Highway Engineering

GATE → (2-4) Questions

IES → obj — (5-9) questions

conv. — (15-30) marks

Topics

1. Geometric Design
2. Traffic Engineering   ⎫
3. Pavement Design   ⎬ (80-90)% questions
4. Highway material   ⎭

1. Geometric Design

→ Geometric Design of Highway deals with visible elements of the road

→ Various Geometric design components depends upon:

1) Type of road :—

a) Rural roads ;

i) National Highway → Joins various states

ii) Express ways → Speed upto 120 kmph

iii) State Highways → Joins various districts

iv) Major district roads (MDR) → Joins areas of population (or) production to the main highway.

v) Other district roads (ODR) → Joins rural areas to market place.

vi) Village roads → Joins various villages.

Note :—

→ IRC:73 is concerned with the design of Rural Highways.

b) Urban roads ;

i) Express ways

ii) Arterial roads

iii) Sub-arterial roads

iv) Collector streets

v) Local streets

2) Type of Vehicle :—

→ The vehicle for which road elements are designed is called "Design Vehicle."

→ The length, width, height of Design vehicle are used as design parameters for the roads.

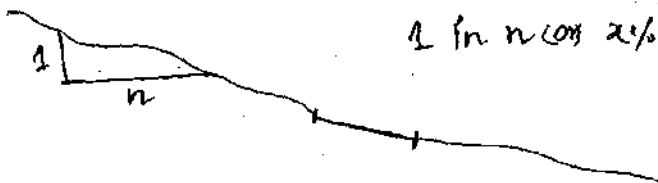Ex: width of Non-transport vehicle = 2.5m

width of Transport vehicle = 2.7m   (No need to remember)

Height of Double decker bus = 4.75m.

) Topography :-

> It is classified on the basis of general country slope across the road alignment.

. It is generally expressed as 1 in n or x%

1 in n or x%

$$x\% = \frac{1}{n} \times 100$$

> Classification based on cross-slope of the country :

Remember

Cross-Slope	Class
(0-10)%	Plain
(0-25)%	Rolling
(25-60)%	Mountaneous
>60%	Steep

→ longitudinal gradient :
gradient along the length of road

→ Country slope → means big area here.

or Area

if cross-slope of the country is large then large expenditure has to be made in altering the alignment for Highway design speeds

i.e, to provide a larger radius of curve to safeguard the vehicle against centrifugal force which causes skidding/overturning problems. Hence when cross-slope is large velocity is restricted.

4) Traffic Capacity :-

→ Traffic capacity is the ability of road to accommodate the maximum traffic volume, i.e, traffic capacity is maximum traffic volume with a given level of serviceability.

Traffic volume → It is the no. of vehicles crossing a given point or section in unit time.

→ Both Traffic capacity and Traffic volume are expressed in "Vehicles per hr"

(or) PCU/hr

where, PCU → Passenger car unit.

$$PCU = \frac{Capacity \text{ with passenger cars only}}{Capacity \text{ with the corresponding vehicle only}}$$

Ex:- PCU for pedal cycle, motor cycle, scooter → 0·5 $(0.5 = \frac{1}{2})$

PCU for Passenger Cars, Vans, Autorickshaw → 1·0   depends on other factors

PCU for cycle rickshaw   → 1·5   (creating congestion)

PCU for Truck   → 3·0

PCU for Bullock cart   → 6·0

→

Hourly volume as % of AADT

[AADT → Avg. Annual Daily Traffic]

design capacity (8-10% of AADT)

1 (rank)

(given rank as 1)

2

30th

365×24

→ Generally, Design capacity is taken as 30th highest hourly volume.

→ For Indian conditions, 30th highest hourly volume comes around (8-10)% of AADT where, AADT → Average annual Daily traffic.

$$AADT = \frac{Total\ yearly\ traffic}{365}$$

Ex: AADT = 2000 veh/day ⟶ (8-10)%

30th highest Hourly Volume = (160 - 200) veh./hr.

→ Depending upon the Traffic capacity width of road is decided

. Design speed :-

→ Design speed is decided theoritically as 98th percentile speed, that is the speed at or below which 98% of vehicles are moving.

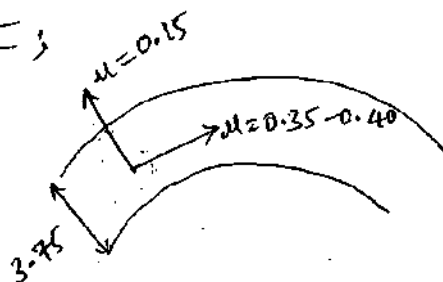However from economical point of view IRC has limited the Design speed on the basis of topography.

→ Normally, RULING SPEED should be the guiding criteria, however minimum speed can be adopted in localised sections where cost considerations doesnot Permits Ruling speed

x:

Express way ⟶

NH/SH ⟶

Plain	
Ruling	minimum speed
120kmph	100 kmph
100kmph	80 kmph

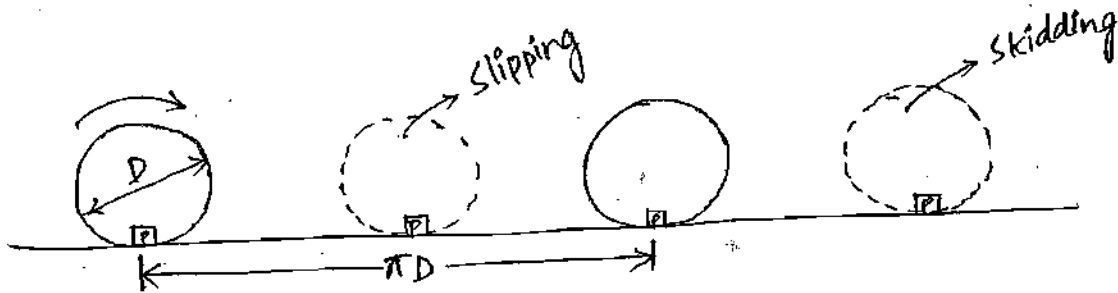. Surface characteristics :-

. Friction coefficient ;

μ = 0.15

μ = 0.35 - 0.40

3.75

→ longitudinal friction coefficient as recommended by IRC is taken as 0.35-0.40

→ lateral or Transverse friction coefficient as recommeded by IRC is taken as 0.15
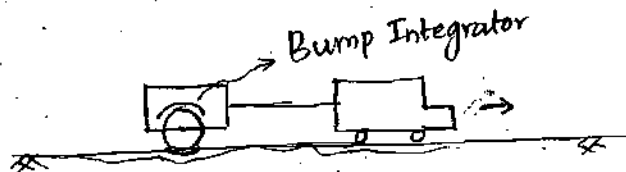
→ lack of friction causes skidding or slipping

→

a) if one revolution of wheel leads to longitudinal movement less than πD it is called "Slipping"

b) if one revolution of wheel leads to longitudinal movement greater than πD it is called "Skidding".

ii) Unevenness Index ;

→ This index is a cumulative measure of vertical undulations of pavement per unit length of the road.

→ It is measured using "Bump Integrator".

Bump Integrator

* Classification of Road surface based on unevenness Index :—

a) Good Surface → Unevenness Index < 1500mm per km.

b) Satisfactory surface → Unevenness Index upto 2500 mm per km
(for speed upto 100 kmph)

c) Unsatisfactory surface → Unevenness Index > 3200mm per km
(for speed 55 kmph)
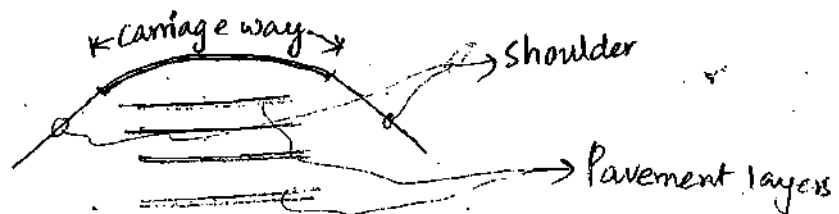
> Various Geometric Design Components are)

1. Cross-sectional elements

2. Sight distances

3. Horizontal alignment detail.

4. Vertical alignment detail.

5. Intersection details.

1. Cross-sectional elements :-

) width of Carriage way)

Type of road	width of carriage way
Single lane	3.75m
Dual lane (no kerb)	7m
Dual lane (with raised kerb)	7.5m
multi Lane	3.5m per lane
Intermediate lane	5.5m

[carriage way → It carries traffic]

← carriage way → → shoulder

→ Pavement layers

Shoulder ;

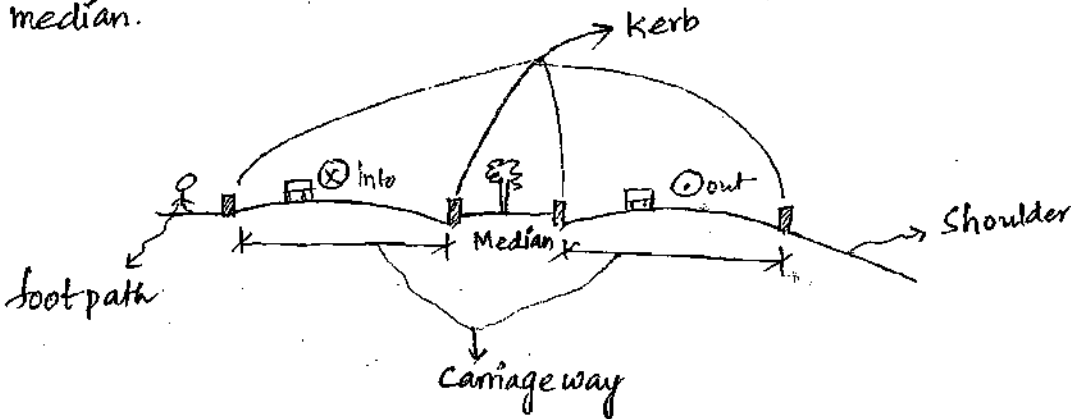→ shoulders are provided to accommodate stopped vehicles and to provide lateral continement to the pavement layers.

→ Desirable width of shoulder is 4.5m with a minimum of 2.5m on a two lane Rural Highway.

(for one side)

Ex:

Formation width for 2-lane rural Highway = $(2 \times 3.5) + (2 \times 2.5) = 12m$.

iii) **kerb** ;

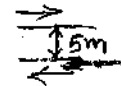→ It indicates the boundary between Pavement & shoulder (or) footpath (or) median.
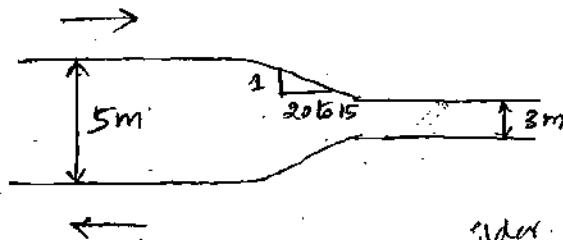

iv) **Median** ;

→ The purpose of median is to prevent Headon Collision of vehicles.

→ It is also known as "Traffic separator".

→ Minimum desirable width for Rural highway is <u>5m</u> and it lane width is restricted then the value may be reduced to <u>3m</u>
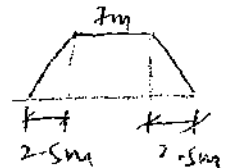
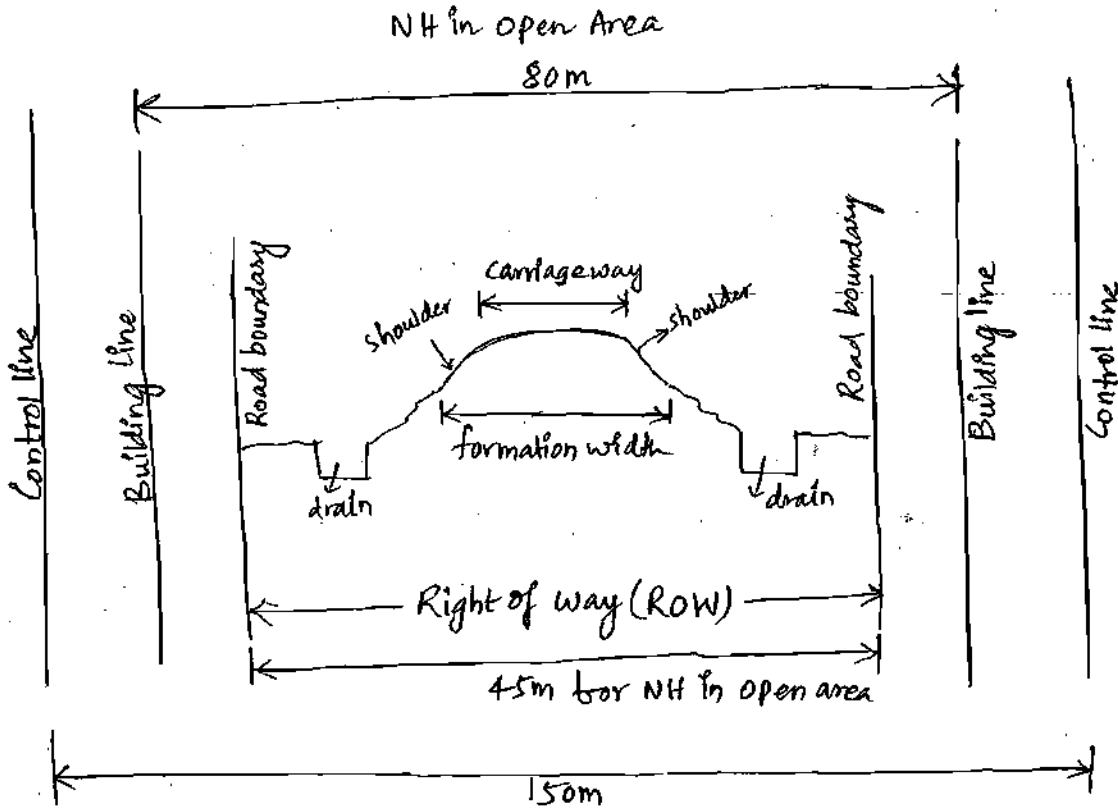→ width of median for bridges should be between <u>1.2 to 1.5m</u>

→ Transition in median should be <u>1 in 20</u> to <u>1 in 15</u> → steeper

Note :-

Ex: formation width for 2-lane road is ; $= 7m + 2.5m + 2.5m = 12m$.

) Road Margins :

NH in open Area
80m

Control line

Building line

Road boundary

shoulder

Carriageway

shoulder

formation width

drain

Road boundary

Building line

Control line

drain

Right of way (ROW)

45m for NH in open area

150m

Building line → represents the road width upto which no building Activity is Permitted. [ROW → Acquiring full width of land before finalizing highway alignment]

ontrol line → represents distance upto which nature of building is controlled (used for future widening of roads)

) Camber (or) Cross-slope (or) Cross fall :

> It is the slope provided to the road surface in transverse direction to drain off rain water.

Crown

* straight camber

* Parabolic camber

straight

Parabolic

straight

* mixed Camber