

1. stopping sight distance (SSD)
2. decision sight distance (DSD)
3. passing sight distance (PSD)
4. intersection sight distance (ISD)

3.4 SSD - stopping sight distance

SSD is a key input for geometric design, including horizontal and vertical alignment

PRT includes: recognize an object + decide a stop + react and prepare to apply the brake
Deceleration rate: $11.2 ft/sec^2$, 10th percentile deceleration rate, by AASHTO

$SSD = D_{p-r} + D_b$

D_{p-r}: in ft, perception-reaction distance

D_b: in ft, braking distance

$D_{p-r} = 1.47 \times 2.5s \times v = 3.675v$

D_{p-r}: in ft, perception-reaction distance

v: in mi/h, design speed

$$D_b = \frac{(v_0)^2 - (v_f)^2}{30(\frac{a}{g} \pm G)}$$

D_b: in ft, braking distance

v_0: in mi/h, design speed

v_f: in mi/h, final velocity

a: 11.2 ft/sec^2, deceleration rate, by AASHTO, in [10, 15]

g: 32.2 ft/sec^2

f = a/g: 0.35 by ASSHTO, coefficient of friction, 0.7 for dry roads, 0.3-0.4 for wed roads

G: grade, e.g. down grade: -0.06

3.5 SSD on vertical curve

crest curve:
- Driver eye height: 3.5ft
- Height of object in readway: 2.0ft

sag curve:
- headlight height: 2ft
- headlight beam angle: 1 degree (departure from horizontal, suggest changing to 0.75 degree)

3.6 DSS - decision sight distance

For A or B (avoidance maneuvers):
$DSD = 1.47V_t + 1.075(V^2/a)$

For C, D, and E:
$DSD = 1.47V_t$

3.7 DSS - decision sight distance

Decision sight distance for various conditions:

Avoidance Maneuver A: Stop on rural road, t = 3.0 s
Avoidance Maneuver B: Stop on urban road, t = 9.1 s

Avoidance Maneuver C: Speed/path/direction change on rural road, t varies between 10.2 and 11.2 s
Avoidance Maneuver D: Speed/path/direction change on suburban road, t varies between 12.1 and 12.9 s
Avoidance Maneuver E: Speed/path/direction change on urban road, t varies between 14.0 and 14.5 s

Source: AASHTO Green Book, 2011, Table 3-3

Table 1: U.S. Customary Decision Sight Distance

Design Speed (mph)	Decision Sight Distance (ft)				
	A	B	C	D	E
30	220	490	450	535	620
35	275	590	525	625	720
40	330	690	600	715	825
45	395	800	675	800	930
50	465	910	750	890	1030
55	535	1030	865	980	1135
60	610	1150	990	1125	1280
65	695	1275	1050	1220	1365
70	780	1410	1105	1275	1445
75	875	1545	1180	1365	1545
80	970	1685	1260	1455	1650

Table 2: Metric Decision Sight Distance

Design Speed (km/h)	DSD (m)				
	A	B	C	D	E
50	70	155	145	170	195
60	95	195	170	205	235
70	115	325	200	235	275
80	140	280	230	270	315
90	170	325	270	315	360
100	200	370	315	355	400
110	235	420	330	380	430
120	265	470	360	415	470
130	305	525	390	450	510

3.8 PSD - Passing sight distance

passing vehicle speed - passed vehicle speed >= 12 mi/h

On two-lane rural highways
overtaking and returning to lane
before opposing vehicle reaches passing vehicle

3.9 Passing sight distance assumptions - Green Book

1. Speeds of passing and opposing vehicles equal the design speed
2. Speed differential between the passing and passed vehicle is 12 mi/h
3. Design vehicle is passenger car for all vehicles involved
4. Perception-reaction time to decide to abort is 1 second
5. Deceleration rate in abort maneuver is $11.2 ft/sec^2$
6. Headway at end of maneuver is 1 second

3.10 vertical sight distance - Sighting Rod and Target Rod - AASHTO

Sighting rod (driver eye, used by observer): 3.5ft tall

Target rod (object, used by assistant): 4.25ft tall

Table 3: U.S. Customary Assumed Speeds and Passing Sight Distance

Design Speed (mph)	Passed Vehicle (mph)	Passing Vehicle (mph)	Passing Sight Distance (ft)
20	8	20	400
25	13	25	450
30	18	30	500
35	23	35	550
40	28	40	600
45	33	45	700
50	38	50	800
55	43	55	900
60	48	60	1000
65	53	65	1100
70	58	70	1200
75	63	75	1300
80	68	80	1400

Table 4: Metric Passing Sight Distance

Design Speed (km/h)	Assumed Speeds Passed Vehicle (km/h)	Passing Vehicle (km/h)	PSD (m)
30	11	30	120
40	21	40	140
50	31	50	160
60	41	60	180
70	51	70	210
80	61	80	245
90	71	90	280
100	81	100	320
110	91	110	355
120	101	120	395
130	111	130	440

3.11 ISD - Intersection Sight Distance

1. **a.k.a Green Book/PGDHS:** A Policy on Geometric Design of Highways and Streets, 2018, 7th Edition
2. Guidelines for Geometric Design of Very Low Volume Local Roads, 2001
3. A Guide to Achieving Flexibility in Highway Design, May 2004
4. Guide for the Planning, Design, and Operation of Pedestrian Facilities, July 2004
5. Guide for the Development of Bicycle Facilities, June 2012

6. Good for New Highway Design

7. TRB Special Report 214, Designing Safer Roads: Practices for Resurfacing, Restoration, and Rehabilitation for guidance.

3.12 ISD - formula

The Intersection Sight Distance (ISD) is given by the formula:

$$ISD = 1.47 V_{\text{major}} \times t_g \tag{1}$$

where:

- ISD in ft, the intersection sight distance (length of the leg of sight triangle along the major road)
- V_{major} in mph, the design speed of the major road in miles per hour (mph).
- t_g in seconds, is the time gap for a minor road vehicle to enter the major road

where t_g:

- design vehicle: passenger car 7.5s; single-unit truck 9.5s; combination truck 11.5s
- a stopped vehicle turns **left** to a 2-lane highway; without median; grade <= 3%
- Major highway: each additional lane, passenger car $+0.5s$; trunck $+0.7s$;
- Minor road: grade > 3%, add 0.3s for each percent grade

3.13 design elements

Design elements affect design consistency, driver expectancy, and vehicular operation.

1. horizontal and vertical alignment
2. embankments and slopes
3. shoulders, crown and cross slope, superelevation
4. bridge widths
5. signing and delineation
6. guardrail and placement of utility poles or light supports

3.14 Highway Design Control Factors

1. Highway Function (Arterials, Collections, Locals)
2. Design speed of the facility
3. Physical characteristics of the "design vehicle"
4. Performance of the design vehicle (heavy trucks, RVs)
5. Acceptable degree of congestion

3.15 Highway functions

Highway Function: Arterials, Collections, Locals
Arterials: principal arterials, minor arterials Mobility: the ability to move goods and passengers to their destination in a reasonable time Accessibility: the ability to reach desired destination

3.16 Hierarchy of Movements - 6 stages

Main Movement
Transition
Distribution
Collection
Access
Termination

3.17 Hierarchy of Movements

Roadway Class	**% Through Movement**	**VMT in Rural**	**Miles in Rural**	**VMT in Urban**	**Miles in Urban**
Freeways	100%				
Arterials	60-80%	**45-75%**	6-12%	**65-80%**	15-25%
Collectors	40-60%	20-35%	20-25%	5-19%	5-10%
Local Streets	0-40%	5-20%	**65-75%**	10-30%	**65-80%**

3.18 Highway Design Volume

Highway Type	Approximate Design Speed	Approximate Design Volume
Freeway – free flow	70-75 mph	2400 veh/h/ln
Freeway – free flow	65 mph	2300 veh/h/ln
Rural Highways		
a) Multilane-one way		1600-2000 veh/h/ln
b) Two lane		2000-2800 veh/h
Urban Highways		
a) Arterials		See Highway Capacity Manual
b) Signalized intersections		1900 pc/h/ln
c) Unsignalized intersections		1100-2000 veh/h

3.19 Traffic Information for Roadway Designers

These traffic information should be available to the designer prior to or very early in the design process:

1. AADT for the current year: opening year (completion of construction), and design year
2. Existing hourly traffic volumes over a minimum of 24-hour period, including peak hour turning movements and pedestrian counts
3. Directional distribution factor (D30).
4. 30th highest hour factor (K30).
5. Truck factors (T) for daily and peak hour.
6. Design speed and proposed posted speed.
7. Design vehicle for geometric design.
8. Turning movements and diagrams for existing and proposed signalized intersections.
9. Special or unique traffic conditions, including during construction.
10. Crash history, including analyses at high crash locations within the project limits.
11. Recommendations regarding parking or other traffic restrictions.

3.20 Terms

1. PRT - perception-reaction time
2. MT - maneuver time
3. trajectory -
4.

3.21 Rules

3.22 Formulas

3.23 Reference