TRANSPORTATION

CIVIL ENGINEERING-CE

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CONTENT

CHAPTER-1
HIGHWAY PLANNING

MAJOR MODES OF TRANSPORTATION ARE:

1. Roadways
2. Railways
3. Water ways
4. Airways

HISTORICAL DEVELOPMENT ABOUT ROADS:

1. Roman road:

Roman Roads are one of the earliest types of roads out of which some of them are still in existence. The main features of these roads are:

(i) These are plane roads without having any slopes

(ii) The thickness of the road is in between 0.75 to 1.2 m.

(iii) Large stones are put in the bottom as well as at the top where as small stones are sandwiched between them.

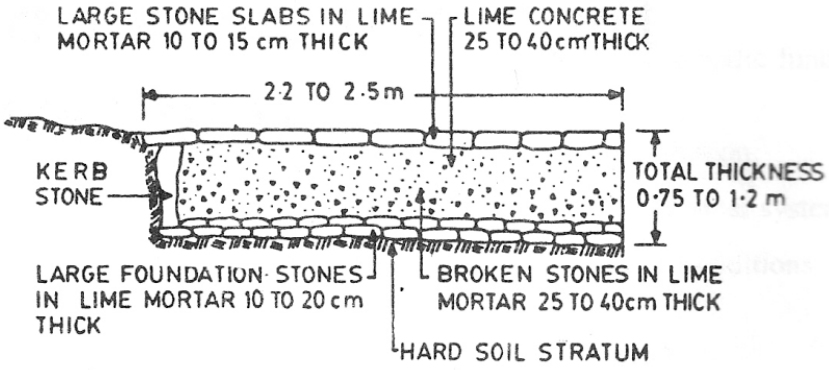


Figure: Typical Cross section of Roman Road

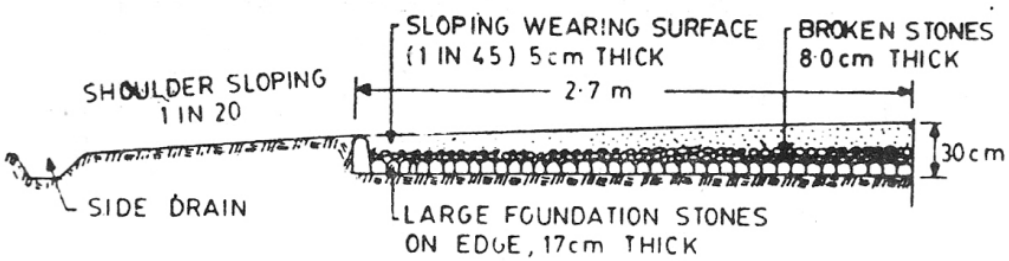
2. Tresaguet road:

Pierre Tresaguet, the Inspector general of roads in France, was the first to consider the importance of drainage of roads. So, camber started to be introduced in his methods of road construction. Main features of his construction was:

(i) Unlike Romans, thickness is in the order of only 30 cm.

(ii) Shoulders and Cambers are provided to drain water.

Figure: Typical Cross Section of Tresaguet's Construction (1775 A.D.)

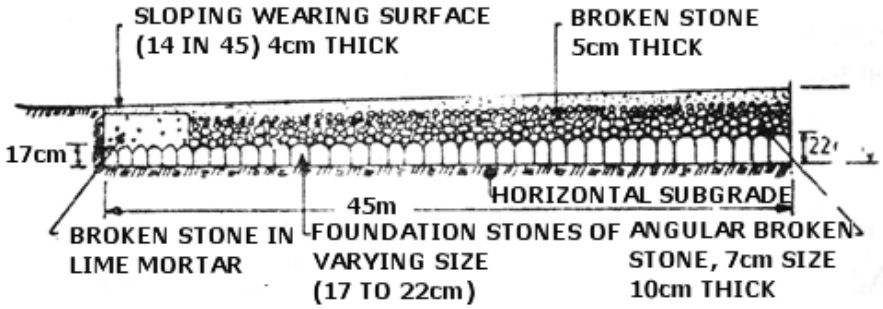


3. Telford road:

Thomas Telford was a civil engineer in London. Main features of his construction were:

(i) Like others methods, heavy foundations stones of thickness 17 to 22 cm were put at the bottom.

(ii) Level subgrade of width of 9 meters were provided.



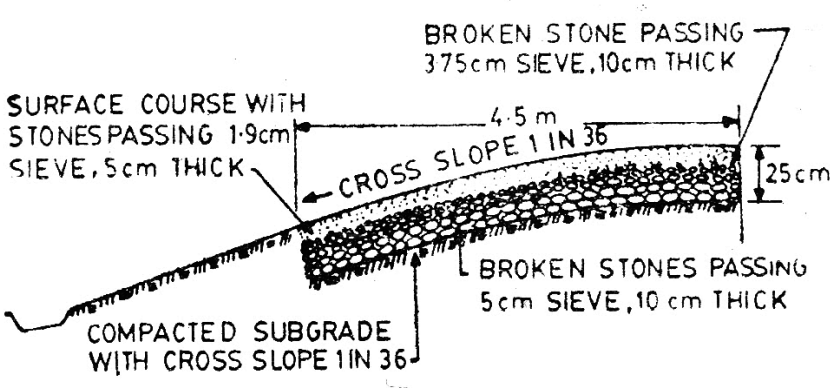
4. Macadam road:

Macadam started entirely new method on scientific technique in England. The main feature of the Macadam's roads were:

(i) The cross-slope of subgrade is 1 in 36 to facilitate drainage.

(ii) Unlike others compacted layers of smaller size broken stones are placed at the bottom.

(iii) The total thickness was kept uniform to a minimum value of 25 cm.



- First method of road construction on scientific basis.
- The cross - slope of sub-grade is 1 in 36 to facilitate drainage.

HIGHWAY DEVELOPMENT IN INDIA:

After the coming of British in India, Major roads development plan started. The British interest in roads was for military importance and administrative requirements. After the First World War periods, there was a rapid growth in motor transport. It was that period after which major steps were taken for road development in India. Various committee, institute were formed, various acts were passed and funds were started for road development

- Jayakar committee - 1927
- Central road fund (C.R.F) - 1929
- Indian roads congress - 1934
- Central road research Institute - 1950
- Motor vehicle act - 1939
- National highway act passed in - 1956
- Highway research board - 1973

- National transport policy committee - 1978

CLASSIFICATION OF ROADS:

(A) Based on usage of roads during different season of roads:

(i) All weather road

(ii) Fair weather road

(B) Based on type of carriage way:

(i) Paved road : Provided with a hard pavement course, e.g. - water bound macadom (WBM) road etc.

(ii) Unpaved road : Provided without a hard pavement course, e.g. - earth road, gravel road etc.

(C) Based on type of pavement surfacing :

(i) Surface road: e.g. Bituminous or cement concrete surfacing etc.

(ii) Unsurfacedroad :

(D) Based on traffic volume:

(i) Heavy traffic road

(ii) Medium traffic road

(iii) Light traffic road

(E) Based on load transported or tonnage :

(i) Class I, II, III etc.

or

(ii) Class A, B, C etc.

(F) Based on location and function as per Nagpur road plan :

(i) National highway (NH): Main highway running across the country, e.g. - NH - 1 (Delhi - Ambala - Amritsar), NH - 3 (Bombay, Agra) etc.

(ii) State highway (SH): Arterial roads of a state connecting with the national highways of adjacent state, district head quarters etc.

(iii) Major district road (MDR) :

(iv) Other district road (ODR) :

(v) Village road (VR) :

(G) As per 3rd twenty year road development plan, Lucknow Road Plan (1981 - 2001) :

(i) Primary system

(a) Expressway

(b) Nationan highways (NH)

(ii) Secondary system:

(a) State highways (SH)

(b) Major district roads (MDR)

(iii) Tertiary system :

(a) Other district road (ODR)

(b) Village road (VR)

- **As per third twenty year road development plan (1981 - 2001), Urban road are classified as:**

(i) Arterial road

(ii) Sub - Arterial road

(iii) Collector street

(iv) Local street

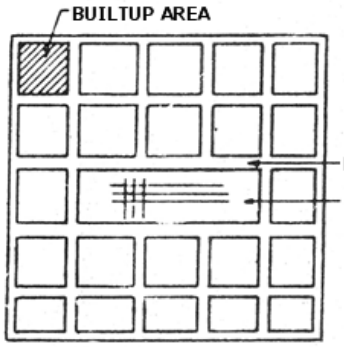
CLASSIFICATION OF ROAD PATTERNS :

(i) Rectangular or block pattern

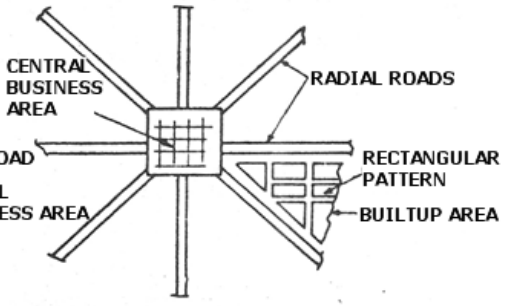
(ii) Radial or star and block pattern

(iii) Radial or star and circular pattern

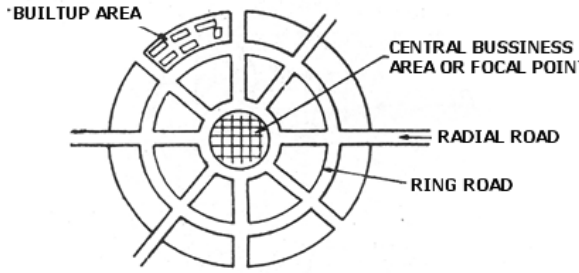
(iv) Radial or star and grid pattern
(v) Hexagonal pattern
(vi) Minimum travel pattern



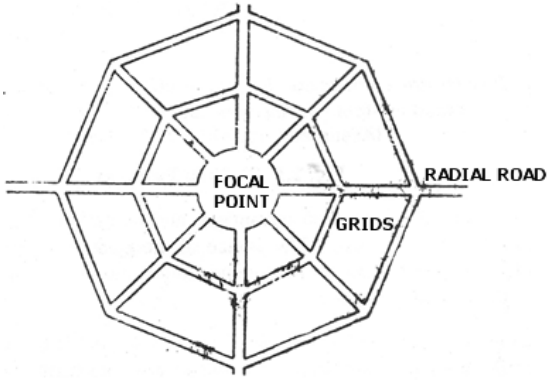
(a) Rectangular or block pattern



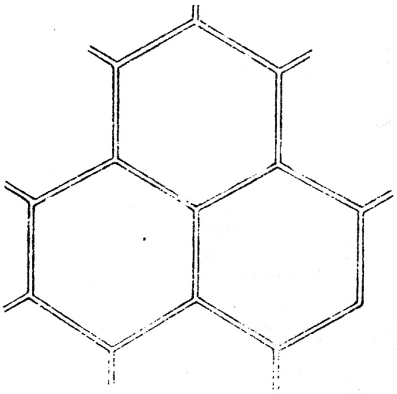
(b) Radial or star and block pattern



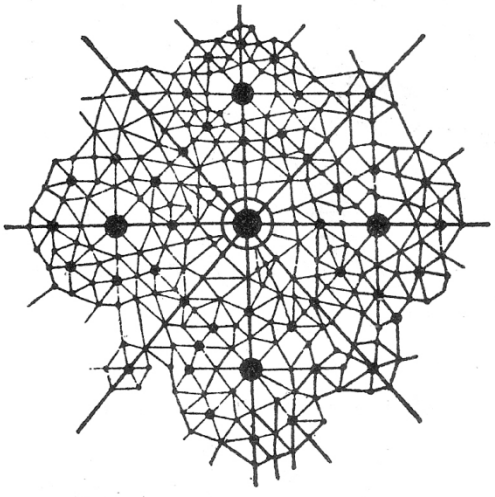
(c) Radial or star and circular pattern



(d) Radial or star and grid pattern



(e) Hexagonal pattern



Legend : City centre – encircled dot, sector centers - ●, Suburban centers - ●, Neighbourhood centers - •, Representation of a "Minimum Travel" city (Assumed population of 2 million)

Figure: Road Pattern (Contd.)

Note :

- Rectangular or block pattern is adopted in road network of **Chandigarh**
- Radial and circular patter is adopted in road network of **Cannaught place, New Delhi**

HIGHWAY PLANNING IN INDIA :

1. First 20 year road plan or Nagpur road plan (1943 - 63)

Salient features:

- Road network was classified into fire categories :
  (i) National highway (NH)
  These are the roads connecting major ports, foreign highways, capitals of large states and large industrial and tourist centres.
  (ii) State highway (SH)
  Important roads within a district, which connect the traffic from main roads to the interior of the districts.
  (iii) Major district road (MDR)
  (iv) Other district road (ODR)
  (v) Village road (VR)
  Expressways are highways with superior facilities and design standards. The costs of construction of these highways are very high so, designed for routes having very high traffic volume.
- **Recommendations** for geometric standards of roads, bridges, highway were made.
- Star and Grid pattern of road network was assumed.
- Total length of first category or metalled roads for National, State highways and Major district roads in given by :

$$NH + SH + MDR(Km.) = \left[\frac{A}{8} + \frac{B}{32} + 1.6N + 8T\right] + D - R$$

where,
A = Agricultural area (km^2)
B = Non - agricultural area (km^2)
N = No. of towns and villages with population range 2001 - 5000.
T = No. of towns and villages with population over 5000.
D = Development allowance (15%) of road length calculated to be provided for agricultural and industrial development during the next 20 year.
R = Existing length of railway track, (km.)

- Total length of 2nd category roads for ODR & VR is given by :

$$ODR + VR(Km.) = \left[0.32V + 0.8Q + 1.6P + 3.2S\right] + D$$

where,
V = No. of villages with population 500 or less.
Q = No. of villages with population range 501–1000.
P = No. of villages with population range 1001–2000.
S = No. of villages with population range 2001–5000.
D = Development allowance (15%) for next 20 year.

- Target in this plan was :
  (i) Approx. 2,00,000 km. surfaced road and remaining unsurfaced road so as to make total road length of 5,32,700 km.
  (ii) Road density : 16 km/100 km^2 area.

2. Second twenty year road plan or Bombay road plan (1961 -81) :

Salient futures :

- Nagpur road plan was completed in 1961
- Target for total length of road network : 10, 57, 330 km.

- **Formulas for calculation of road length :**

(a) National highway (km) $= \left[\frac{A}{64}+\frac{B}{80}+\frac{C}{96}\right]+\left[32K+8M\right]+D$

(b) National highway (NH) + State highway (SH) (km)

$$=\left[\frac{A}{20}+\frac{B}{24}+\frac{C}{32}\right]+\left[48K+24M+11.2N+1.6P\right]+D$$

(c) National highway (NH) + State highway (SH) + Major district road (MDR)

$$(Km)=\left[\frac{A}{8}+\frac{B}{16}+\frac{C}{24}\right]+\left[48K+24M+11.2N+9.6P+6.4Q+2.4R\right]+D$$

(d) National highway (NH) + State highway (SH) + Major district road (MDR) + Other district road (ODR) (km)

$$=\left[\frac{3A}{16}+\frac{3B}{32}+\frac{C}{26}\right]+\left[48K+24M+11.2N+9.6P+12.8Q+4R+0.8S+0.32T\right]+D$$

(e) National highway (NH) + State highway (SH) + Major district road (MDR) + Other district road (ODR) + Village road (VR) (km)

$$=\left[\frac{A}{4}+\frac{B}{8}+\frac{C}{12}\right]+\left[48K+24M+11.2N+9.6P+12.8Q+5.9R+1.6S+0.64T+0.2V\right]+D$$

where,

A = Developed and agricultural area (km^2)
B = Semi - developed area (km^2)
C = Undeveloped area (km^2)
K = No. of towns with population over 1,00,000.
M = No. of towns with population range 1,00,000 - 50,000.
N = No. of towns with population range 50,000 - 20,000.
P = No. of towns with population range 20,000 - 10,000.
Q = No. of towns with population range 10,000 - 5000.
R = No. of towns with population range 5000 - 2000.
S = No. of towns with population range 2000 - 1000.
T = No. of towns with population range 1000 - 500.
V = No. of towns with range below 500.
D = Development allowance (5%)

- Road density : $32km/100km^2$
- Maximum distance of any place in a developed or agricultural area should be 6.4 Km. from a metalled road and 2.4 Km. from any category of roads.
- Maximum distance from any place in a semi - developed area should be 12.8 km. from a metalled road and 4.8 km. from any road
- Maximum distance in an undeveloped area should be 19.2 km. from a metalled road and 8.0 km. from any road.
- Expressways have been considered in this plan and its length was proposed to be 1600 km. in traget of National highway.
- Length of railway track is considered independent of the road system and hence it was not subtracted to get the road length.

3. Third Twenty Year Road Plan or Lucknow Road Plan (1981 - 2001) :

Salient Features :

- Road density : 82 km/100 km^2
- National highway (NH) network should be expanded to form square grids of 100 km. sides so that no part of the country is more than 50 km. away from a NH.
- Expressways should be constructed along major traffic corridors.

Road network system was classified into :

(i) Primary system (ii) Secondary system (iii) Tertiary system

- **Formulaes for calculating road length :**

(i) Primary System :

- Target of expressways = 2000 km.
- National highway are to be based on the concept of 100 km. square grids i;e. the road density wil be of 1 km/50 km^2 area.

(ii) Secondary road system :

- The roads consisting of NH and SH should pass through every town or urban areas.
- Total length of SH required for any state is determined the on following two basis.

(i) By total area, SH (km) = Area of state (km^2)/25.

(ii) By total no. of towns and area in the state, SH (km)

= 62.5 × no. of towns in the state - Area of the state (km^2) / 50

- Total length of MDR in the country has been worked out as 3,00,000 km.
- Total length of MDR required in a state is determined on the following basis :

(i) By total area, MDR (km) = Area of state (km^2)/12.5

(ii) By total no. of towns in the state, MDR (km) = 90× no. of towns in the state.

(iii) Tertiary road system :

- Total length of ODR and VR in the country by the year 2001 should be 21,89,000 km.

1. Which one of the following is the sequence in regard to road construction design development?

(a) Telford, tresaguet, CBR, macadam (b)Tresguet, Telford, macadam, CBR

(c) Macadam, CBR, tresaguet, Telford (d) Tresguet, macadam, Telford, CBR

[IES-1998]

Answer (b)

2. The length of national highways as per 3rd 20 year (Lucknow) road plan is given by

(a) Area of the country / 75 (b)Area of the country / 50

(c) Area of the county / 40 (d) Area of the country / 25 **[IES-2000]**

Solution: (b)

Question: The area of a certain district in India is 18,400 sq. km and there are 15 towns as per 1981 census. Determine the lengths of different categories of roads to be provided in this district by the year 2001.

Solution :

The census is based on Third twenty year Road Plan or Lucknow Road Plan (1981-2001)

(i) Length of NH, km = 18400/50 = 368 km

(ii) Length of SH:

(a) By area, SH, km = 18400/25 = 736 km

(b) By area and no. of town, SH, Km $= \left(62.5\times15-\frac{18400}{50}\right)\text{km} = 570\text{ km}$

Higher of the two is adopted = 736 km

(iii) Length of MDR, in the District:

(a) By area, $\text{MDR} = \dfrac{18400}{12.5} = 1472 \text{ km}$

(b) By no. of town $= 90 \times$ no. of towns in the state $= 90 \times 15 = 1350$ km

$\therefore$ Provided length of MDR (Higher of above 2) = 1472 km

(iv) As per Lucknow road plan

Road density $= 82 \text{ km} / 100 \text{ km}^2$

Total length of all categories of roads

$= 18400 \times \dfrac{82}{100} \text{km} = 15088 \text{ km}$

From the above calculation :

$\text{NH} + \text{SH} + \text{MDR} = (368 + 736 + 1472)\text{km} = 2576 \text{ km}$

$\therefore$ Length of Tertiary road system $(\text{ODR} + \text{VR}) = (15088 - 2576)\text{km} = 12512 \text{ km}$

CHAPTER-2

HIGHWAY ALIGNMENT AND SURVEYS

BASIC REQUIREMENTS OF AN IDEAL ALINGMENT :

(i) Short
(ii) Easy
(iii) Safe
(iv) Economical

FACTORS CONTROLLING ALIGNMENT ARE :

(i) Obligatory points
(ii) Traffic
(iii) Geometric design
(iv) Economics
(v) Stability
(vi) Drainage
(vii) Resisting length

(i) Obligatory points :

- These are control points governing the alignment of highway.
- These control points can be classified into :

(a) Points through which the alignment is to pass: e.g. A town, A bridge site etc.
(b) Points through which the alignment should not pass: e.g. Religious places, like temple, mosque, pond etc.

Stages of the engineering surveys are :

(i) Map study: In India, topographic maps are available from the survey of India with 15-30 mm. contour intervals. The main features like rivers, forests, hills, valleys etc.

(ii) Reconnaissance:

Reconnaissance is the stage in which general characteristics of area is examined for deciding the most feasible routes for detailed studies. Simple instruments like level, clinometers, barometer etc are used to take the details rapidly. After reconnaissance, the alignment is passed or may be altered also.

Objective of reconnaissance are:

- To find the approximate values of gradient, length, radius of the curves of the alignment.
- To find sources of construction materials and soil characteristics
- No. and type of cross drainage structures, maximum flood level, natural ground water level etc.

(iii) Preliminary survey:

Objective of preliminary survey are:

- To survey the various alternate alignments proposed after the reconnaissance.
- To collect the details of the topography, drainage condition, soil type etc.
- To estimate quantity of various construction activities.
- To select the best alternatives for the alignment from all consideration.

(iv) Final location and detailed survey:

- To transfer the centre line of the finalised road on the ground. This is done using various survey equipments like the theodolite chain etc.

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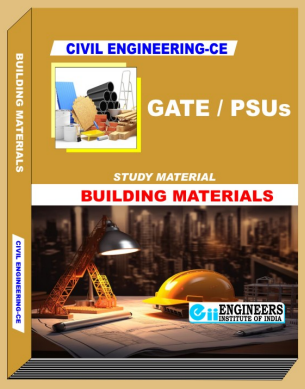

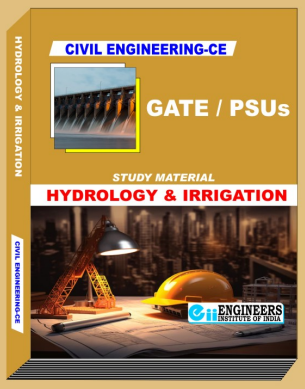

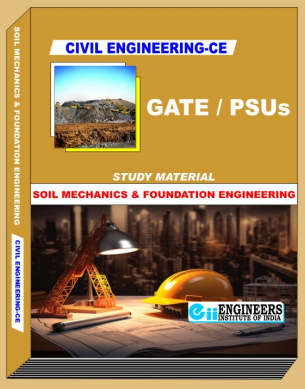

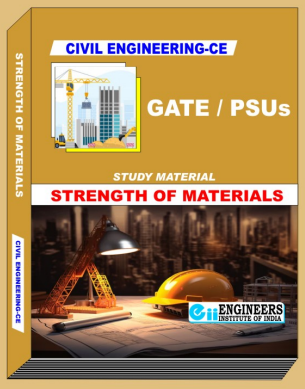

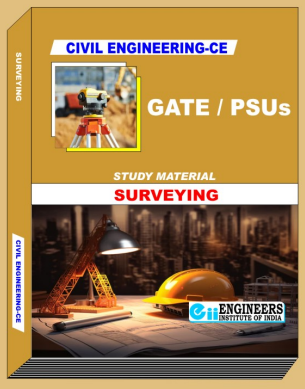

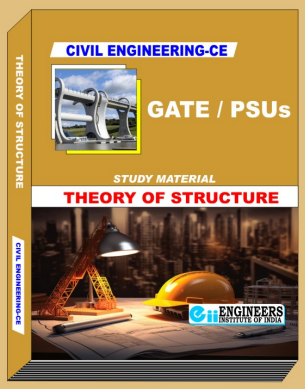

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