3 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   Intersection Sight Distance - ISD

Sighting Rod - 3.5 feet height Target Rod - 4.25 feet height Observer - 10 feet
behind stop bar

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

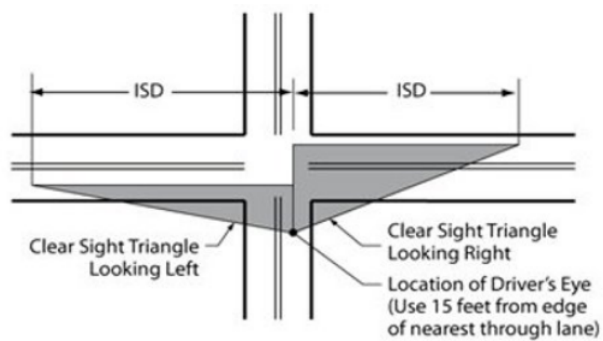| Design Speed (mph)	Passed Vehicle (mph)	Passing Vehicle (mph)	Passing Sight Distance (ft)
20	8	20	400
25	13	25	450
30	18	30	500
35	23	35	550
40	28	40	600
45	33	45	700
50	38	50	800
55	43	55	900
60	48	60	1000
65	53	65	1100
70	58	70	1200
75	63	75	1300
80	68	80	1400

Figure 1: ISD - Left Turn

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 Intersection sight distance fomulas

$ISD = 1.47V_{major} \cdot t_g$

V_{majro} : in mph, design speed of major road

t_g : in seconds, time gap for minor road vehicle to enter the major road

3.12 ISD - left turn

Design vehicle	t_g in seconds, LT Time Gap
Passenger car	7.5
Single-unit truck	9.5
Combination truck	11.5

1. **Left turn and multilanes**: If requiring to cross one more lane, +0.5s for passenger cars, +0.7s for trunks.

2. **Grade of minor road**: If the approach grade > +3%, add 0.2s per additional grade.

3.13 ISD - right turn

Design vehicle	t_g in seconds, RT time gap
Passenger car	6.5
Single-unit truck	8.5
Combination truck	10.5

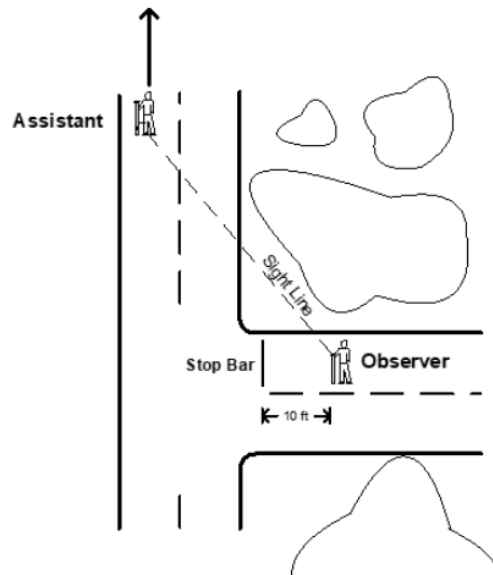1. **right turn and multilanes**: If requiring to cross one more lane, +0.5s for passenger cars, +0.7s for trunks.

Figure 2: ISD - Observer

2. **Grade of minor road**: If the approach grade $> +3\%$, add 0.1s per additional grade.

3.14 Terms

3.15 Rules

3.16 Formulas

3.17 Reference