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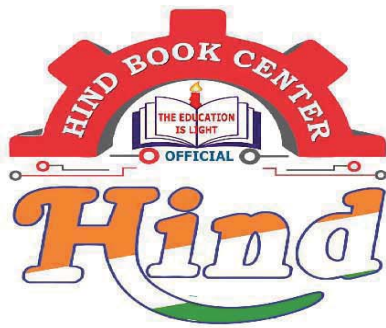
### **Highway Engineering**

**By-Saurabh Sir**

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# HIGHWAY ENGINEERING

## INTRODUCTION :-

### HISTORY :-

- 1) Roman Road
- 2) Tresaguet
- 3) Metcalf
- 4) Telford (ICE-UK)
- 5) Macadam
- 6) WBM (Water Bound Macadam)
- 7) Bituminous Macadam

### Major Recommendation of JAYKAR COMMITTEE :-

- (1) Road development should be considered as national Interest.
- (2) An extra tax should be levied on petrol to create Road development fund i.e. central Road Fund (CRF) developed in 1929.
- (3) A semi official technical body should be established i.e. Indian Road Congress (IRC) in 1934.
- (4) In research & development organization should be established i.e. central Road Research Institute (CRRRI) in 1950.

other measures are —

(1) Motor vehical Act — 1939

Revised in 1988, for violation of Traffic Laws.

(2) Highway Research Board (HRB) in 1973.

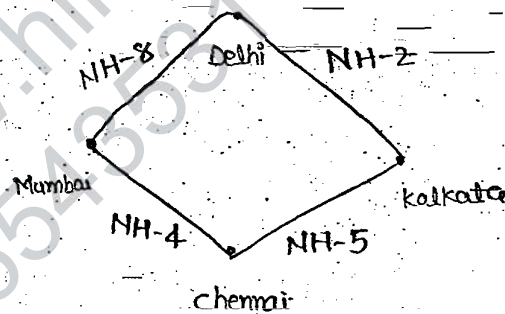
NATIONAL HIGHWAY Act - 1956 :-

(1) central govt. is responsible for the construction of National Highway.

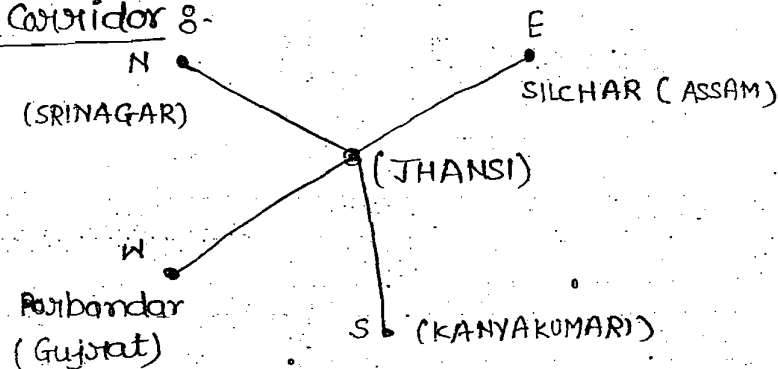
(2) central govt. is empowered to omit any N.H from the list of N.H or it can declare any S.H as N.H.

NATIONAL HIGHWAY DEVELOPMENT PLAN PROGRAM 1988 (NHDP) :-

(1) Golden Quadrilateral :-



(2) E-W & N-S Corridor :-



NH-1 :-

Delhi to Amritsar Via Ambala.

NH-58

NH-24

NH-3 :-

Aggra to Mumbai.

NH-7 :-

Varanasi to Kanyakumari (longest N.H.)

NH-15 :-

It is covering more than 50% area of Rajasthan.

NH-223

Andaman Nicobar (only Highway).

Note :-

Lord Dalhousie established PWD in 1865.

Classification of Roads :-

Rural Highways

- 1) National Highway (NH)
- 2) State Highway (SH)
- 3) MDR (Major District Road)
- 4) ODR (Other District Road)
- 5) VR (Village Road)

Rural Road

Urban Roads

- (1) Arterial
- (2) Subarterial
- (3) Collector street
- (4) Local street

## Comparison of 20 Year Road Plan :-

Features	1st 20 Yr. Road Plan	2nd 20 Yr. Road Plan	3rd 20 Yr. Road Plan
(1) Duration	1943 - 63	1961 - 81	1981 - 2001
(2) Other Name	Nagpur	Mumbai (Bombay)	Lucknow
(3) Target density	16 km/100 km <sup>2</sup>	32 km/100 km <sup>2</sup>	82 km/100 km <sup>2</sup>
(4) Road Pattern	STAR & GRID	—	SQUARE GRID
(5) Development Allowance	15%	5%	NIL
(6) Expressway	NO	1600 km	200 Dkm
(7) Road classification	NH, SH, MDR, ODR, & VR	Primary Road - NH & Expressway. Sec. Road - SH & MDR Ter. Road - ODR & VR	



### Length of Road According to 3rd 20 Year Plan :-

$$(1) \text{ Length of NH } = \frac{\text{Area (km)}^2}{50}$$

(in km)

$$(2) \text{ Length of S.H } = \frac{\text{Area (km)}^2}{25} \text{ (or) } [62.5 \times \text{No. of Towns} - \text{length of NH}]$$

(in km)

$$(3) \text{ Length of MDR } = \frac{\text{Area (km)}^2}{12.5} \text{ (or) } [90 \times \text{No. of Towns}]$$

(in km)

Ques: Total area = 80,000 km<sup>2</sup>

No. of Towns = 86

Road Density = 82 km/100 km<sup>2</sup>

Find out length of Rural Road by 3rd 20 year Road Plan.

Solution :-

$$\text{Length of NH} = \frac{80,000}{50} = 1600 \text{ km}$$

$$\text{Length of S.H} = \frac{80,000}{25} = 3200 \text{ km}$$

$$\text{(OR) } [62.5 \times 86 - 1600] = 3775 \text{ km}$$

$$\therefore \text{Length of SH} = 3775 \text{ km}$$

$$\text{Length of MDR} = \frac{80,000}{12.5} = 6400 \text{ km}$$

$$\text{(OR) } [90 \times 86] = 7740 \text{ km}$$

$$\begin{aligned} \text{Total length of Road} &= \frac{82 \text{ km}}{100 \text{ km}^2} \times 80,000 \\ &= 65600 \text{ km} \end{aligned}$$

$$\begin{aligned} \text{Length of Rural Road} &= 65600 - (1600 + 3775 + 7740) \\ &= \underline{\underline{52485 \text{ km}} \text{ Ans}} \end{aligned}$$

## Maximum Utility System (OR) Saturation System :-

It is used to calculate optimum road length & it depends upon —

- (1) Length of Road
- (2) Production — (Industrial & Agriculture)
- (3) Population

Proposal	Length	No. of Towns & Villages served with Population Ranges				Total Production (In 1000 Tons)
		1000-2000 0.5	2000-5000 1	5000-10,000 2	>10000 4	
P	300 km	160	80	30	6	200
Q	400 km	200	90	60	8	270
R	500 km	240	110	70	1	315
S	500 km	248	112	73	1	355

Total utility / unit length	Proposal
$\frac{(160 \times 0.5 + 80 \times 1 + 30 \times 2 + 6 \times 4) + 200}{300}$	P
= 1.48	Q
1.53	R
1.37	S
1.482	

QSPR  $\Rightarrow$

optimum road  $\rightarrow$  Q

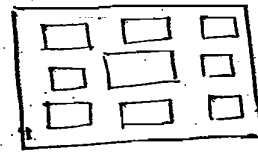


## ROAD PATTERNS :-

### (1) Rectangular & Grid Pattern :-

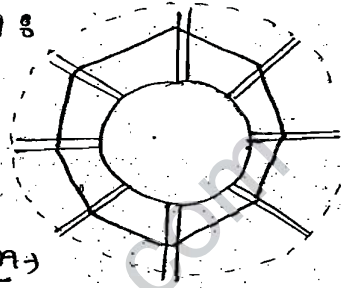
Ex. - Chandigarh

→ Le - Corbusier



### (2) Radial or Star & Grid Pattern :-

Nagpur Road Plan



### (3) Radial or Star & Circular pattern :-

Ex. Connaught Place

## Steps of Engineering Survey :-\*\*\*

### (1) Map study :- (Topographical Map)

(2) Reconnaissance Survey - It is used for deciding the most feasible road for detailed studies.

(3) Preliminary Survey - It is performed to collect the physical information.

(4) Final location & Detailed Survey Centre line of the road is translated on ground.

# GEOMETRIC DESIGN OF RURAL HIGHWAY (IRC-73)

## Elements of Geometric Design :-

- (1) Cross Section element
- (2) Sight Distance consideration
- (3) Horizontal Alignment
- (4) Vertical Alignment.

### 1. CROSS-SECTION ELEMENT

#### (A) Pavement characteristics :-

##### (i) Friction :-

Acc. to IRC coefficient of longitudinal friction lies b/w 0.35 to 0.40.

& Coefficient of lateral friction = 0.15

##### (ii) Skid & slip :-

Skid : longitudinal movement > Rotational movement.

Slip : Rotational movement > longitudinal movement.

##### (iii) Light Reflecting characteristic :-

Black top pavement with white border.

##### (iv) Pavement unevenness :- v.t.m.p

It is a cumulative measurement of vertical undulation of pavement per unit horizontal length.

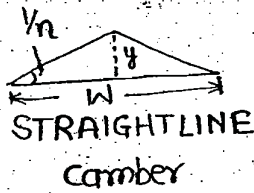
→ It is measured by bump indicator developed by CRR I.

Note 8 -

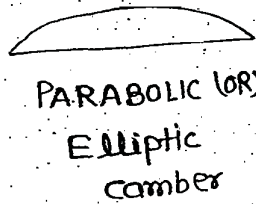
For a good pavement, pavement unevenness should not be greater than 150 cm/km.

(B) Camber or cross slope :-

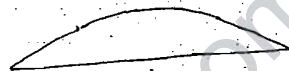
Camber  $\rightarrow$  Transverse slope given to the road to drain off storm water from the surface.



STRAIGHTLINE  
Camber



PARABOLIC (OR)  
ELLIPTIC  
Camber



Combination of  
Parabolic & Straight

$$\frac{1}{n} = \tan \theta = \frac{y}{w/2}$$

$$y = \frac{w}{2n}$$

$\Rightarrow$  eq<sup>n</sup> of parabola -

$$x^2 = ay$$

at  $x = 0$  ;  $y = 0$

at  $x = \frac{w}{2}$  ;  $y = y$

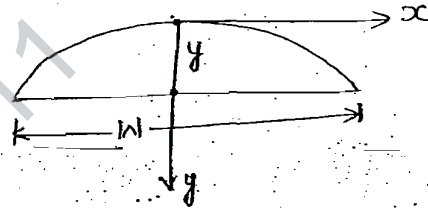
$$\left(\frac{w}{2}\right)^2 = ay$$

$$\left(\frac{w}{2}\right)^2 = a \cdot \frac{w}{2n}$$

$$\therefore a = \frac{nw}{2}$$

$$x^2 = \frac{nw}{2} \cdot y$$

$$y = \frac{2x^2}{nw}$$



Type of Pavement	Rainfall	
	Heavy	Light
1. Cement Concrete or High type Bituminous	2%	1.7%
2. Thin Bituminous	2.5%	2%
3. WBM & Gravel Road	3%	2.5%
4. Earth Road	4%	3%

Note :

- (1) Camber depends on rainfall intensity and types of Pavement.
- (2) Camber of shoulder is 0.5% steeper than the camber of the Road.
- (3) For cement concrete pavement straight line camber is provided b/c it is difficult to provide parabolic.
- (4) Parabolic or elliptical camber are preferred for fast moving vehical for overtaking operation.
- (5) Relation b/w Camber & Gradient  $\Rightarrow \boxed{G = 2C}$

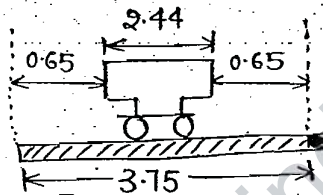
Disadvantages of <sup>excessive</sup> Camber :-

- (1) Transverse tilt of Vehical & discomfort.
- (2) Cross - Ruts or depression.
- (3) Centre line tendency.

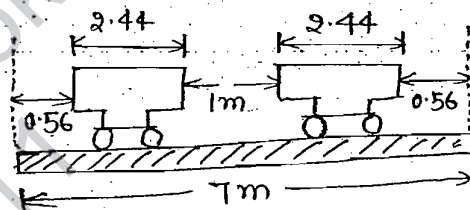
### (C) Width of Pavement (or) Carriageway :-

Class of Road	Width of Road
(1) Single lane Road	3.75 m
(2) Double lane Road without kerb	7.0 m
(3) Double lane Road with kerb	7.5 m
(4) Intermediate lane	5.5 m
(5) Multilane Pavement	3.5 m/lane

Note :- Acc. to IRE minimum width of Vehicle = 2.44 m.



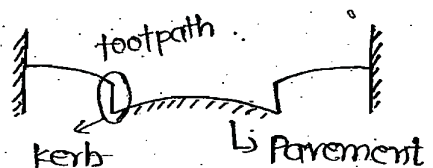
for single lane



for double lane

### (D) Kerb :-

kerb is the boundary b/w Road & Shoulder / footpath.



### Types of kerb :-

- (1) Low or mountable type kerb = 10 cm
- (2) Semi Barrier type kerb. = 15 cm
- (3) Barrier type kerb. = 20 cm



(E) Width of formation or Roadway :-

For single lane road width of roadway equal to width of pavement + width of shoulder.

For 2 lane road with median

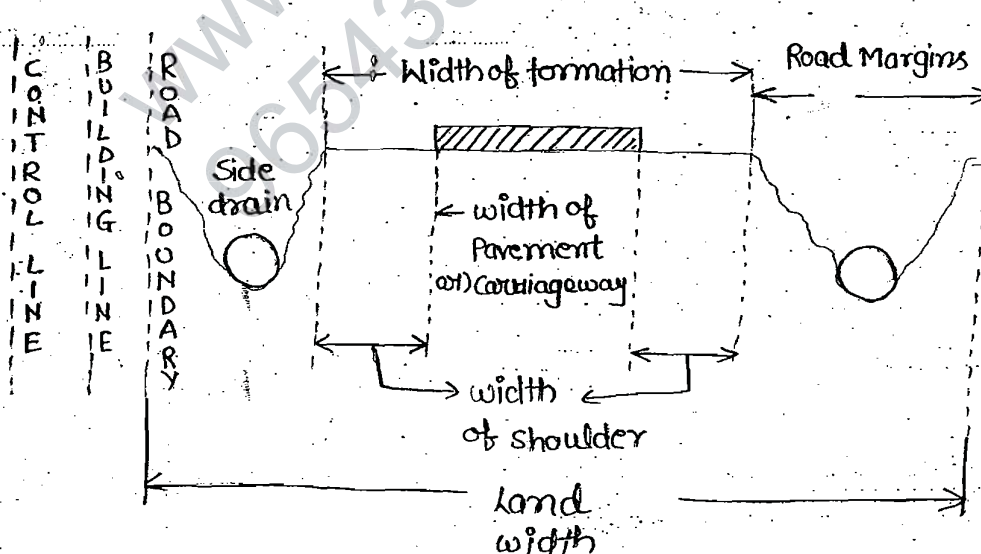
width of formation = width of pavement + shoulder + median.

Note 8 -

Min<sup>m</sup> roadway width on single lane Bridge = 4.25m

Classification of Road	Terrain	
	Plain & Rolling	Mountainous & Steep
(A) NH		
1. single lane	12m	6.25m
2. Double lane	12m	8.8m

(F) Road Margins :-



### ROAD MARGINS :-

- (1) cycle Track.
- (2) Guard Rail.
- (3) Lay - byes.
- (4) Drive ways. (Petrol Pump)
- (5) Shoulder.
- (6) Footpath.

Lay  
byes



### SHOULDER :-

- It is provided along road edge to serve as emergency lane.
- Calam of shoulder is different road from road & also rougher than road so as not be used as a regular traffic lane.

### RIGHT OF WAY :-

It is area of land required for construction of road, and width of that area along the road alignment is known as land width.

### 2. SIDE DISTANCE

#### (A) STOPPING