B.T.K.I.T DWARAHAT ALMORA

Lecture Series During Lockdwn:COVID19

SIGHT DISTANCE

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Sight Distance

Definition:

Sight distance available from a point is the actual distance along the road surface, over which a driver from a specified height above the carriage way has visibility of stationary or moving objects.

Need for Sight Distance

- The safe and efficient operation of vehicles on the road depends very much on the visibility of the road ahead of the driver
- The geometric design of the road should be done such that any obstruction on the road length could be visible to the driver from some distance ahead

Sight Distance Considerations

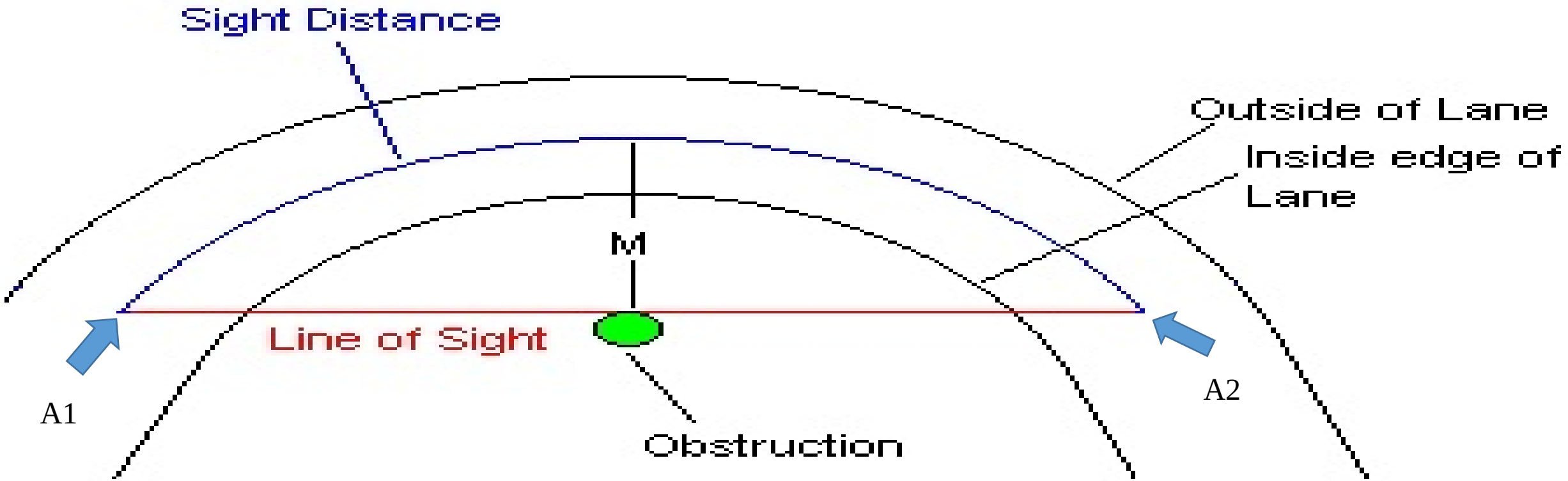

Fig. 1 Sight distance at Horizontal Curve

Note: **When the line of sight is obstructed by objects at inner side of curve. The sight distance is measured along the centre line of the horizontal curve when the vehicle driver (A1) is able to see another vehicle (A2) or object on the carriageway.**

Sight Distance Considerations

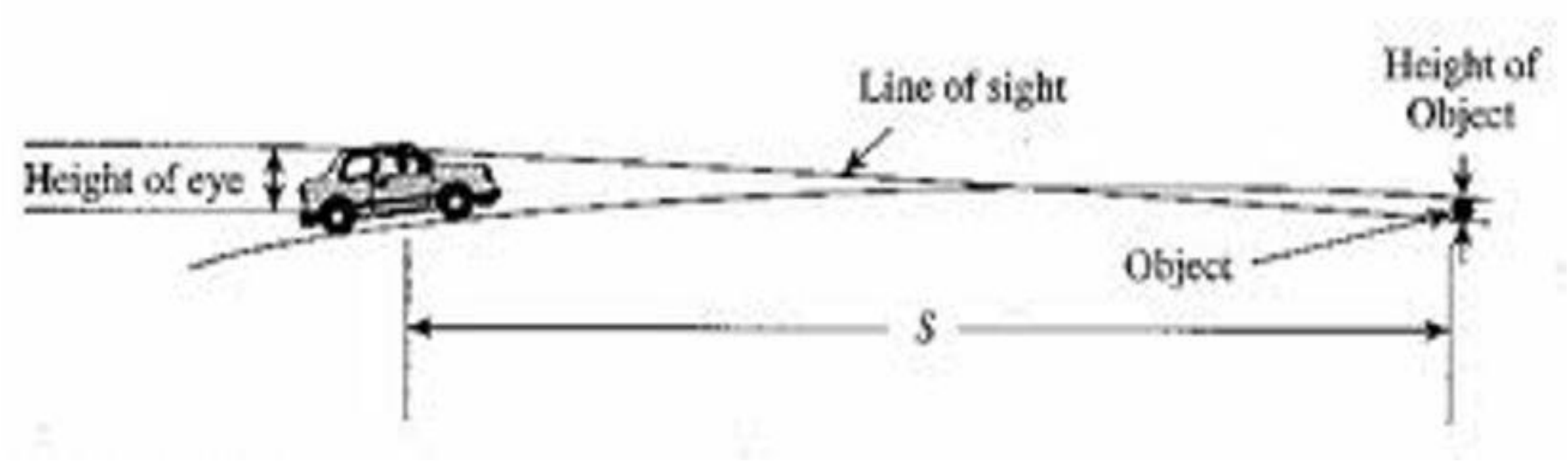

Fig. 2 Sight distance at Vertical Curve

Note: **At vertical curve the line of sight is obstructed by the road surface of the summit curve(i.e., a vertical curve of the road with convexity upwards)**

Sight Distance Considerations

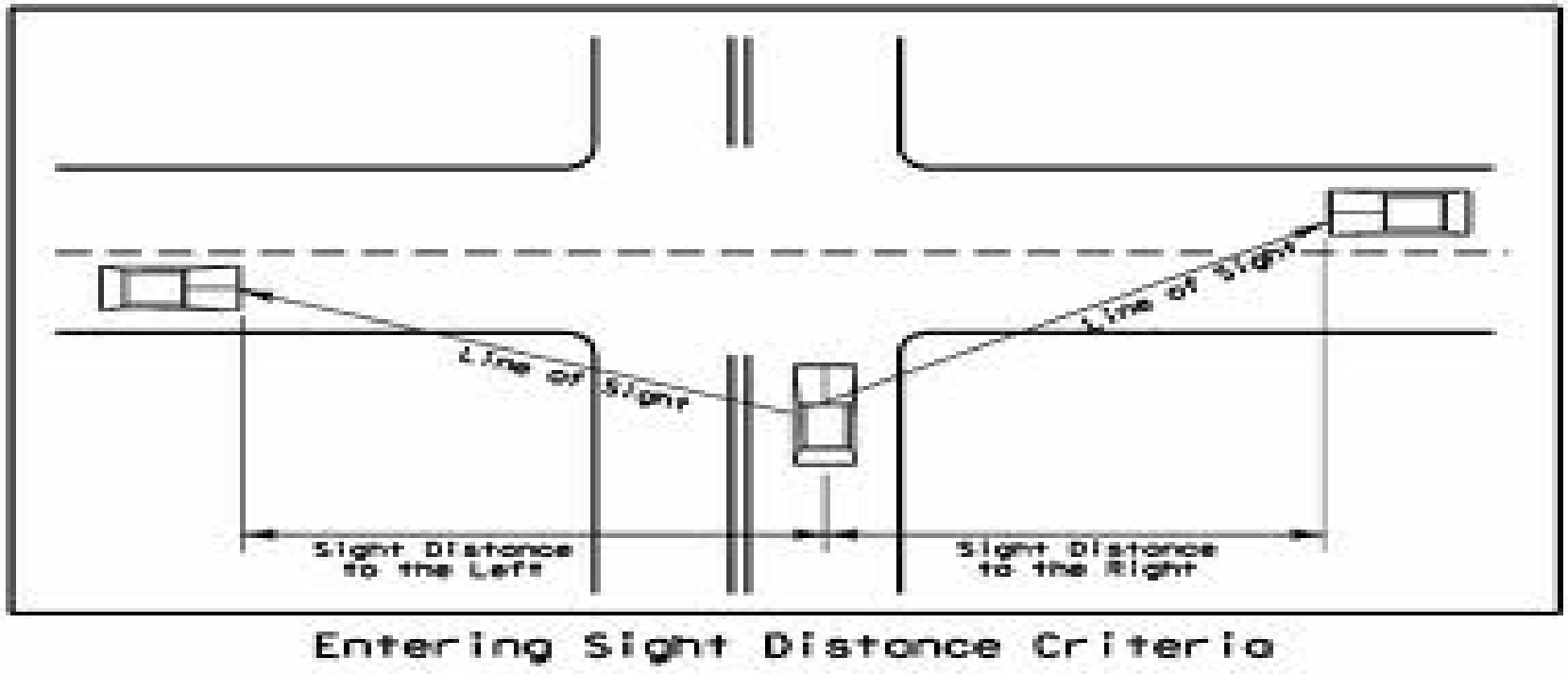

Fig.3 Sight distance at Intersection

Note: **At an uncontrolled intersection when a driver from one of the approach roads is able to sight a vehicle from another approach road proceeding towards the intersection. Here the sight distance for each vehicle driver is the distance from the position when the two can see each other up to the intersection point of the roads.**

Types of Sight Distance

Sight distance by drivers applies to both geometric designs of highway and for traffic control.

- Stopping sight distance (SSD) or the absolute minimum sight distance or some time also called “non passing sight distance”
- Overtaking sight distance (OSD) for safe overtaking operation
- Safe sight distance to enter into an intersection.

Sight distance consider by IRC in highway design

- Intermediate sight distance (ISD) is defined as twice SSD
- Head light sight distance, is the distance visible to a driver during night driving under the illumination of head lights

Factors affecting visibility or Sight Distance

- Feature of the road ahead: Horizontal and vertical profile of road ahead, traffic condition and position of obstruction.
- Height of the driver's eye above the road surface: IRC has suggested the height of eye level of driver as 1.2 m above road surface
- Height of the object above the road surface: IRC has suggested the height of the object as 0.15 m above road surface

Factors affecting Sight Distance

- Reaction Time
- Speed of the Vehicle
- Efficiency of the Brakes
- Frictional Resistance between Tyre and Road
- Gradient of the Road

Reaction Time

- Reaction time of a driver is the time taken from the instant the object is visible to the driver to the instant when the brakes are applied
- Total reaction time may be split up into four components based on PIEV theory
- Under Normal conditions, the Reaction time is 1.5-2s
- As per IRC recommendation it is 2.5s.

Total reaction time of driver

- Time taken from the instant the object is visible to the driver to the instant the brakes are effectively applied
- Consists of two parts
  - Perception time
  - Brake reaction time
- Reaction time varies from driver to driver and also depends on various factors like speed of vehicle, distance of object, environmental factors etc.
- The reaction time of drivers is explained by PIEV theory

PIEV Theory

- According to this theory, time taken by driver is split into four parts
  - Perception time: time to perceive a situation
  - Intellection time: time to understand the situation
  - Emotion time: time for emotional sensations like fear, anger etc.
  - Volition time: time for final action
- PIEV time depends on several factors and may vary from 0.5 second in simple situations to 3-4 second in complex problems

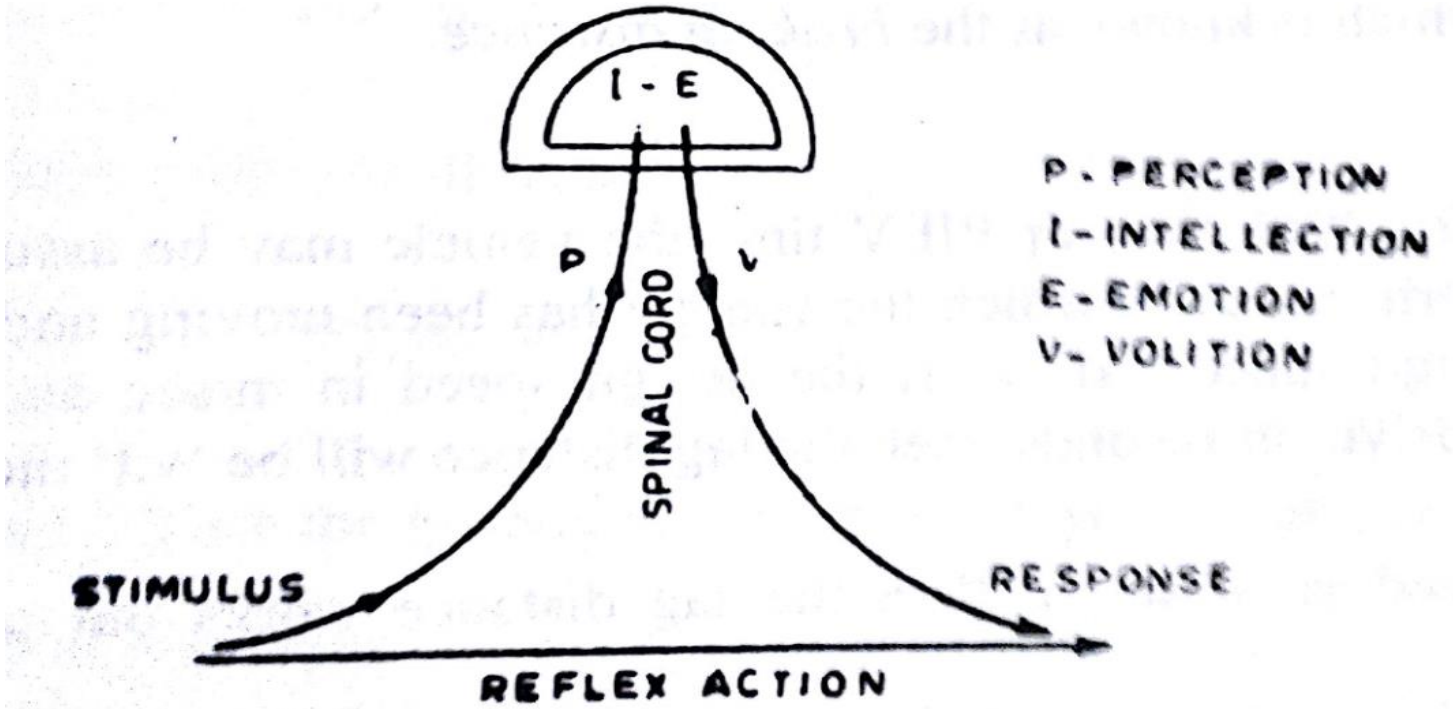

Fig .4 Reaction time and “PIEV” Process

Speed of the Vehicle

- Higher the speed, more time will be required to stop the vehicle

- As the speed increases, sight distance also increases

Efficiency of brakes

- Efficiency of the brakes depends upon the age of the vehicle, vehicle characteristics etc.,
- If the efficiency is 100%, vehicle will stop immediately on the application of brakes which is practically impossible
- Sight distance is more when the efficiency is less
- For design purpose 50% efficiency is assumed
- No separate provision for brake efficiency is provided while computing the sight distance.
- This is taken into account along with the factor of longitudinal friction

Frictional Resistance

- When the frictional resistance between tyre and road is higher, the vehicle stops immediately
- IRC has specified the value of longitudinal friction in between 0.35 to 0.4

Gradient of the road

- Vehicle stops sooner in a rising gradient, therefore the sight distance required is less
- In a descending gradient , gravity comes into action, therefore more distance is required to stop a vehicle

Stopping Sight Distance

Definition:

SSD is the minimum sight distance available on a highway at any spot having sufficient length to enable the driver to stop a vehicle traveling at design speed, safely without collision with any other obstruction

Continue……..

- SSD-It is the distance a vehicle travels from the point at which a situation is first perceived to the time the deceleration is complete
- Drivers must have adequate time if they are to suddenly respond to a situation
- Hence in a Highway design, a sight distance at-least equal to the safe stopping distance should be provided

Analysis of Stopping Sight Distance (SSD)

- Stopping Sight Distance consists of two parts
  - Lag Distance
  - Braking Distance

- Lag distance- Distance travelled in reaction time

- Braking distance- Distance travelled by the vehicle during braking action

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Lag distance = v*t

If the design speed is V kmph then,

Lag distance = V*t*1000/(60*60)

= 0.278 V*t

= 0.28 V*t (in meter)

Where, v is the velocity of vehicle in m/s

t is the reaction time (2-2.5s)

Braking distance is obtained by equating work done in stopping a vehicle to the kinetic energy of the vehicle.

If the maximum frictional force developed is F (Kg) and the braking distance is l (m),then work done against friction force in stopping the vehicle is,

Work done in stopping the vehicle (F*l) = f*W*l .....(i)

Where, f is the coefficient of longitudinal friction

W is the weight of the vehicle

l is distance travelled after braking

Continue.....

Also kinetic energy is given by,

➢Kinetic Energy = ½*Wv^2/g .....(ii)

Equating equation (i) and (ii)

$fWl = ½*Wv^2/g$

$l = v^2/2gf$

Therefore,

➢Stopping Sight Distance = Lag Distance + Braking Distance

$= vt + v^2/2gf$

If speed is V kmph,

Stopping Sight Distance (SSD) = $0.278\ Vt + (V^2/254f)$

Where, v is the velocity (in m/s)

t is the reaction time (s)

g is the acceleration due to gravity (m/s^2)

f is the coefficient of friction

SSD

- When ascending or descending gradient is present the braking distance is affected as gravity comes into action
- When there is an ascending gradient (+n%), the gravity adds to the braking action and when the gradient is descending (-n%), gravity opposes the braking action
- The Stopping sight distance is as follows when gradient is present

$$SSD = vt + v^2/2g(f \pm 0.01n)$$

where, n is the gradient

Table 1: Recommended stopping sight distance value for different speeds

Design Speed, kmph	20	25	30	40	50	60	65	80	100
Safe stopping sight distance for design, m	20	25	30	45	60	80	90	120	180

Overtaking Sight Distance

- The overtaking sight distance is the minimum distance open to the vision of the driver of a vehicle intending to overtake the slow vehicle ahead safely against the traffic in the opposite direction.
- Also called as safe passing sight distance
- The overtaking sight distance or passing sight distance is measured along the center line of the road over which a driver with his eye level 1.2 m above the road surface can see the top of an object 1.2 m above the road surface.

Note: Here one vehicle is seeing another vehicle coming towards him. So in this case object is coming vehicle towards the vehicle, the height of eye level of driver is 1.2 m above road surface while in SSD stationary object is 0.15 m above from ground surface.

Factors affecting OSD

- Velocities of the overtaking vehicle, overtaken vehicle and of the vehicle coming in the opposite direction.
- Spacing between vehicles, which in-turn depends on the speed
- Skill and reaction time of the driver
- Rate of acceleration of overtaking vehicle
- Gradient of the road

Overtaking Sight Distance (OSD)

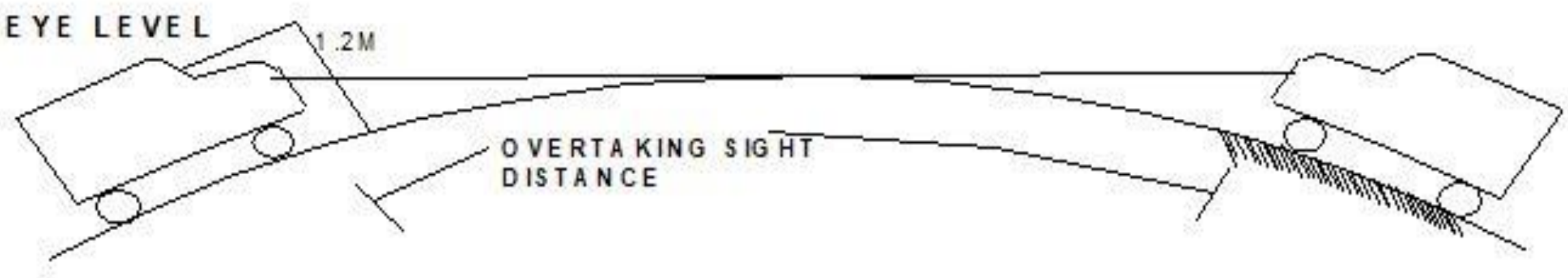

Fig.5 Measurement of overtaking sight distance

Overtaking Sight Distance (OSD)

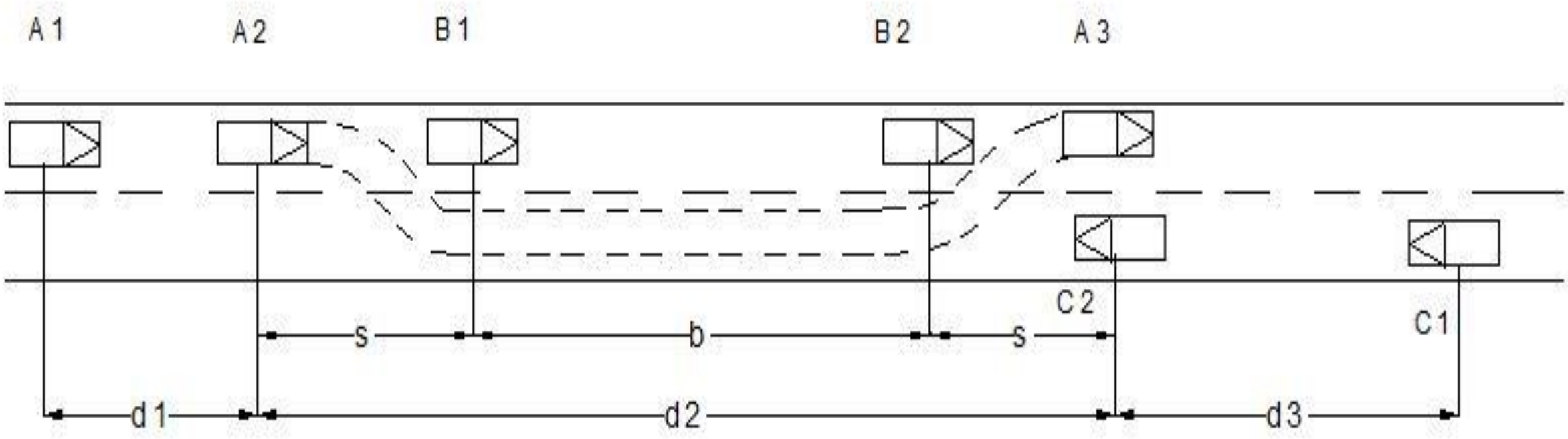

Fig.6 Overtaking manoeurve

Analysis of Overtaking Sight Distance (OSD)

The overtaking sight distance consists of three parts:

- d1= Distance travelled by overtaking vehicle A during the reaction time (A1 to A2)
- d2= Distance travelled by the vehicle during the actual overtaking operation (A2 to A3)
- d3= Distance travelled by on-coming vehicle C during the overtaking operation (C1 to A3)

Continue……..

Overtaking sight distance, OSD= d1+d2+d3

Vehicle A- Overtaking vehicle
Vehicle B- Overtaken vehicle
Vehicle C- Vehicle in opposite lane

Assumption is Vehicle A reduces its speed to v_b, speed of Vehicle B and travels behind it for the reaction time t

Therefore, $d1= v_b*t$

Continue……..

Then the vehicle A starts to accelerate, shifts the lane, overtake and shift back to the original lane

Vehicle A maintains a spacing “s” before and after overtaking

$s=0.7v_b+6$

T= time taken for overtaking

$d2= 2s+v_b*T$

Continue……..

During Time “T”, vehicle A accelerated from initial velocity v_b and overtaking is completed while reaching final velocity v

Therefore the distance travelled is

$$d2 = v_bT + 1/2aT^2$$

$$2s + v_bT = v_bT + 1/2aT^2$$

$$2s = 1/2aT^2$$

$$T = \sqrt{(4s/a)}$$

Therefore, $d2 = 2s + v_b\sqrt{(4s/a)}$

or $d2 = 2s + v_b*T$

Continue……..

Distance travelled by the vehicle C moving at design speed V during overtaking operation is

$$d3 = v*T$$

Overtaking Sight Distance,

$$OSD = v_b*t + 2s + v_b T + v*T$$

In kmph units, $OSD = 0.28V_b*t + 2s + 0.28V_b*T + 0.28V*T$

where, v_b is the speed of overtaken vehicle (m/s)

t is the reaction time (s)

s is the spacing between the vehicles (m)

a is acceleration of overtaking vehicle (m/s^2)

T is the time taken for overtaking operation (s)= $\sqrt{(4s/a)}$ or $\sqrt{(14.4s/A)}$

A is average acceleration during overtaking, kmph/sec

v is the design speed of the vehicle (m/s)

If the speed of overtaken vehicle V_b is not given, the same may be assumes as (V -16) kmph or (v – 4.5) m/s

Maximum overtaking acceleration at different speed

Table 2: Maximum overtaking acceleration at different speeds

Speed		Maximum overtaking acceleration	
V, kmph	v, m/sec	A, kmph/sec	A, m/sec^2
25	6.93	5.00	1.41
30	8.34	4.80	1.30
40	11.10	4.45	1.24
50	13.86	4.00	1.11
65	18.00	3.28	0.92
80	22.20	2.56	0.72
100	27.80	1.92	0.53

OSD

- On divided highways, d3 need not be considered
- On divided highways with four or more lanes, IRC suggests that it is not necessary to provide the OSD, but only SSD is sufficient
- Overtaking zones are provided when OSD cannot be provided throughout the length of the highway
- The desirable length of overtaking zones is 5 times OSD and the minimum is 3 times OSD

Overtaking Zones

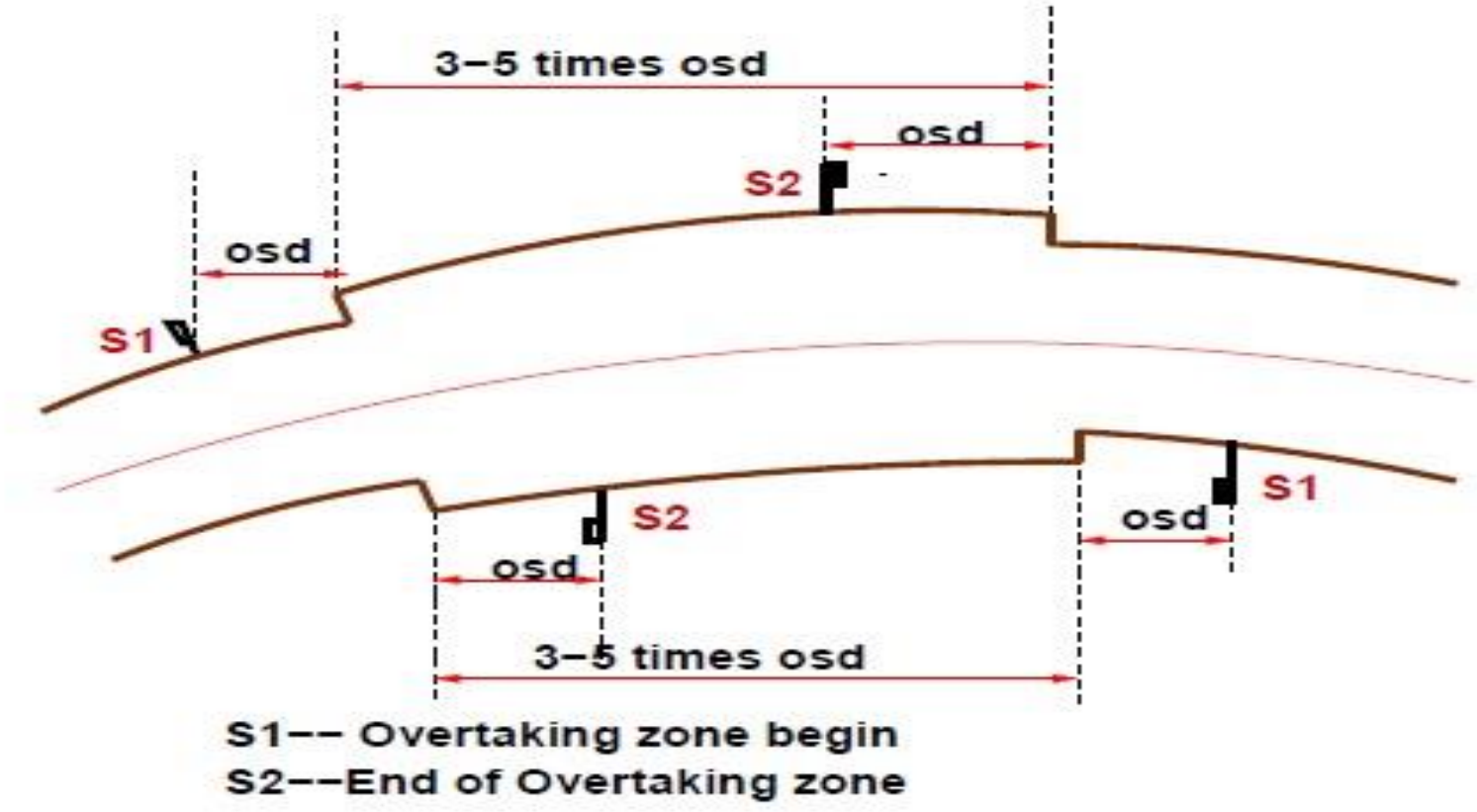

Fig. 7 Overtaking zone

Sight distance at intersections

- At intersections where two or more roads meet, visibility should be provided for the drivers approaching the intersection from either sides
- They should be able to perceive a hazard and stop the vehicle if required
- Stopping sight distance for each road can be computed from the design speed
- The sight distance should be provided such that the drivers on either side should be able to see each other

Sight distance at intersections

Design of sight distance at intersections may be used on three possible conditions:

- Enabling approaching vehicle to change the speed
- Enabling approaching vehicle to stop
- Enabling stopped vehicle to cross a main road

Sight distance at intersections

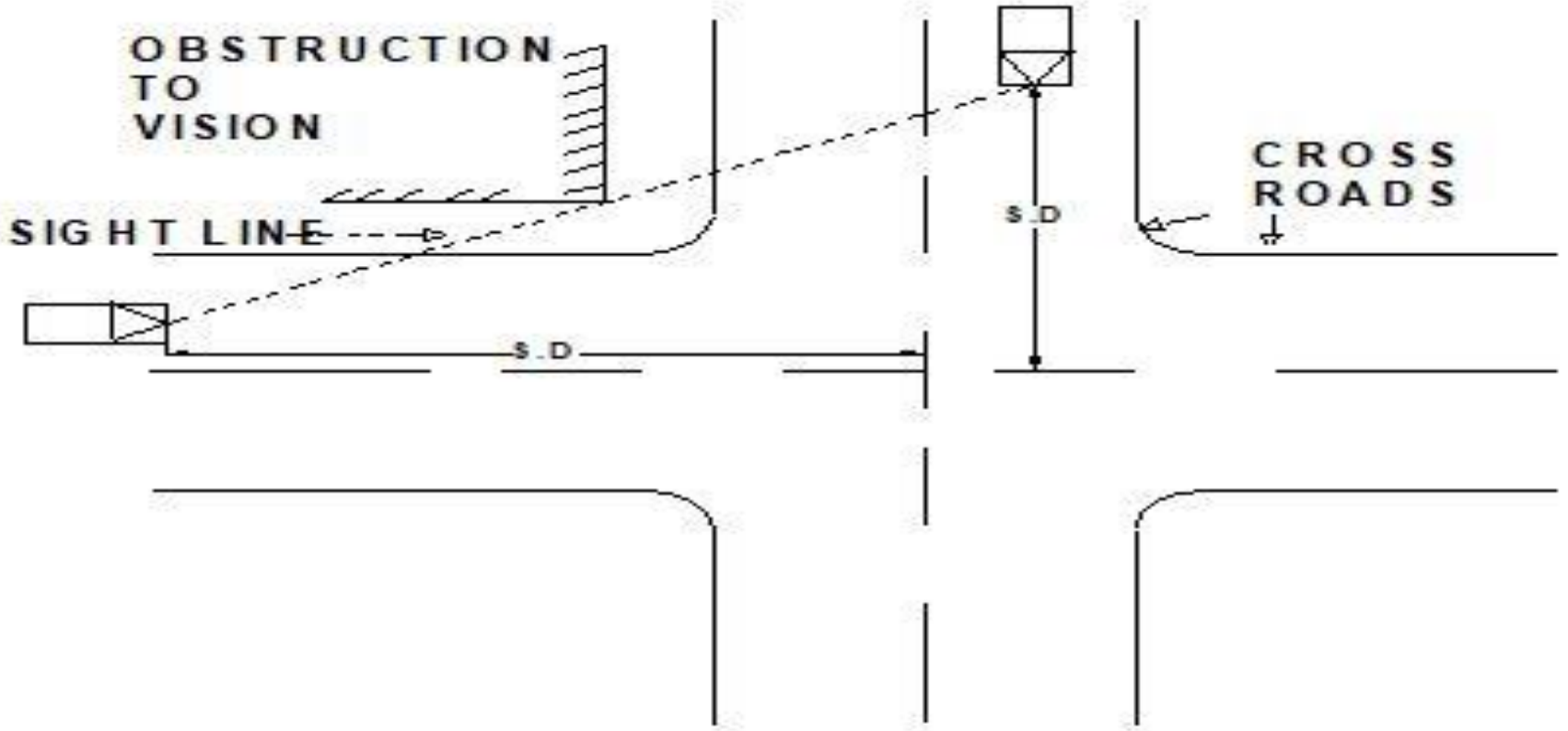

Fig.8 Sight distance at intersection

Sight distance at intersections

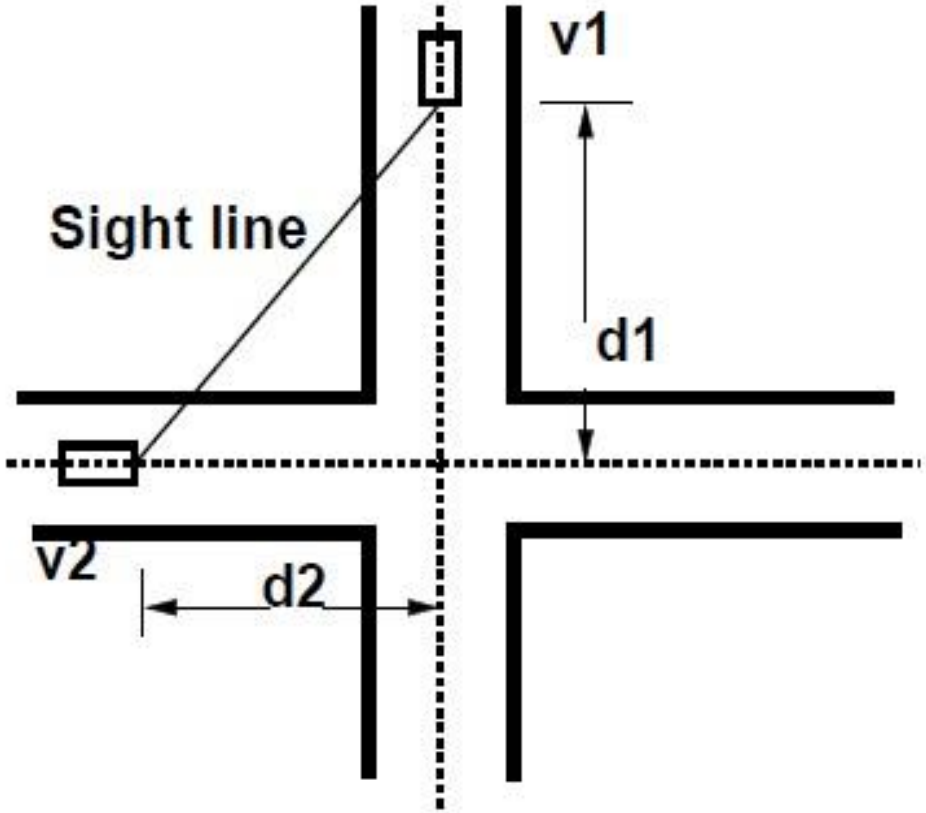

Fig.9 Sight distance at intersection

THANK YOU

FOR

YOUR TIME & ATTENTION