LECTURE NOTE

ON

HIGHWAY ENGINEERING **(TH.4)**

4TH SEMESTER IN CIVIL ENGG.

PREPARED BY

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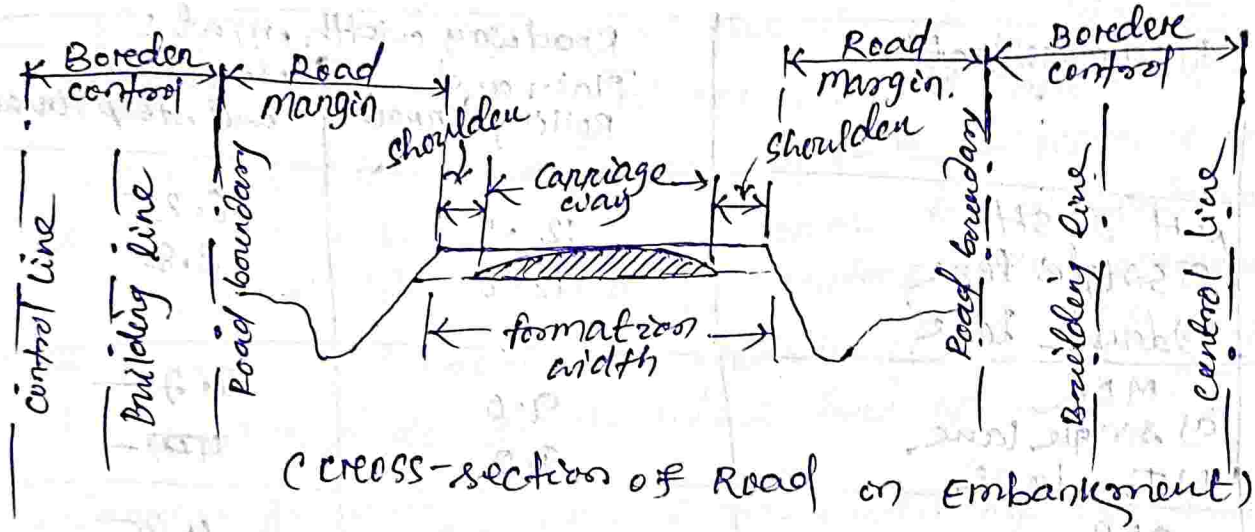
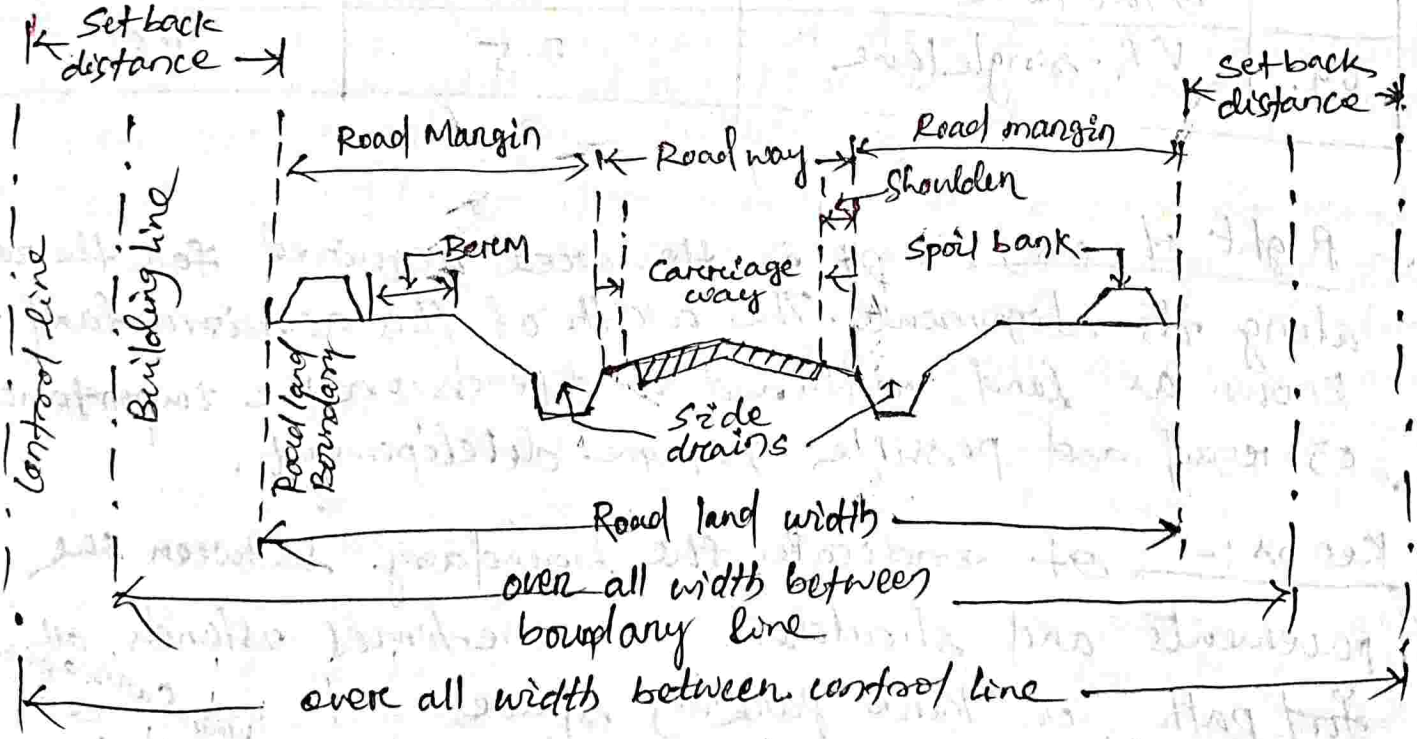
ROAD GEOMETRICS :

Geometric design of highways deals with following elements :

1) Cross-section elements
2) Sight distance considerations.
3) Horizontal alignment details
4) Vertical alignment details
5) Intersection elements.



(Cross-section of Road on Embankment)



(Cross section of a road in cutting)

Terms used in Geometric and their Importance :-

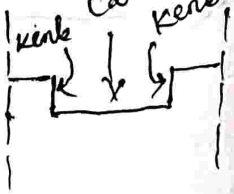
1. **Shoulders :-** It is provided along the road edge to serve as an emergency lane for vehicle compelled to be taken out of the pavement or roadway. It is act as a service road for vehicles that have broken down. Min^{m} shoulder width recommended by the IRC is 2.5m.

2. **Formation width :-** It is the sum of width of pavements or carriageway including separatores if any and the shoulders

Sl No.	Road classification	Roadway width, m at : Plain and Rolling terrain	Mountaneous and steep terrain
01.	NH & SH a) single lane b) double lane	12.0 12.0	6.25 8.80
02.	MDR a) single lane b) Two lane	9.0 9.0	4.75 (10)-
03.	ODR a) single lane b) Two lane	7.5 9.0	4.75 -
04.	VR - single lane	7.5	4.00

3. **Right of way :-** It is the area acquired for the road along its alignment. The width of this acquired land is known as land width and it depends on the importance of road and possible future development.

4. **Kerbs :-** It indicates the boundary between the pavements and shoulders or sometimes islands or foot path or kerb parking space.



i) Low / mountable type kerbs – 10cm
ii) Semi barrier type kerbs – 15cm
iii) Barrier type kerbs – 20cm

5. Road Margin :- Road margin includes. shoulders, parking lane, frontage road, driveway, cycle track footpath, guard rail and embankment slope.

6. Embankment Slope :- It is flat for the purpose of safe traffic movement and also for aesthetic reasons generally a raised portion above the ground and below the road and two side slope.

7. Medians :- These are the dividers / traffic separators are generally provided to prevent head-on collision between vehicles moving in opposite directions on adjacent lanes. It may be in the form of pavement markings, physical dividers / area separators. IRC recommend min^m desirable width 5.0 m for median of rural highway & it may be reduced to 3.0 m where land is restricted.

8. Carriage Way :- It is the width of the roadway constructed for movement of vehicular traffic. carriage-way width depends upon on the width of traffic lane and number of lanes required. According to IRC specification the maximum width of a vehicle is 2.44 m and carriageway width for single lane traffic is 3.75 m.

9. Road Shoulders :- These are the portions of roadway between the edges of the carriage way and edges of the top surface of Embankment or inner edges of side drains in cutting. These are provided to serve as an emergency lane for vehicle required for breakdown vehicles. According to IRC minimum shoulder would have a clearance of 1.85 m from the pavement edge. The minimum shoulder width recommended by IRC is 2.5 meter.

10. Side Slopes :- These are provided to the sides of earthwork of a road in embankment or in cutting for its stability. Side slopes in a road are so designed as to keep the earthwork stable in embankment or in cutting.

11. Camber → camber is the transverse slope provided to the road surface to drain off the rainwater from the road surface.

SIGHT DISTANCE:—

It is the length of road visible ahead to the driver at any instance.

There are four following sight distance,

1. Stopping sight distance (SSD)
2. Decission sight distance (DSD)
3. Overtaking " " (OSD)
4. Intermediate " " (ISD)

Stopping sight distance :- (SSD)

The minimum sight distance available on a highway at any spot should be of sufficient length to stop a vehicle traveling at design speed, safely without collision with any other obstruction. It is also known as non-passing sight distance.

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

→ Factors affecting SSD,

(a) Total reaction time
(b) Speed of vehicle
(c) Efficiency of brakes
(d) frictional resistance bet' the road & the tyres
(e) Gradient of the road, if any.

total Reaction time:

Total reaction time is the time taken from the instant the object is visible to the driver to the instant the brakes are effectively applied. Total reaction time may be split up into two parts.

i) Perception time
ii) Brake reaction time.

→ Perception time is the time required for a driver to realise that brakes must be applied.

→ Brake reaction time also depends on several factors including the skill of the driver, type of the problem & various other environmental factors.

PIEV Theory :-

According to this theory the total reaction time of the driver is split into four parts,

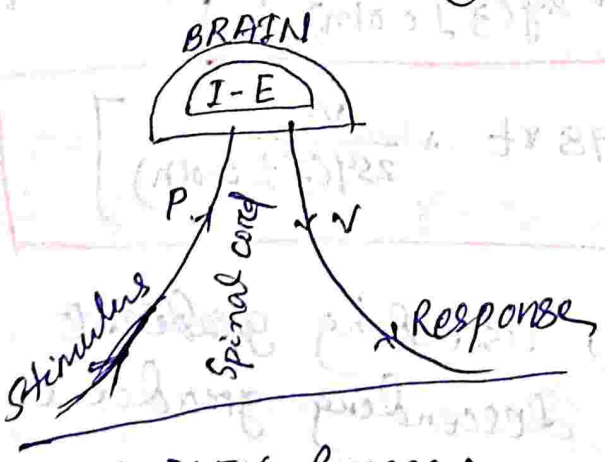
(I) Perception
(II) Intellection
(III) Emotion and
(IV) Volition.

→ Perception time is the time required for the sensations received by the eyes or ears to be transmitted to the brain through the nervous system and spinal chord.

→ Intellection time is the time required for understanding the situation. It is also the time required for comparing the different thoughts, regrouping and registering new sensations.

→ Emotion time is the time elapsed during emotional sensations and disturbance such as fear, anger or any other emotional feelings such as superstition, etc. with reference to the situation.

→ Volition time is the time taken for the final action.



(PIEV Process)

Note- IRC has specified a design of co-efficient of friction = 0.35 - 0.4 (longitudinal) depending upon the speed.

Analysis of 'SSD' :-

SSD = lag distance + braking distance

$$SSD_{(in\ m)} = vt + \frac{v^2}{2gf}, \text{ if } v \text{ is in m/sec.}$$

$$SSD_{(in\ m)} = 0.278vt + \frac{v^2}{254f}, \text{ if } v \text{ is in kmph}$$

where, V = design speed

t = total reaction time of the driver in seconds = 2.5 secs.

f = design co-efficient of friction = 0.4 - 0.35 depending upon the speed (30-80 kmph)

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

Note - SSD at slope,

$$SSD = \left[vt + \frac{v^2}{2g(f \pm 0.01n)}\right] \leftarrow v = m/sec$$

$$SSD = \left[0.278vt + \frac{V^2}{254(f \pm 0.01n)}\right] \leftarrow v \text{ kmph}$$

$\pm n$ = +ve, ascending gradient (+n%)

-ve, descending gradient (-n%)

Longitudinal friction value for different speeds :-

speed, Kmph.	20 to 30	40	50	60	65	80	100
Longitudinal coefficient of friction, (f)	0.40	0.38	0.37	0.36	0.36	0.35	0.35

Stopping sight distance values for different speeds :-

Design speed, Kmph	20	25	30	40	50	60	65	80	100
Safe SSD for design cm)	20	25	30	45	60	80	90	120	180

Ex-1 calculate the safe stopping sight distance for design speed of 50 Kmph for (a) two way traffic on a two lane road (b) two way traffic on a single lane road.

Sol?- $SSD = vt + \frac{v^2}{2gf}$, v = m/sec. Assume, $t = 2.5$ secs.

(a) $SSD = 0.278\,vt + \frac{v^2}{254f}$, v = kmph $\quad f = 0.37$

$= 0.278 \times 50 \times 2.5 + \frac{50^2}{254 \times 0.37}$

$= 34.75 + 26.60 = 61.35$ m.

(b) SSD for two way traffic on a single lane road :

$2 \times SSD = 2 \times 61.35 = 122.7$ m. (Ans)

Ex-2 calculate SSD on a highway at a descending gradient of 2% for a design speed of 80 kmph. Assume other data as per IRC recommendations.

Sol?- $v = 80$ kmph, $t = 2.5$ secs, $f = 0.35$, $\eta = -2\% = -0.02$

$\therefore SSD = 0.278\,vt + \frac{v^2}{254(f - \eta)}$

$= 0.278 \times 80 \times 2.5 + \frac{80^2}{254(0.35 - 0.02)}$

$= 55.6 + 76.36 = 131.96$ m $\simeq 132$ m (Ans)