CE 380

Highway and Traffic Engineering

Lec 3

Sight Distance

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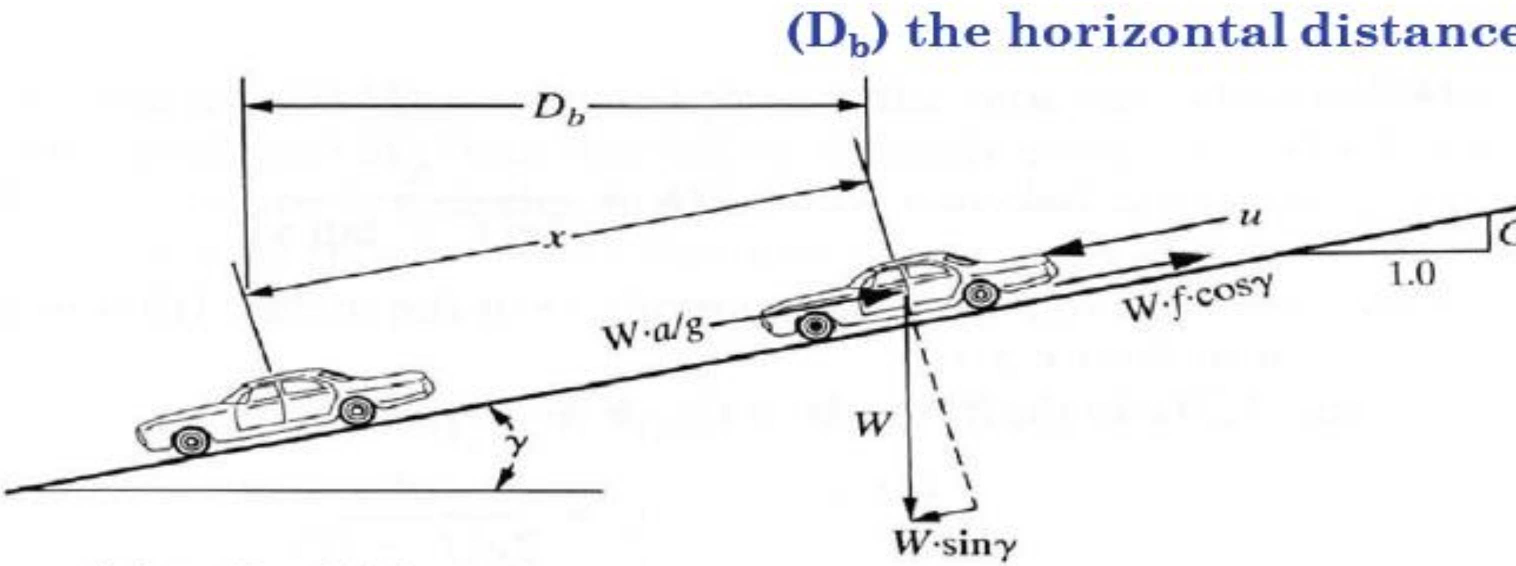
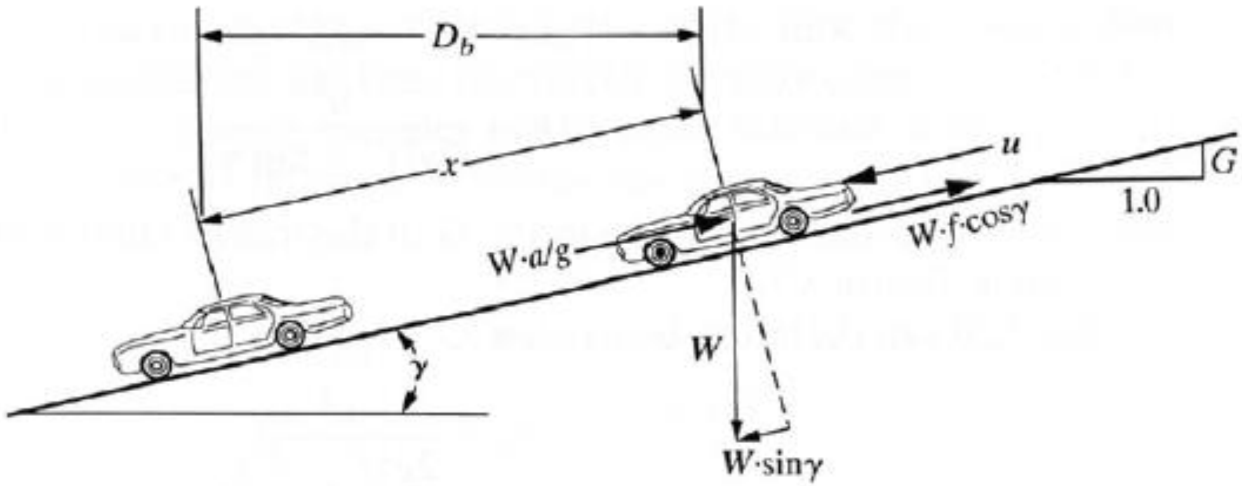
Braking distance



W = weight of vehicle
f = coefficient of friction
g = acceleration of gravity
a = vehicle acceleration
u = speed when brakes applied
D_b = braking distance
γ = angle of incline
$G = \tan\gamma$ (% grade/100)
x = distance traveled by the vehicle along the road during braking

Frictional force on the vehicle $= Wf\cos\gamma$



$$W \sin\gamma - W f \cos\gamma = \frac{Wa}{g}$$

$$a = -u^2/2x$$

$$W \sin\gamma - W f \cos\gamma = -\frac{Wu^2}{2gx}$$

$$D_b = x \cos\gamma$$

$$\frac{Wu^2}{2gD_b} \cos\gamma = W f \cos\gamma - W \sin\gamma$$

$$\frac{u^2}{2gD_b} = f - \tan\gamma$$

$$D_b = \frac{u^2}{2g(f - \tan\gamma)}$$

$$D_b = \frac{u^2}{2g(f - G)}$$

If g is taken as 9.81 m/sec^2

u is expressed in km/h

$$D_b = \frac{u^2}{254(f - G)}$$

- A similar equation could be developed for a vehicle traveling uphill , in which case the following equation is obtained.

$$D_b = \frac{u^2}{254(f + G)}$$

- A general equation for the braking distance can therefore be written as:

$$D_b = \frac{u^2}{254(f \pm G)}$$

AASHTO recommends the coefficient of friction to be a/g and a to be 4.51 m/s^2 , then braking distance becomes:

$$D_b = \frac{u^2}{254\left(\frac{a}{g} \pm G\right)}$$

- the horizontal distance traveled in reducing the speed of a vehicle from U_1 to U_2 in km /h during a braking maneuver is given by:

$$D_b = \frac{u_1^2 - u_2^2}{254\left(1\frac{a}{g} \pm G\right)}$$

- The distance traveled by a vehicle between the time the driver observes an object in the vehicle's path and the time the vehicle actually comes to rest is longer than the braking distance, since it includes the distance traveled during perception-reaction time.
- This distance is referred to in this text as the stopping sight distance S and is given as

PROBLEMS

What is the distance required to stop an average passenger car when brakes are applied on a 2% downgrade if that vehicle was originally traveling at 40 km/h?

Sight Distance Definition

It is the length of highway ahead which is visible to the driver.

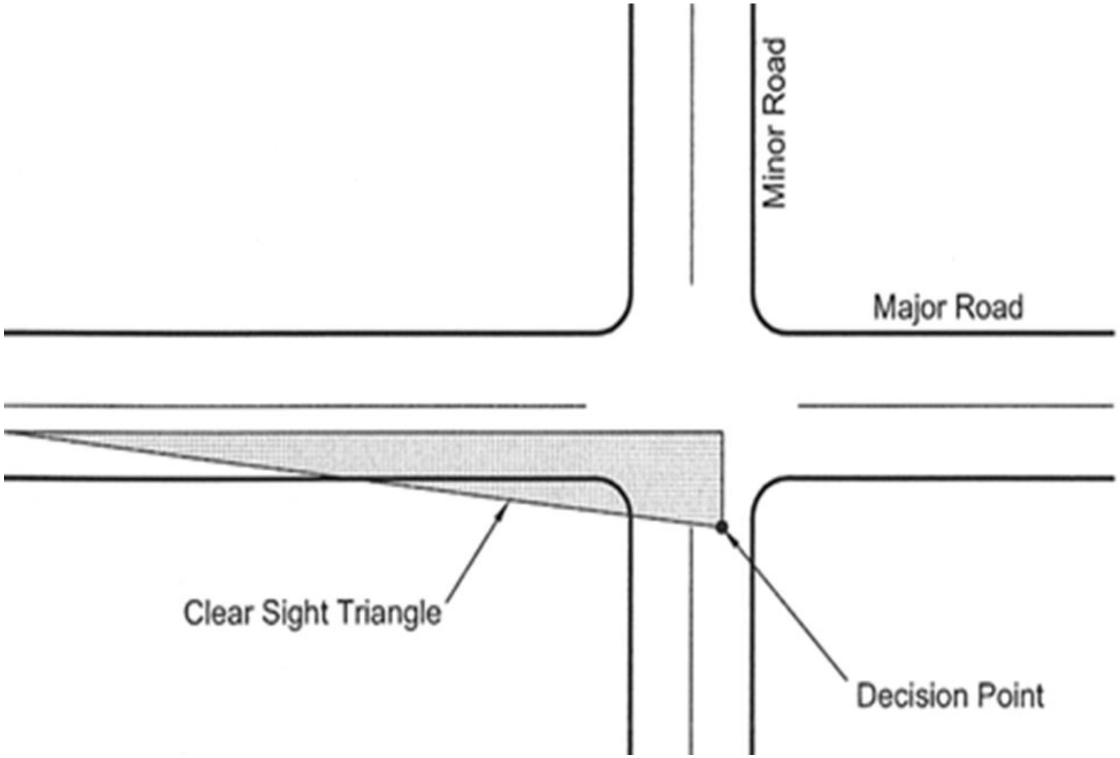
Sight Distance Types

Three basic types of sight distances:

1- Stopping sight distance (SSD)
2- Decision sight distance (DSD)
3- Passing sight distance (PSD)

Locations.

- Sight on straight section.
- Sight on horizontal curve cut sec.
- Sight on vertical curves.
- Sight on Intersection.



Triangle of sight

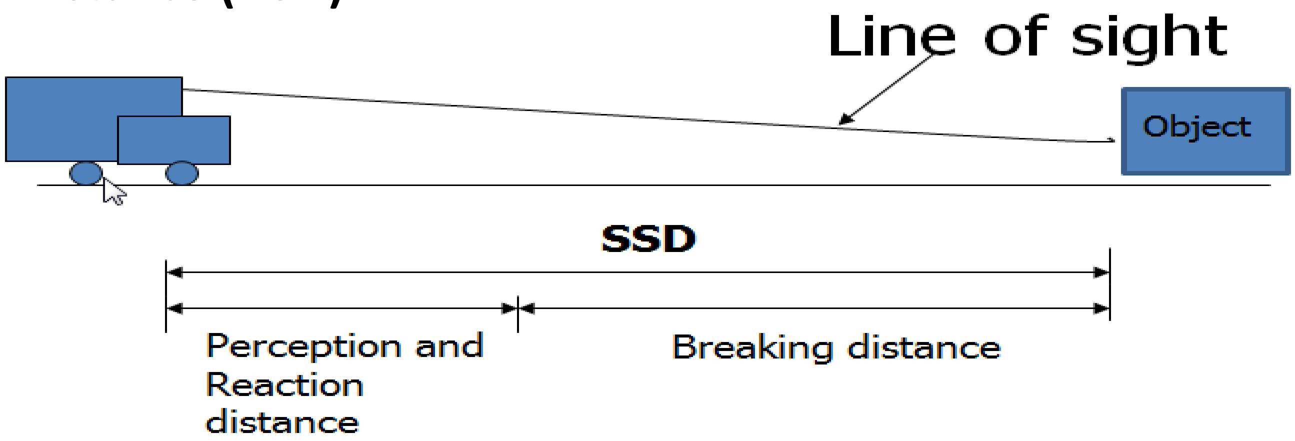
Criteria for Sight Distance

- Driver eye height: for passenger vehicle's = 3.5 ft or 1.05 m above surface
- Height of object in roadway = 2 feet or 0.5m (SSD) – why?
- Height of opposing vehicle = 3.5 feet (PSD)

- Deceleration rate: AASHTO: 3.5 to 4.5 m/sec^2
- Deceleration is within capability of drivers to stay within their lane and control the vehicle when braking on wet surfaces and is comfortable for most drivers
- AASHTO represents friction as (a/g) which is a function of the roadway, tires, etc

1-Stopping Sight Distance (SSD)

2-Decision Sight Distance (DSD)



$$SSD = 0.278Vt + \frac{V_i^2 - V_f^2}{255\,(f \pm g)}$$

v : is the design speed

t : is perception and reaction time. almost 2.5 sec

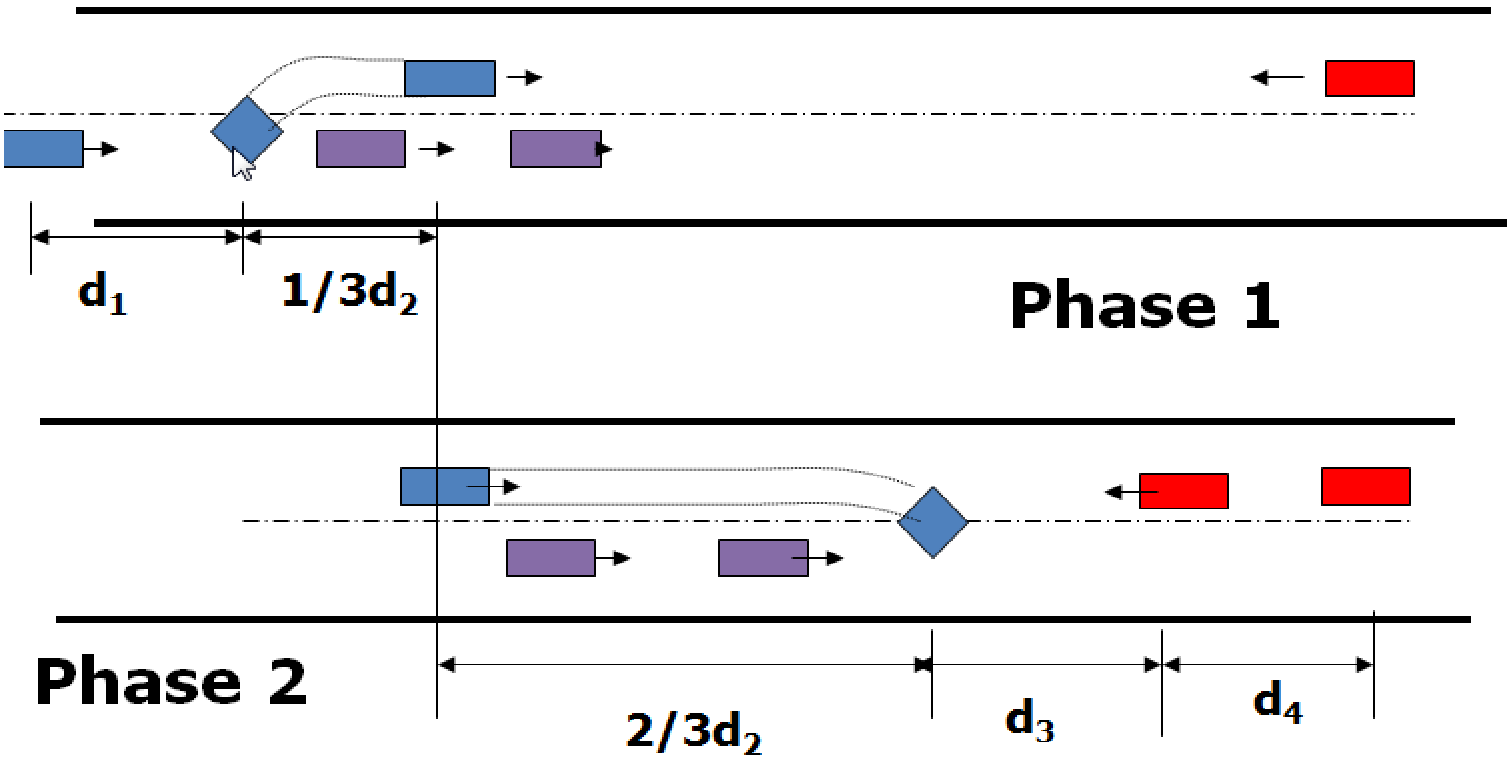
f : is coefficient of long. Friction depend on (V)

g: grade in decimal number %

Relation between design speed and longitudinal friction coefficient

Design Speed (V)	Friction Coefficient (F)
40	0.38
50	0.36
60	0.34
70	0.32
80	0.31
90	0.30
100	0.30
110	0.29
120	0.28
130	0.27
140	0.27

Passing Sight Distance (PSD)



$$PSD = d_1 + d_2 + d_3 + d_4$$

3- Passing Sight Distance (PSD)

Is the sight distance that achieve a safe passing maneuvers on two-lane, two-way highways.

$$PSD = d_1 + d_2 + d_3 + d_4$$

Where:

d_1: is the distance traveled during perception and reaction time and during acceleration.

$$= 0.278\ t_1\ (v - m + a t_1/2)$$

d_2: is distance traveled during the time the passing vehicle is traveling on the left lane.

$$= 0.278\ v\ t_2$$

d_3: is the distance between the passing vehicle at the end of its maneuver and the opposing vehicle.

$$= 30 - 90\ m$$

d_4: is the distance moved by the opposing vehicle during 2/3 of the time the passing vehicle is on left lane. = 2/3 d_2

Passing Sight Distance

$$d_1 = 0.278t_1\left(u - m + \frac{at_1}{2}\right)$$

where

t_1 = time for initial maneuver (sec)
a = average acceleration rate (km/h/sec)
u = average speed of passing vehicle (km/h)
m = difference in speeds of passing and impeder vehicles

$$d_2 = 0.278\,ut_2$$

where

t_2 = time passing vehicle is traveling in left lane (sec)
u = average speed of passing vehicle (km/h)

The clearance distance d_3 between the passing vehicle and the opposing vehicle at the completion of the passing maneuver has been found to vary between 30 m and 90 m.

Passing Sight Distance

- NOTES:

➢ For Divided roads, The passing sight distance is not available.

➢ It is not necessary to consider passing sight distance on highways or streets that have two or more traffic lanes in each direction of travel.

➢ For roads that have special lane for overtaking, The passing sight distance is not available.

➢ When passing sight distance is not available it equals SSD.