TRAFFIC ENGINEERING

Civil Engineering Department

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Road Characteristics

Sight distance : is the length of the roadway ahead visible to the driver.

- Safe highways must be designd to give drivers a sufficient distance of clear vision a head so that they can avoid hitting unexpected obstacles and can pass slow-moving vehicle.

Stopping sight distance (SSD)

Is the minimum distance required to stop a vehicle traveling at the design speed before it reachs a stationary object in the vehicle's path.

- The stationary object may be another vehicle or some object within the roadway.

- Stopping sight distance : is the sum of two distances :

1. brake reaction distance.
2. braking distance.

Brake reaction distance (perception_reation distance)

Intervals between the driver recognizes the object or hazard ahead and the instant the braks are actually applied. A reaction time (2.5)sec. can be considered adequate, some drivers takes 3.5 seconds to response, generally (1.5-2.5) sec.

$$SSD = 0.278\,Vt + \frac{V^2}{254\,(f \mp S)}$$

where:

V: vehicle velocity ($\frac{Km}{hr}$).
t: time (sec.).
s: slope of the road (in decimal form)
SSD: stopping sight distance (m)
f: coefficient of friction between tires and roadway, which is depend on:

- presence of moisture, snow, mud.
- type and condition of pavement surface.
- tread of tires.

usually taken from table of <u>wet</u> pavement condition.

Example : an alret driver (with a reaction time 0.5 sec.) is driving downhill on a 4% grade at 56 km/hr when suddenly a person steps from behind a parked car in the path of the driver, at a distance of 30.5 m.

a- can the driver stop in time (locked wheels), f = 0.7

b- can the driver stop in time on a rainy day, f = 0.4

Solution:

a- $$SSD = 0.278 \times 56 \times 0.5 + \frac{(56)^2}{254(0.7 - 0.04)}$$

$SSD = 26.48$ m

hence, the driver will be able to stop in time.

b- $$SSD = 0.278 \times 56 \times 0.5 + \frac{(56)^2}{254(0.4 - 0.04)}$$

$SSD = 42$ m

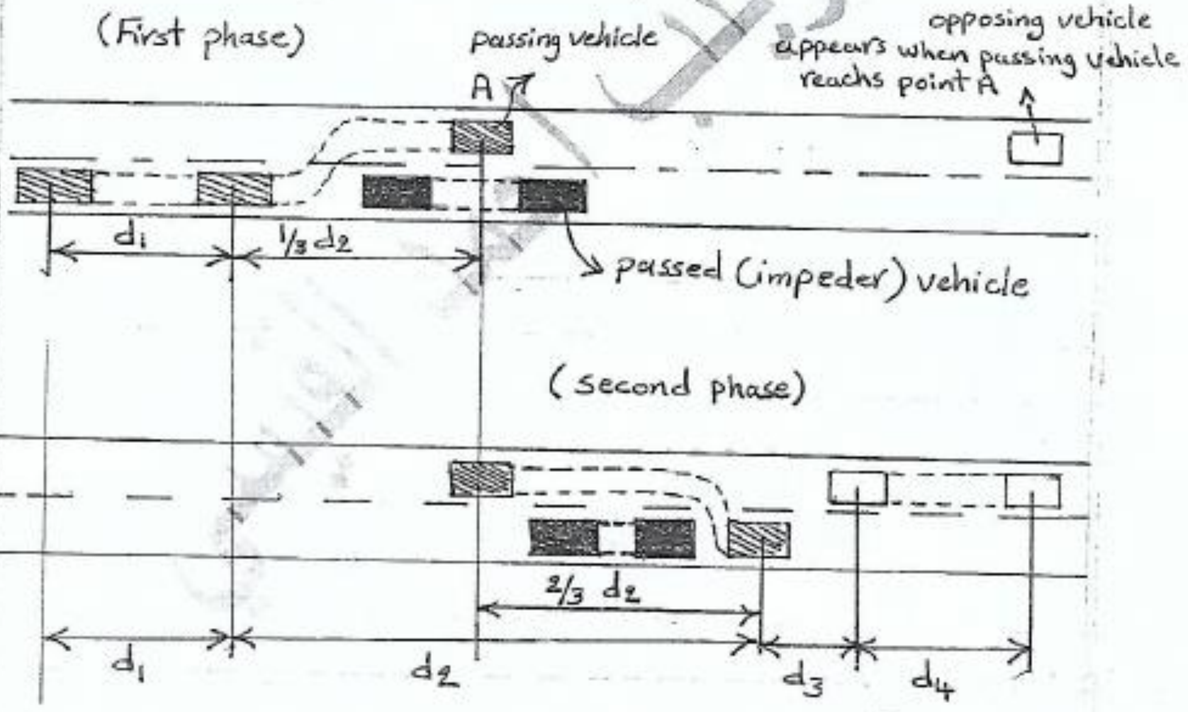
hence, the driver will not be able to stop in time.

Condition of pavement play an important role.

Passing sight distance (PSD)

On most two lane two way highways, vehicles frequently overtake slower-moving vehicles by using the lane of opposing traffic. For safe maneuver passing, the driver should be able to see a sufficient distance a head.

- The minimum passing sight distance for two-lane highway is the sum of the four distances shown in figure below:



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

d_1 : distance traversed during perception-reaction time and during initial acceleration to the point where the passing vehicle just enters the left lane.

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

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

d_4 : distance moved by the opposing vehicle during two thirds of the time the passing vehicle is in the left lane (usually taken to be $2/3\ d_2$).

The distance d_1 is obtained from the expression:

$$d_1 = 1.47\, t_1 \left(v - m + \frac{a t_1}{2} \right)$$

where:

t_1 : time for initial maneuver (sec.).

a : average acceleration rate (mi/h/sec.).

v : average speed of passing vehicle (mph).

m : difference in speeds of passing and impeder vehicles.

The distance d_2 is obtained from :-

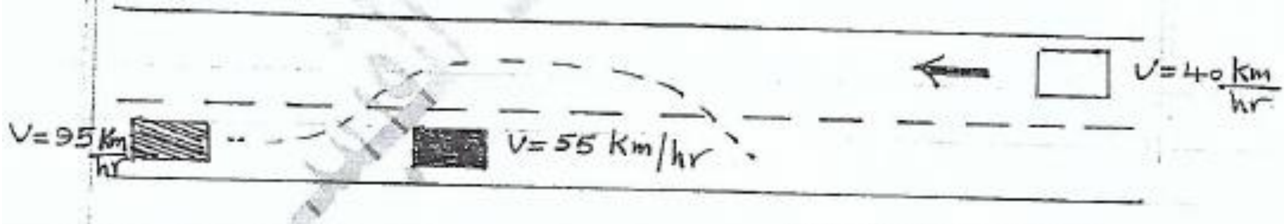
$$d_2 = 1.47\, V t_2$$

where:

t_2 : time passing vehicle is traveling in left lane (sec.)
V : average speed of passing vehicle (mph).

The clearance distance (d_3) between the passing vehicle and the opposing vehicle at the completion of passing manuever has been found to vary between (100 – 300) ft

Example: Calculate the minimum passing sight distance as shown in figure below:



Knowing:

Time of initial manuever is 4 sec.
Time of passing vehicle occupies the left lane 10 sec.
Average acceleration is 2.3 Km/hr/sec.

Solution:

$$d_1 = 0.278\, t_1 \left(v - m + \frac{a t_1}{2}\right)$$

$$d_1 = 0.278 \times 4 \left(95 - 40 + \frac{2.3 \times 4}{2}\right)$$

$$d_1 = 56.05\ m$$

$$d_2 = 0.278\, v\, t_2$$

$$= 0.278 \times 95 \times 10$$

$$d_2 = 264.1\ m$$

$$d_3 \simeq (30 - 90)\, m$$

assume $d_3 = 60\ m$

$$d_4 = \frac{2}{3} d_2 = \frac{2}{3} \times 264.1 = 176.07\, m$$

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

$$= 56.05 + 264.1 + 60 + 176.07$$

$$PSD = 556.22\ m$$

Decision sight distance

Is the distance required for a driver to detect an unexpected or otherwise difficult to perceive information source hazard in roadway environment.

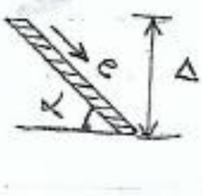
Decision sight distance depend on :

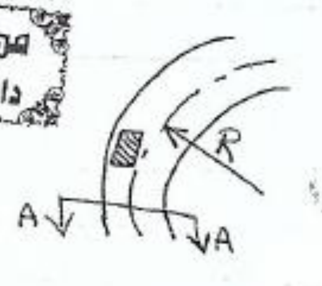
1. the location is on urban or on rural road.
2. the type of maneuver required to avoid hazards.

Superelevation

A vehicle is forced radially outward by centrifugal force when it moves in circular path. The vehicle weight component creates side friction between the road surface and tires to counterbalance the centrifugal force.

- An circular curve





$e = \tan\alpha$ = rate of superelevation

Δ = difference in elevation between outside and inside edges of pavement.

$$R = \frac{V^2}{127(f+e)}$$

V: Km/hr

R: m

Minimum allowable radius

$$R_{min} = \frac{V_D^2}{127(f_s + e_{max})}$$

$R_{min.}$: min. allowable radius.

f_s : safe side friction.

e_{max} : max. superelevated rate.

V_D : design speed.

Example: if a highway is to be designed for design speed of 120 Km/hr., safe side friction factor, $f_s = 0.11$ and max. rate of superelevation, $e_{max} = 6\%$. Calculate the min. allowable radius for horizontal circular curves of this highway.

Solution:

$$R_{min} = \frac{(120)^2}{127(0.11 + 0.06)} = 666.98\, m \cong 667\, m$$