2.2 SIGHT DISTANCE

Sight distance is the length of road visible ahead of the driver at any instance. Sight distance available at any location of the carriageway is the actual distance a driver with his eye level at a specified height above the pavement surface has visibility of any stationary or moving object of specified height which is on the carriageway ahead. The sight distance between the driver and the object is measured along the road surface.

TYPES OF SIGHT DISTANCE

Sight distance required by drivers applies to geometric designs of highways and for traffic control. Three types of sight distances are considered in the design

a)Stopping Sight Distance (SSD) or absolute minimum sight distance

b)Safe Overtaking Sight Distance (OSD) or Passing Sight Distance

c) Safe Sight Distance for entering into uncontrolled intersections.

Apart from the three situations mentioned above, the following sight distances are considered by the IRC in highway design

d) Intermediate Sight Distance)Head Light Sight Distance

STOPPING SIGHT DISTANCE (SSD)

The minimum distance visible to a driver ahead or the sight distance available on a highway at any spot should be of sufficient length to safely stop a vehicle travelling at design speed, without collision with any other obstruction. Therefore, this Stopping Sight Distance (SSD) is also called Absolute Minimum Sight Distance. This is also sometimes called Non Passing Sight Distance.

The sight distance available to a driver travelling on a road at any instance depends on the following factors:

a) Features of the road ahead

b) Height of the driver's eye above the road surface

c) Height of the object above the road surface

IRC has suggested the height of eye level of driver as 1.2 m and the height of the object as 0.15 m above the road surface.

Factors on which stopping distance depends

The distance within which a motor vehicle can be stopped depends upon the factors listed below

a) Total reaction time of the driver

b) Speed of vehicle

c) Efficiency of Brakes

d) Frictional Resistance between the road and the tyre

e) Gradient of the road, if any

TOTAL REACTION TIME OF DRIVER

Reaction time of the driver is the time taken from the instant the object is visible tothe driver to the instant the brakes are effectively applied. The actual time gap or the reaction time of the driver depends on several factors. During this period of time the vehicle travels a certain distance at the original speed, which may be assumed to be the design speed of the road. Thus, the stopping distance increases with increase reaction time of the driver.

The total reaction time (**t**) may be split up into two parts

Perception Time

It is the time required for a driver to realise that brakes must be applied. It is the time from the instant the object comes on the line of sight of the driver to the instant he realises that the vehicle needs to be stopped. The perception time varies from driver to driver and also depends on several other factors such as the distance of object and other environmental conditions.

Brake Reaction Time

It is also depending on several factors including the skill of the driver, the type of the problems and various other environmental factors.

The total reaction time may be explained with the help of PIEV theory.

PIEV THEORY

According to PIEV theory, the total reaction time of the driver is split into four parts, viz., time taken by the driver for

1) Perception

2) Intellection

3) Emotion

4) Volition

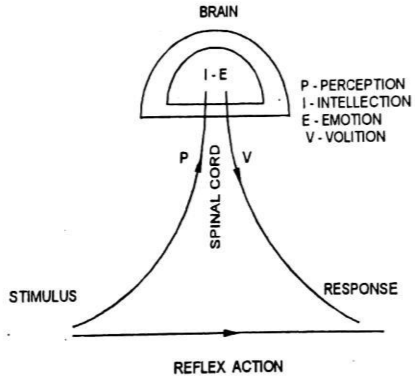

Figure 2.2.1 Reaction Time and PIEV Theory

[Source: "Highway Engineering" by S.K.Khanna,C.E.G.Justo, Page: 89]

The PIEV time of a driver also depends on several factors such as physical and psychological characteristics of the driver, type of the problem involved, environmental conditions and temporary factors.

Speed of vehicle

The stopping distance depends very much on the speed of the vehicle. First, during the total reaction time of the driver the distance moved by the vehicle will depend on the speed. Second, the braking distance or the distance moved by the vehicle after applying the brakes, before coming to a stop depends also on the initial speed of the vehicle.

Efficiency of brakes

The braking efficiency is said to be 100 percent if the wheels are fully locked preventing them from rotating on application of the brakes. This will result in 100 percent skidding which is normally undesirable, except in utmost emergency. Also skidding is considered to be dangerous, as it is not possible for the driver to easily control a vehicle after it starts skidding.

Frictional resistance between road and tyres

The factional resistance developed between road and tyres depends upon the 'skid resistance' or the coefficient of friction, f between the road surface and the tyres of the vehicle.

Analysis of Stopping Distance

The stopping distance of a vehicle is the sum of

a) The distance travelled by the vehicle at uniform speed during the total reaction time, t which is known as **LAG DISTANCE**.

b) The distance travelled by the vehicle after the applications of the brakes, until the vehicles comes to a dead stop which is known as **BRAKING DISTANCE**.

LAG DISTANCE

During the total reaction time, t seconds the vehicle may be assumed to move forward with a uniform speed at which the vehicle has been moving and this speed may be taken as the design speed. If ‘v’ is the design speed in m/sec and ‘t’ is the total reaction time of the driver in seconds, then

Lag Distance = v t

If the design speed is V kmph, then the lag distance = $V\ t \times \left\{\frac{1000}{60 \times 60}\right\}$

$= 0.278\ V t \approx \mathbf{0.28\ V t}$ in meters

IRC has recommended the value of reaction time t as 2.5 sec for calculation of Stopping Distance

BRAKING DISTANCE ON LEVEL SURFACE

The coefficient of friction f depends on several factors such as the type and condition of the pavement and the value of f decreases with the increase in speed. IRC has recommended a set of friction co efficient values for the determination of stopping sight distance.

Speed, kmph	20 – 30	40	50	60	65	80	100 and above
Longitudinal friction coefficient value, f for SSD	0.40	0.38	0.37	0.36	0.36	0.35	0.35

The braking distance, $\mathbf{l} = \frac{v^2}{2gf}$

Where l - braking distance, m

v - speed of the vehicle, m/sec

f - design coefficient of friction, f (0.40 to 0.35)

g – acceleration due to gravity – 9.8 m/sec^2

Overtaking Sight Distance

It is desirable that adequate overtaking sight distance is available on most of the road stretches such that the vehicles travelling at the design speed can overtake slow vehicles at the earliest opportunity.

- On road stretches with two-way traffic movement, the minimum overtaking distance should be **($d_1 + d_2 + d_3$)** where overtaking is not prohibited.

- On divided highways and on roads with one way traffic regulation, the overtaking distance need be only **(d_1 + d_2)** as no vehicle is expected from the opposite direction.
- On divided highways with four or more lanes, it is not essential to provide the usual OSD; however, the sight distance on any highway should be more than the SSD, which is the absolute minimum sight distance.

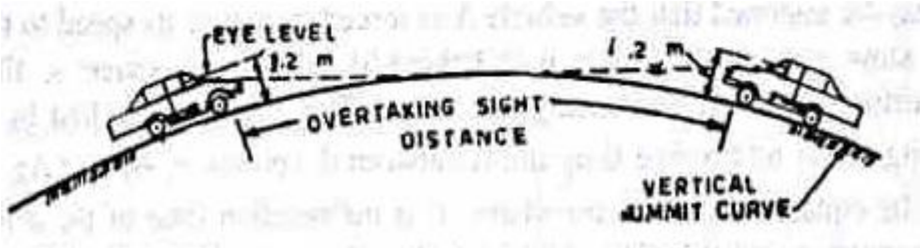

Figure 2.2.2 Overtaking Sight Distance Calculation

[Source: "Highway Engineering" by S.K.Khanna,C.E.G.Justo, Page: 95]

Overtaking Zones

It is desirable to construct highways in such a way that the length of road visible ahead at every point is sufficient for safe overtaking. This is seldom practicable and there may be stretches where the safe overtaking distance cannot be provided. In such zones where overtaking or passing is not safe or is not possible, sign posts should be installed indicating **No Passing** or **Overtaking Prohibited** before such restricted zones start. However overtaking opportunity for vehicles moving at design speed should be given at as frequent intervals as possible. These zones which are meant for overtaking are called **Overtaking Zones**.

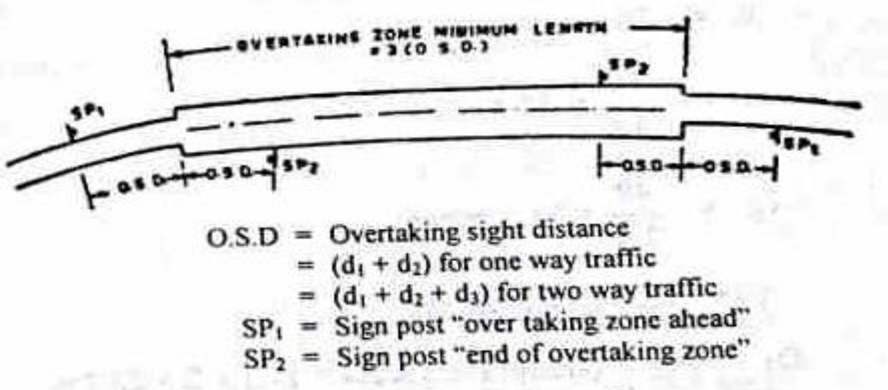

Figure 2.2.3 Overtaking Zones

[Source: "Highway Engineering" by S.K.Khanna,C.E.G.Justo, Page: 101]

The width of carriageway and the length of overtaking zone should sufficient for safe overtaking. Sign posts should be installed at sufficient distance m advance to indicate the start of the overtaking zones, this distance may be equal to

- **(d_1 + d_2) for one-way roads**

- **($d_1 + d_2 + d_3$) for two-way roads**

The minimum length of overtaking zone = 3 (OSD) The desirable length of overtaking zones = 5 (OSD)

INTERMEDIATE SIGHT DISTANCE

At stretches of the road where requires OSD cannot be provided, as far as possible intermediate Sight Distance ISD equal to twice SSD may be provided. The measurement of the ISD may be made assuming both the height of the eye level of the driver and the object to be 1.2 metres above the road surface. Therefore ISD=2SSD.

Sight Distance at Uncontrolled Intersections

It is important that on all approaches of intersecting roads, there is a clear view across the corners from a sufficient distance so as to avoid collision of vehicles. This is all the more important at uncontrolled intersections. The sight line is obstructed by structures or other objects at the corners of the intersections. The area of unobstructed sight formed by the lines of vision is called the sight triangle.

The design of sight distance at intersections may be based on three possible conditions,

a) Enabling the approaching vehicle to change speed
b) Enabling approaching vehicle to stop
c) Enabling stopped vehicle to cross a main road
d) Enabling the approaching vehicle to change speed

PROBLEM BASED ON SIGHT DISTANCE

1. The speed of the overtaking and overtaken vehicles is 80 and 50 kmph respectively. On a two way traffic load, the acceleration of overtaking vehicles is 0.99m/sec^2. Calculate OSD, mention the minimum length of overtaking zone and draw the sketch of the overtaking zone with details. (A.U APRIL-MAY2017)

Data:

Speed of the overtaking,V	= 80 kmph, v = 80/3.6 = 22.2
Speed of the overtaken vehicles,V_b	= 50 kmph, v_b = 50/3.6= 13.8
Acceleration	= 0.99m/sec^2

Solution:

OSD for two way traffic =d1+d2+d3 = $v_b t + v_b T + 2s + vT$

Reaction time forovertaking,t =2s

$d1=v_bt$

$= 13.8x2 = 27.6m$

d1 =27.6m

d2 = v_bT (since$T=\sqrt{4s/a}$;s =0.7v_b+6=15.66)

= 13.8x 7.95

d2 =109.71m

d3 =vT

= 22.2x 7.95 = 176.49m

d3 =176.49m

Therefore,OSD =d1+d2+d3

= 27.6+109.71+ 176.49 = 313.8m = 314m

a) Minimum length of overtaking zone= 3 xOSD

= 942 m

b) Desirable length of overtaking zone= 5 xOSD

= 1570m

2. Calculate the safe stopping distance while travelling a speed of 100 kmph on a level road. Assume all other data.

Data:

DesignSpeed,V = 100kmph

Solution:

OSD for 1-waytraffic = d1+d2 = 0.278v_bt + 0.278v_bT+2s

Assume V_b is 16 km/h lesser than that of V

V_b = 100-16 = 84 km/h

Acceleration = 2.5 km/h/sec

Acceleration ofovertakingvehicle = 2.5 x (1000/3600) = 0.694m/sec^2

Reaction time forovertaking, t =2s

$d1 = 0.278 v_b t$

$= 0.278 \times 84 \times 2 = 46.7m$

$d1 = 46.7m$

$d2 = 0.278 v_b T + 2s$ (since $T = \sqrt{4\square/\square} = \sqrt{4\square 22.8/0.694}$

$= 11.49m$; $s = 0.2 v_b + 6 = 22.80m$) Sub d and T value d2eq.

$d2 = (13.8 \times 84 \times 11.49) + (2 \times 22.8)$

$d2 = 313.91m$

Therefore, $OSD = d1 + d2$

$= 46.7 + 313.91 = 360.61\ m = 361m$

OSD for 1-way traffic $= 361m$