



SSC-JE

STAFF SELECTION COMMISSION

CIVIL ENGINEERING

STUDY MATERIAL

TRANSPORTATION ENGINEERING

Transportation Engineering Syllabus: Highway Engineering – cross sectional elements, geometric design, types of pavements, pavement materials – aggregates and bitumen, different tests, Design of flexible and rigid pavements – Water Bound Macadam (WBM) and Wet Mix Macadam (WMM), Gravel Road, Bituminous construction, Rigid pavement joint, pavement maintenance, Highway drainage. Railway Engineering – Components of permanent way – sleepers, ballast, fixtures and fastening, track geometry, points and crossings, track junction, stations and yards. Traffic Engineering – Different traffic survey, speed-flow-density and their interrelationships, intersections and interchanges, traffic signals, traffic operation, traffic signs and markings, road safety.

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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.

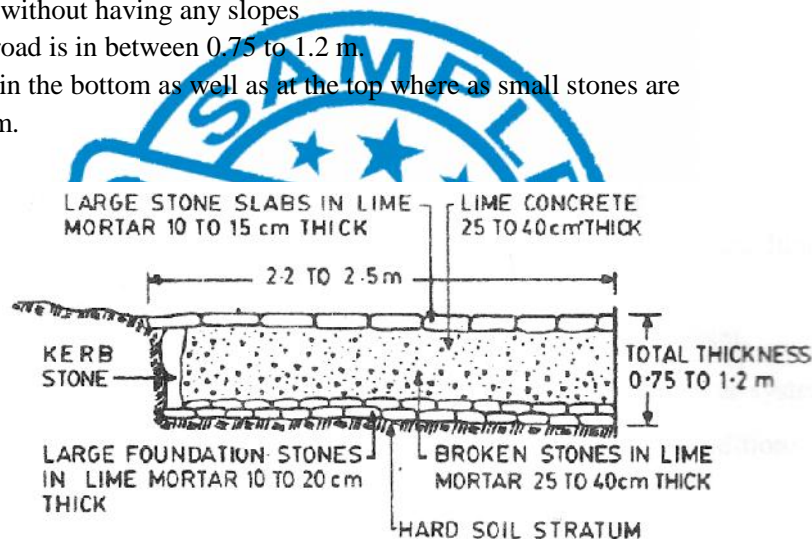
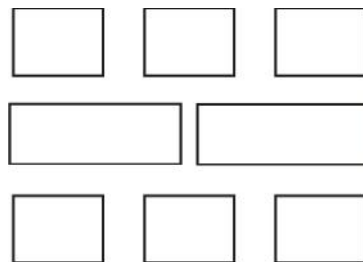


Figure: Typical Cross section of Roman Road



Plan view of Roman roads

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.

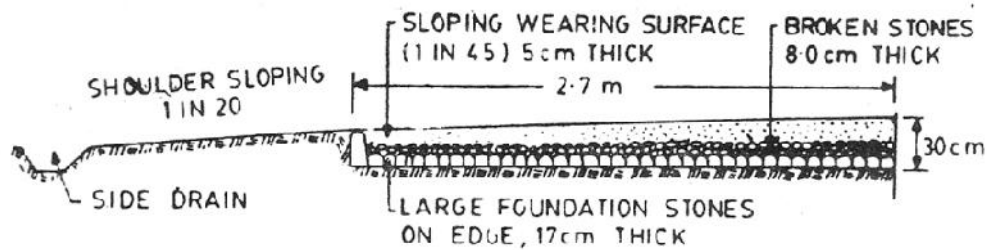
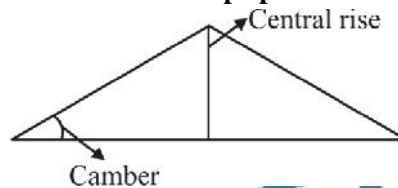


Figure: Typical Cross Section of Tresaguet's Construction (1775 A.D.)

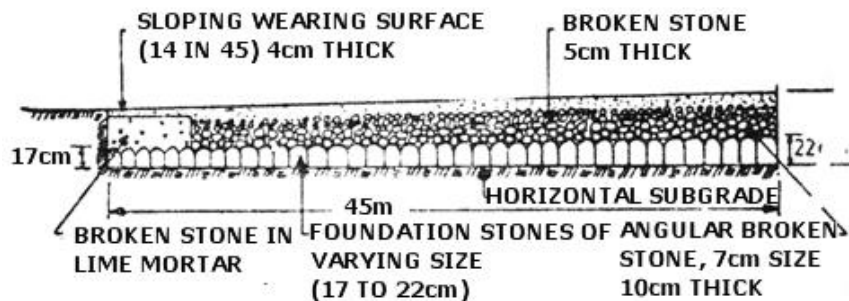
Note:- Camber \bar{E} Transverse slope provided to drain of surface water.



3. Telford road:

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

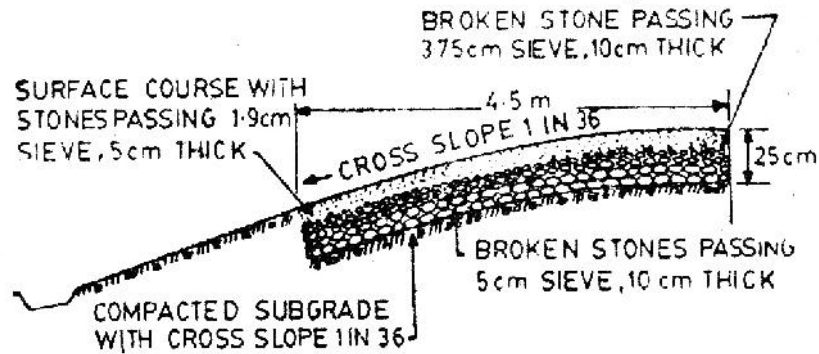
- (i) Like others methods, heavy foundations stones of thickness 17 to 22 cm were put at the bottom.
- (ii) Level subgrade [subgrade was horizontal] of width of 9 meters were provided.
- (iii) Bottom stands of varying thickness were provided



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:- Used in all weather and calbboo in reany seach
- (ii) Fair weather road:- Cruchnot be used in rainy season

(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) Unsurfaced road :

(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) National 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

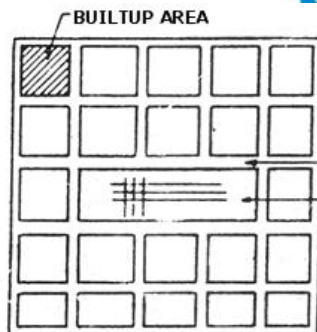
(ii) Radial or star and block pattern

(iii) Radial or star and circular pattern

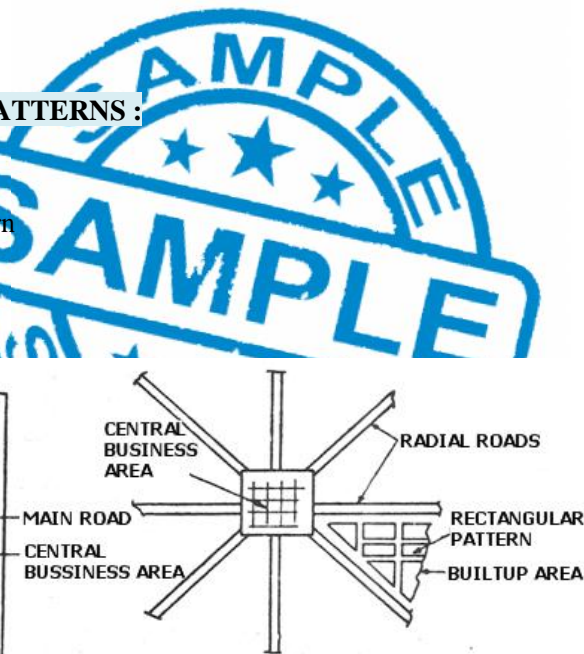
(iv) Radial or star and grid pattern

(v) Hexagonal pattern

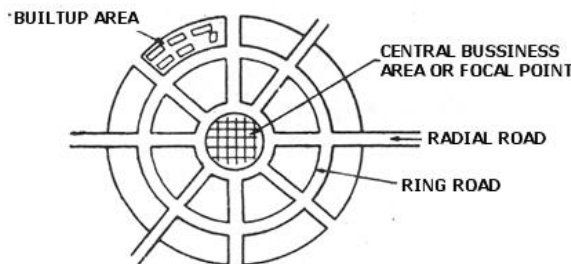
(vi) Minimum travel pattern



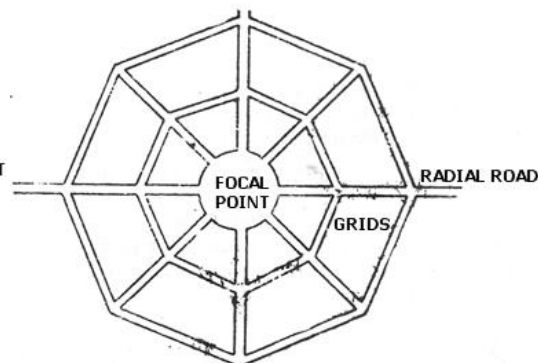
(a) Rectangular or block pattern



(b) Radial or star and block pattern

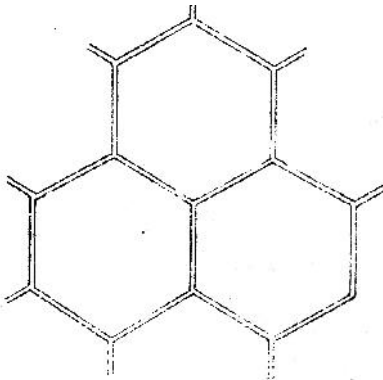


(c) Radial or star and circular pattern

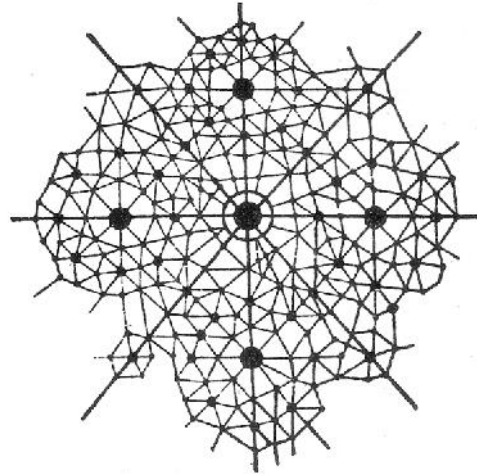


(d) Radial or star and grid pattern

[CP → Rajiv Chowk]



(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 pattern is adopted in road network of Connaught 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 five 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 is given by :

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

where,

A = Agricultural area (km²)

B = Non - agricultural area (km²)

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 :

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

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 km² area.

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

Salient features :

- 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) = $\left[\frac{A}{64} + \frac{B}{80} + \frac{C}{96} \right] + [32K + 8M] + D$

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

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

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

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

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

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

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

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

where,

A = Developed and agricultural area (km²)

B = Semi - developed area (km²)

C = Undeveloped area (km²)

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 : $32\text{km}/100\text{km}^2$
- 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 traquet 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 : $82\text{ km}/100\text{ km}^2$
- 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 will be of 1 $\text{km}/50\text{ km}^2$ area.

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