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ADICHUNCHANAGIRI UNIVERSITY

BGSIT BG NAGARA

DEPARTMENT OF CIVIL ENGINEERING

HIGHWAY ENGINEERING

18CV55

TRANSPORTATION ENGINEERING

- **Transportation engineering** is the application of technology and scientific principles to the planning, functional design, operation and management of facilities for any mode of transportation in order to safe,efficient,rapid,comfortable,convenient,economical, and environmentally compatible movement of people and goods from one place to other.

Role of transportation

Transportation contributes to the prosperity of a nation

- Transportation contributes to the economic, industrial, social and cultural development of any country.
- Transportation is important for the economic development of any region since every commodity produced whether it is food, clothing, industrial products or medicine needs transport at every stage from production to distribution.
- In the production Stage, transportation is required for carrying raw materials like seeds,manure,coal,steel etc.
- In the distribution stage, transportation is required from the production centres farms and factories to the marketing centres and later to the retailers and the consumers for distribution

Significance Of Transportation

1.Transport contributes in **Growth of industries whose product requires quick marketing**
Perishable articles like fish and green vegetables are carried to various consumers quickly even in distant markets through transport.

2.Transport helps in **increase in the demand for goods**.

3.Transport **creates place utility**. Geographical and climatic factors force industries to be located in particular places far away from the markets and places where there may not be any demand for the products. Transport bridges the gap between production and consumption centers.

4.Transport **creates time utility**. Of late transport has started creating the time utility also. It has been made possible by virtue of the improvements in the speed of transport. It helps the product to be distributed in the minimum possible time.

5.Transport helps in **stabilization of price.** Transport exerts considerable influence upon the stabilization of the prices of several commodities by moving commodities from surplus to deficit areas. This equalizes the supply and demand factors and makes the price of commodities stable as well as equal.

6.Transport **ensures even flow of commodities** into the hands of the consumers through out the period of consumption.

7.Transport **enables the consumers to enjoy the benefits of goods not produced locally.** This increases the standard of living, an essential factor for further development of marketing and economy.

8.Transport **identifies competition**, which in turn, reduces price. Prices are also reduced because of the facilities offered by transport for large-scale production. Advantages of large-scale production is possible only due to transport.

9.Transport **increases mobility of labor and capital.** It makes people of one place migrate to other places in search of jobs. Even capital, machineries and equipments are imported from foreign countries through transport alone.

10.Bring countries closer : No country in the world is self-sufficient. They have to depend on one another to fulfill their requirements. Transportation has brought the countries closer. It not only caters to the need of mobility but also provides comfort and convenience.

11. **Creates employment:** Transport also contributes to economic development through job creation. It creates both direct and indirect employment opportunities. In India, a sizeable portion of the country's working population is directly or indirectly employed in the transport sector.

It also facilitates movement of labors and thereby encourages employment resulting into industrial development and thereby economic development.

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12. Serve several purposes:

Transportation provides access to natural resources and promotes trade, allowing a nation to accumulate wealth and power. Transportation also allows the movement of soldiers, equipment, and supplies during war.

Hence transportation is vital to a nation's economy as it serve several purposes. It includes the manufacture and distribution of vehicles, the production and distribution of fuel, and the provision of transportation services.

MODES OF TRANSPORTATION

- Basic media of transportation are
  - Land
    - Roadway
    - railway
  - Water
  - Air

MODES OF TRANSPORTATION

- **Highways**

  Car, Bus, Truck, non- motorized ..etc

- **Railways**

  Passenger and Goods

- **Airways**

  Aircraft and Helicopters

- **Waterways**

  Ships, boats…

- **Continuous Flow systems**

  Pipelines,belts,elevetor,ropeway…etc.

- Merits and Demerits: Based on accessibility, mobility, cost, tonnage..

Rail Transport

- **Advantages of Rail transport:**
- It is a convenient mode of transport for travelling long distances.
- It is relatively faster than road transport.
- It is suitable for carrying heavy goods in large quantities over long distances.
- Its operation is less affected by adverse weathers conditions like rain, floods, fog, etc.
- **Limitations of Railway transport:**
- It is relatively expensive for carrying goods and passengers over short distances.
- It is not available in remote parts of the country.
- It provides service according to fixed time schedule and is not flexible for loading or unloading of goods at any place.
- It involves heavy losses of life as well as goods in case of accident.

ROAD TRANSPORT

Advantages

- It is a relatively cheaper mode of transport as compared to other modes.
- Perishable goods can be transported at a faster speed by road carriers over a short distance.
- It is a flexible mode of transport as loading and unloading is possible at any destination. i.e., for travel with reference to route , direction , time and speed of travel.
- It provides door-to-door service.
- It helps people to travel and carry goods from one place to another, in places which are not connected by other means of transport like hilly areas.

Limitations of Road transport

- Due to limited carrying capacity road transport is not economical for long distance transportation of goods.
- Transportation of heavy goods or goods in bulk by road involves high cost.
- High degree of accident due to flexibility of movement

WATER TRANSPORT

Advantages:

- It is a relatively economical mode of transport for bulky and heavy goods.
- It is a safe mode of transport with respect to occurrence of accidents.
- The cost of maintaining and constructing routes is very low most of them are naturally made.
- It promotes international trade. It needs minimum energy to haul unit load through unit distance.

Disadvantages:

- The depth and navigability of rivers and canals vary and thus, affect operations of different transport vessels.
- It is a slow moving mode of transport and therefore not suitable for transport of perishable goods.
- It is adversely affected by weather conditions.
- Sea transport requires large investment on ships and their maintenance.

Air Transport:

Advantages:

- It is the fastest mode of transport.
- It is very useful in transporting goods and passengers to the area, which are not accessible by any other means.
- It is the most convenient uneconomical mode of transport during natural calamities.
- It provides vital support to the national security and defence

Disadvantages:

- It is relatively more expensive mode of transport.
- It is not suitable for transporting heavy and bulky goods.
- It is affected by adverse weather conditions.
- It is not suitable for short distance travel.
- In case of accidents, it results in heavy losses of goods, property and life.

CHARACTERISTICS OF ROAD TRANSPORT

- Roads are used by various types of road vehicles, like passenger cars, buses, trucks, pedal cycle and animal drawn vehicle.
- It requires a relatively small investment for the government.
- It offers a complete freedom to road users to transfer the vehicle from one lane to another and from one road to another according to need and convenience.
- Speed and movement is directly related with the severity of accident.
- Road transport is the only means of transport that offers itself to the whole community alike.

HISTORICAL DEVELOPMENT OF ROAD CONSTRUCTION

- Oldest mode
  - Foot tracks- animals- animal drawn cart path……..
- As civilization evolved the need for transportation increased

ROMAN ROADs-(500 B.C.)

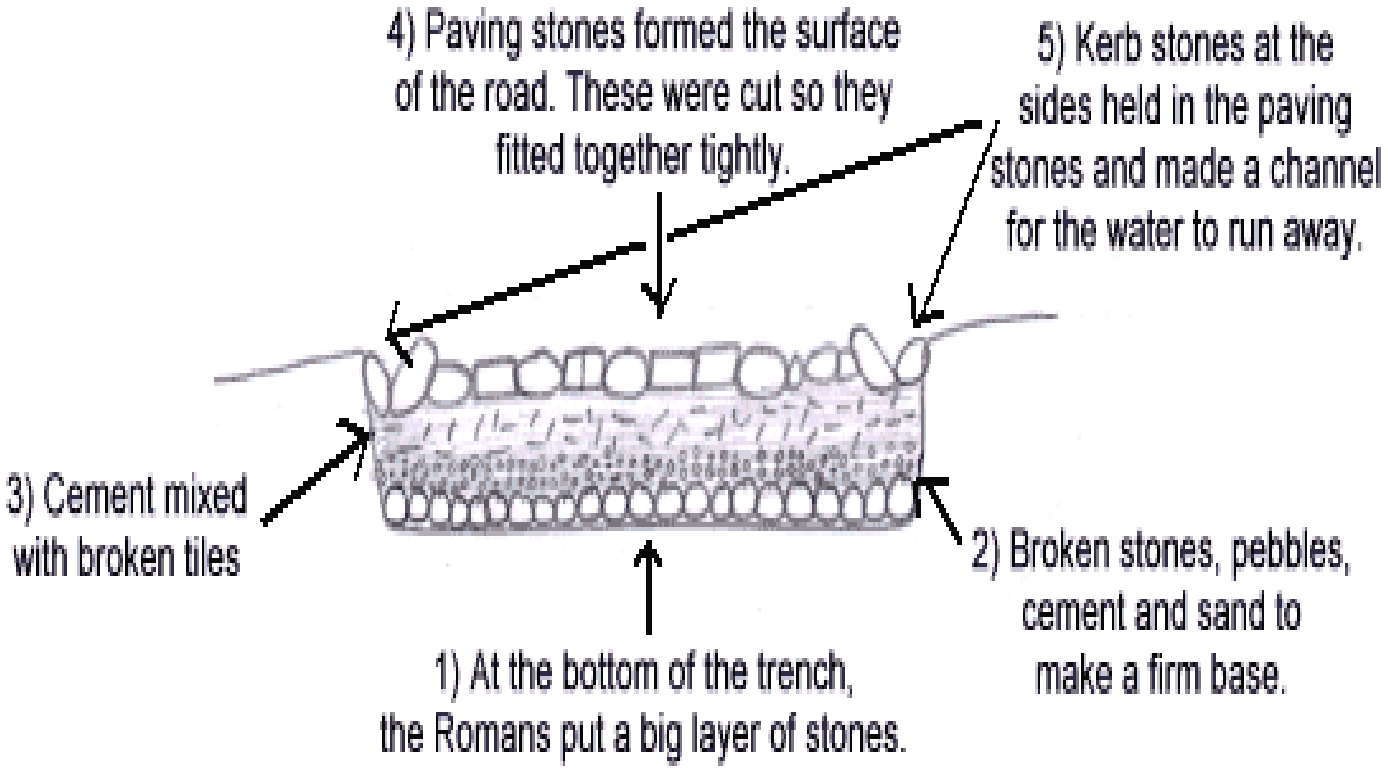
- They were built straight regardless of gradient
- The soft soil from top was removed till the hard stratum was reached.
- Thickness varies from 0.75 m to 1.2m

- The first and most famous great **Roman road** was the Via Appia (or **Appian Way**).
- Constructed from 312 BCE and covering 196 km (132 **Roman** miles), it linked **Rome** to Capua in as straight a line as possible and was known to the **Romans** as the Regina viarum or 'Queen of **Roads**'.

Ancient Roman Roads

Roman road construction

Basic cross section



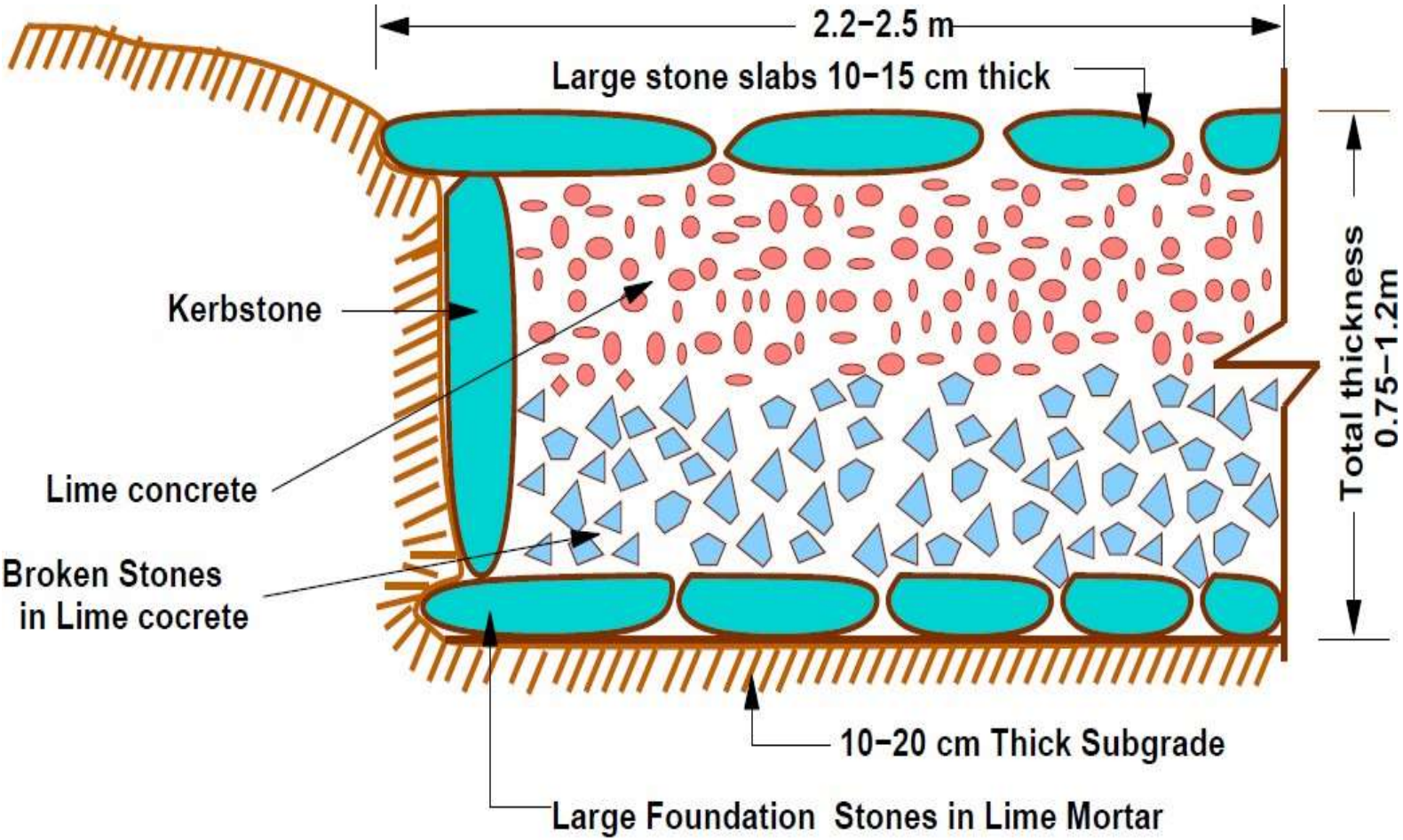


Figure 2:1: Roman roads

Roman Roads

Modern Highway

Other oldest road transport are

- Tresaguet method of construction
- Metcalf method
- Telford method
- Macadam method of construction

French roads or Tresaguet road

- The next major development of road system in France took place in during the regime of Napoleon.
- The signicant contributions were given by Tresaguet in 1764 and a typical cross section of this road is given in further.
- He developed a cheaper method of construction than the locally unsuccessful revival of Roman practice
- The pavement used 200 mm pieces of stone of a more compact form and shaped such that they had at least one at side which was placed on a compact formation.
- Smaller pieces of broken stones were then compacted into the spaces between larger stones to provide a level surface.
- Finally the running layer was made with a layer of 25 mm sized broken stone.

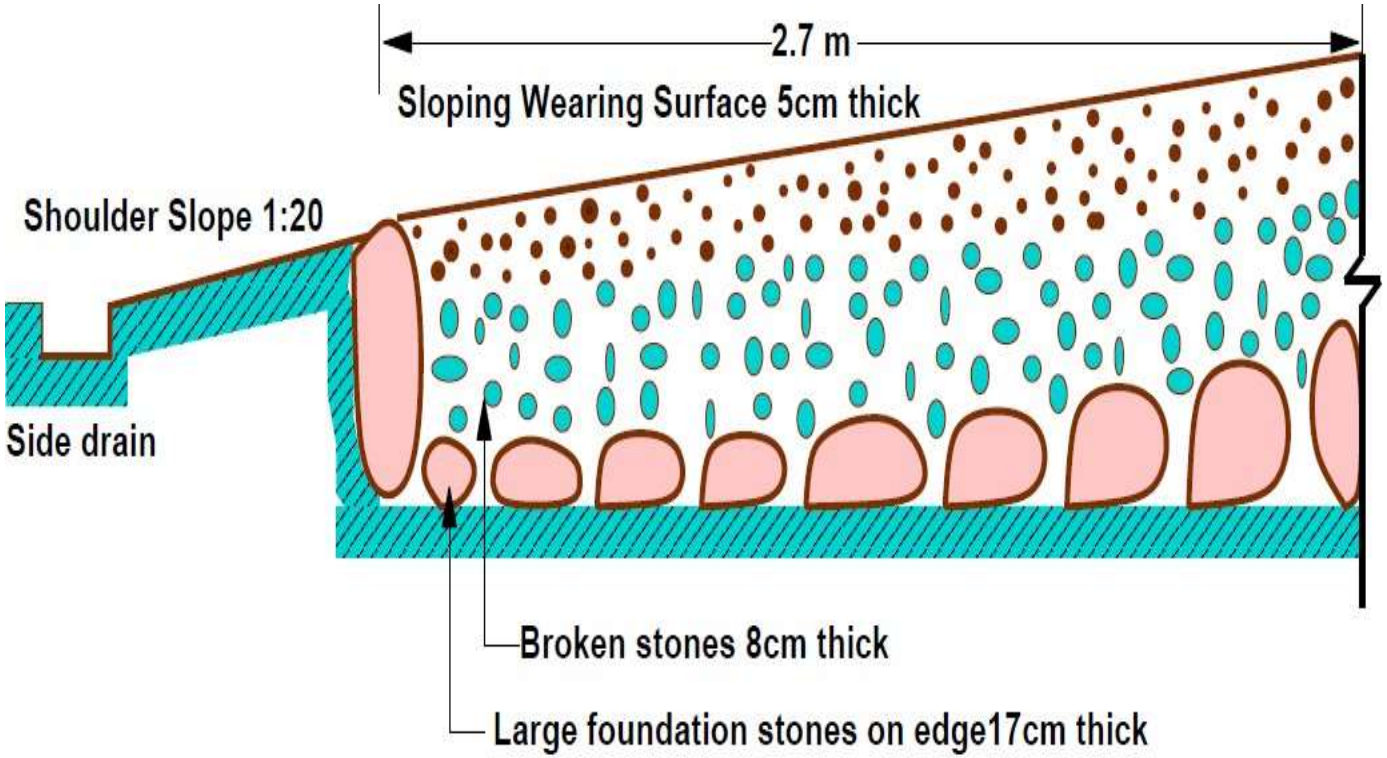
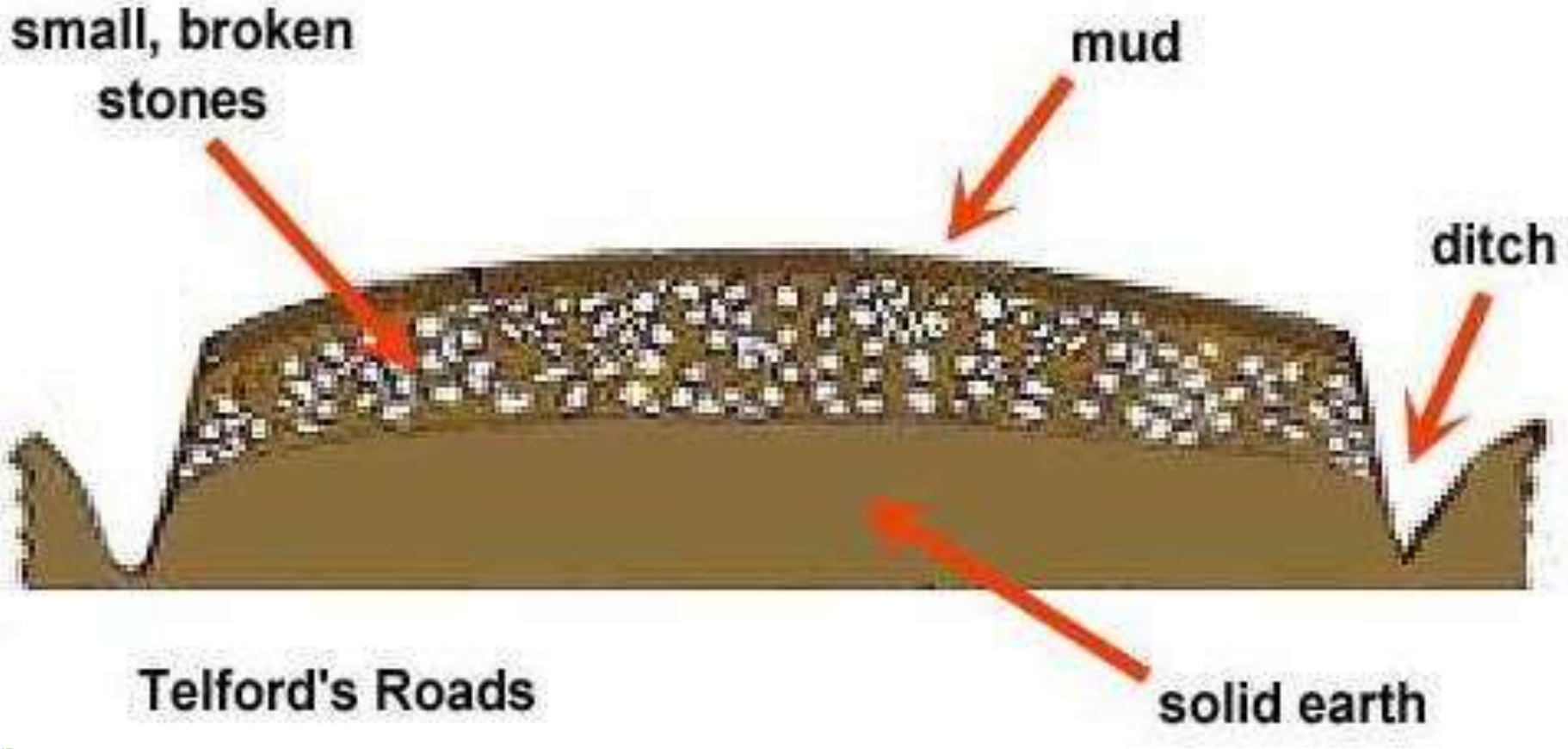


Figure 2:2: French roads

Telford Construction

- The next development was done by Scottish engineer Thomas Telford (1757-1834).
- The foundation was prepared for a road with width of 9 m and it was levelled.
- Large size foundation stones of width equal to 40 mm and depth 170 to 220 mm were then laid.
- Stones lesser than 170mm placed at the edges and stones upto 220mm laid towards centre , such that it provides cross slope
- After filling the spaces between foundation stones, two layers of stones having compacted thickness of 100 and 50 mm respectively laid in the center of 5.4 m. of width.
- The top layer of road was made of 40 mm thick binding layer of gravel laid with a slope of 1 in 45.


small, broken stones
mud
ditch
Telford's Roads
solid earth

British roads or Macadam Road

- The British engineer John Macadam introduced what can be considered as the first scientific road construction method.
- Stone size was an important element of Macadam road. By empirical observation of many roads, he came to realize that 250 mm layers of well compacted broken angular stone would provide the same strength and stiffness and a better running surface than an expensive pavement founded on large stone blocks. Thus he introduced an economical method of road construction.
- A typical cross section of British roads is given in Figure 2:3.

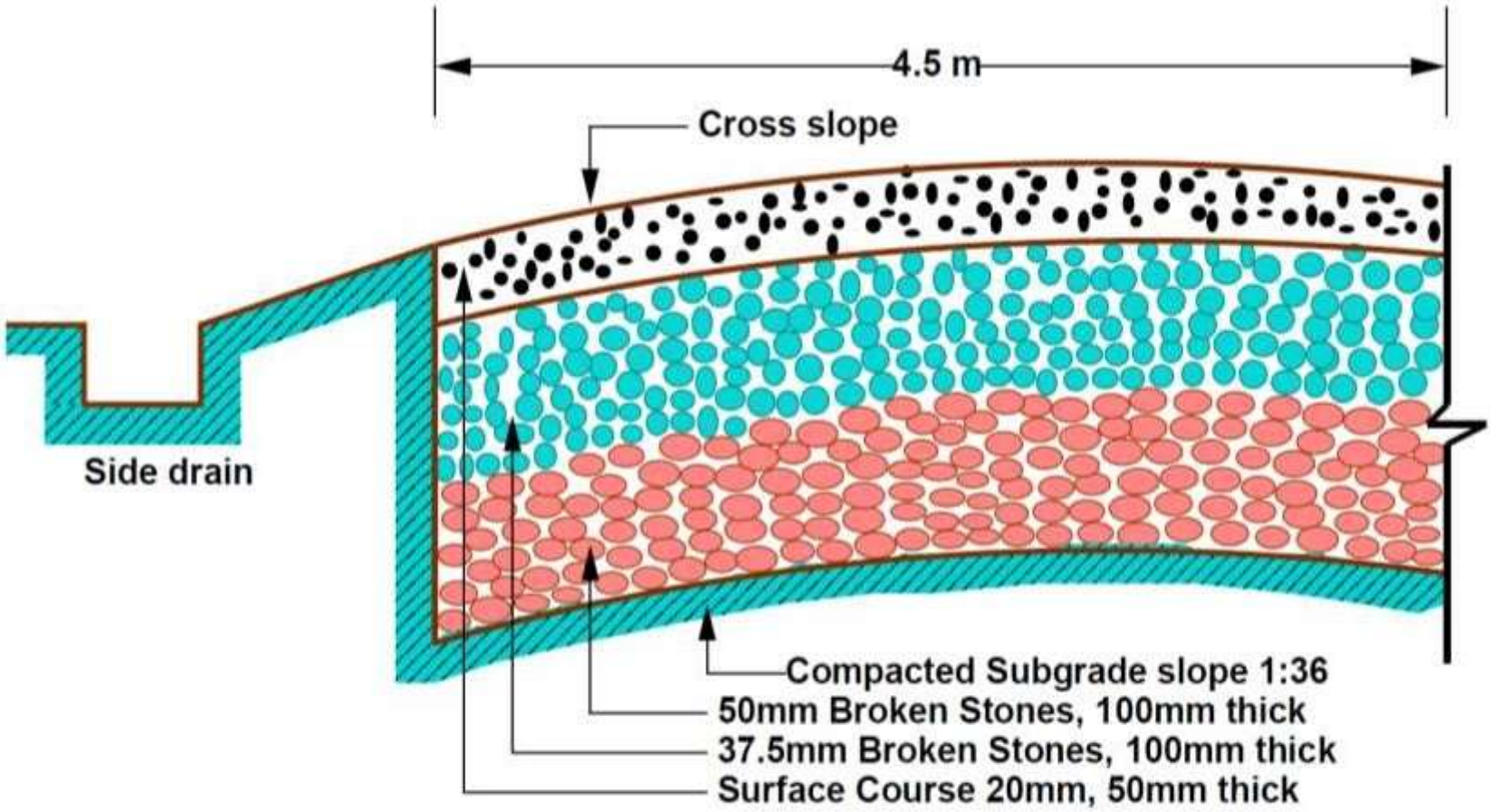
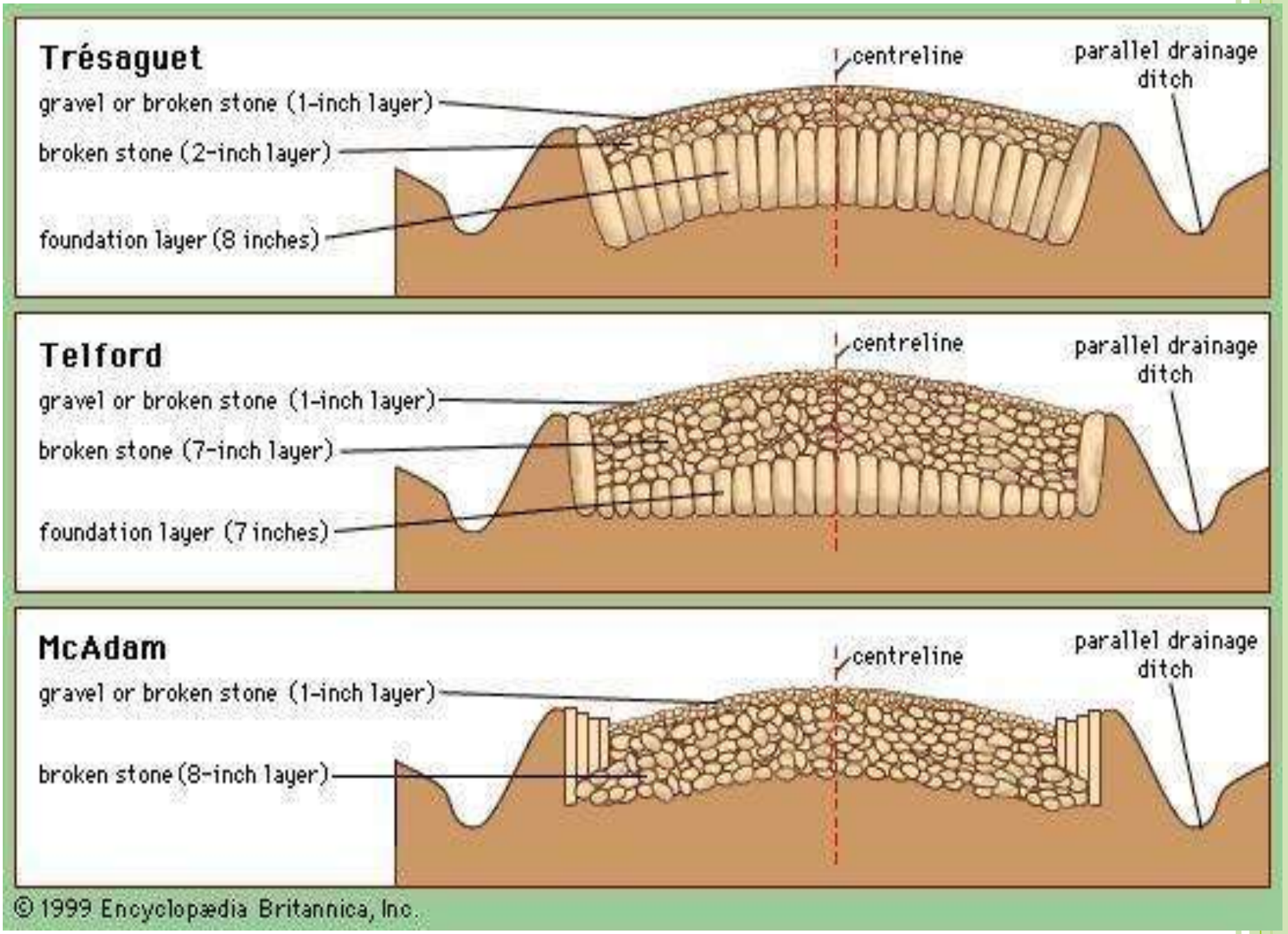


Figure 2:3: British roads



HIGHWAY DEVELOPMENT IN INDIA

- Jayakar Committee (1927)
- Central Road Fund (1929)
- Indian Roads Congress (IRC), 1934
- Central Road Research Institute (CRRI), 1950
- Motor vehicle act (1936)
- National Highway Authority of India (NHAI),1995
- First twenty year road plan (1943-61)
- Second twenty year road plan (1961-81)
- Highway Research board (1973)
- National Transport Policy committee (1978)
- Third twenty year road plan (1981-2001)

JAYAKAR COMMITTEE,1927

- After the first World War, motor vehicle using the roads increases, this demanded a better road network.
- In 1927,Indian road development committee was appointed by the government with M.R. Jaykar as chairman.
- Road development in the country should be made as a national interest since local govt. do not have financial and technical capacity for road development.
- An extra tax should be levied on petrol from road users to create the road development fund.
- To establish a semi-official ,technical institution to pool technical knowledge, sharing of ideas and to act as an advisory body.
- To create a national level institution to carry research , development works and consultation.

IMPLEMENTATIONS

Central Road Fund- 1929

Semi-official technical body called 'INDIAN ROAD CONGRESS' – 1934

Central Road Research Institute - 1950

CENTRAL ROAD FUND

- It was formed on 1st march 1929
- The consumers of petrol were charged an extra levy of 2.64 paisa per litre of petrol to built up this road development fund.
- From this 20% of annual reveneu is to be retain as a central reserve , for meeting expenses on the administration of road fund, road research and experimental work expenses..etc
- Balance 80% is allowed by central govt. to various states based on actual petrol consumption or revenue collected on sale of petrol.

CENTRAL ROAD FUND , 1929

CRF Act , 2000

Distribution of 100% cess on petrol as follows:

- 57.5% for NH
- 30% for SH

} **MORTH**

- 12.5% for safety works on rail-Road crossing.

50% cess on diesel for Rural Road development

INDIAN ROADS CONGRESS, 1934

- Central semi official body known as IRC was formed in 1934.
- To provide national forum for regular pooling of experience and ideas on matters related to construction and maintenance of highways.
- It is a active body controlling the specification, standardization and recommendations on materials, design of roads and bridges.
- It publishes journals, research publications and standard specifications guide lines.
- To provide a platform for expression of professional opinion on matters relating to roads and road transport.

MOTOR VEHICLE ACT

- It was formed in 1939
- To regulate the road traffic in the form of traffic laws, ordinances and regulations.
- Three phases primarily covered are control of driver, vehicle ownership and vehicle operation on roads and in traffic stream.
- It was revised on 1988

CENTRAL ROAD RESEARCH INSTITUTE(1950)

- engaged in carrying out research and development projects relating to road technology.
- design, construction and maintenance of roads and runways, traffic and transportation planning of mega and medium cities, management of roads in different terrains,
- Improvement of marginal materials.
- Utilization of industrial waste in road construction.
- Landslide control.
- Ground improvements, environmental pollution.
- Road traffic safety.

MINISTRY OF ROAD TRANSPORT & HIGHWAYS

- Planning, development and maintenance of National Highways in the country.
- Extends technical and financial support to State Governments for the development of state roads and the roads of inter-state connectivity and economic importance.
- Evolves standard specifications for roads and bridges in the country.
- It stores the data related to technical knowledge on roads and bridges.

HIGHWAY RESEARCH BOARD

- Set up in 1973 to give proper direction and guidance to road research activities in India.
- Act as national body for co-ordination and promotion of highway research.

Objectives:

- To ascertain the nature and extent of research required
- To correlate research information from various organisation in India and abroad
- To co-ordinate and conduct correlation services.
- To collect and sisseminate results of research
- To channelise consultative services

First 20-years road plan(1943-63)

- It is the first attempt to prepare the road development programme in a planned manner.
- The conference of chief engineers held at Nagpur in 1943 finalized the first 20-years road development plan for India called Nagpur road plan.
- Road network was classified into five categories- NH, SH, MDR, ODR and VR.
- The responsibility of construction maintenance of NH was assign to central govt.
- The target road length was 5,32,700 km at the end of 1961.
- Density of about 16km of road length per 100 sq. km area would be available in the country by the year 1963.

FIRST 20-YEARS ROAD PLAN CONT…

- The formulae were based on star and grid pattern of road network.
- An allowance of 15% is provided for agricultural industrial development during the next 20-years

SECOND 20-YEARS ROAD PLAN(1961-81)

- It was initiated by the IRC and was finalised in 1959 at the meeting of chief engineers.
- It is known as the Bombay road plan.
- Due consideration to the development that are actually taking place and developments that have to take place
- The target road length was almost double that of Nagpur road plan i.e. 10,57,330 km.
- Or Density about 32 km per 100 sq. km. and an outlay of 5200 crores
- Every town with population above 2000 in plans and above 1000 in semi hill area and above 500 in hilly area should be connected by roads.

SECOND 20-YEARS ROAD PLAN CONT…

- the maximum distance from any place in a semi develop area would be 12.8 km from metalled road and 4.8 from any road
- Expressways have also been considered in this plan and 1600km of length has been included in the proposed target NH
- Length of railway track is considered independent of road system
- 5% are to be provided for future development and unforeseen factor

THIRD TWENTY YEARS ROAD PLAN (1981-2001)

- Prepared by Roads Wing of the Ministry of Transport
- The future road development should be based on the revised classification of roads system i.e. primary, secondary and tertiary
- Due consideration given for improvement of transportation facilities in villages, conservation of energy, preservation of environmental quality and improvement in road safety.
- Develop the rural economy and small towns with all essential features.
- Population over 500 should be connected by all weather roads.
- Density increases to 82 km per 100 sq. km area by 2001

THIRD TWENTY YEARS ROAD PLAN

cont…

- The NH network should be expanded to form a square grids of 100 km sides so that no part of the country is more than 50 km away from the NH
- Expressway should be constructed along major traffic corridors
- All towns and villages with population over 1500 should be connected by MDR and villages with population 1000-1500 by ODR.
- Road should be built in less industrialized areas to attract the growth of industries
- The existing roads should be improved by rectifying the defects in the road geometry, widening, riding quality and strengthening the existing pavement to save vehicle operation cost and thus to conserve energy

PRADHAN MANTRI GRAM SADAK YOJANA(PMGSY)

- The government of India have launched PMGSY in year 2000 with the objective of providing connectivity to all villages having population more than 500 persons and above by the year 2003.
- The PMGSY covers only ODR and VR.
- Primary focus will be on providing connectivity to unconnected villages and habitations in districts through good quality all-weather rods.
- Surface roads(black topped or cement roads).

HIGHWAY PLANNING

- Planning is the basic requirement for any new project or an expansion programme. Particularly when funds available are limited and requirement are higher.

The objects of planning are:

1. To plan a road network for efficient and safe traffic operations, but at minimum cost.

2. To arrive at the road system and the lengths of different categories of roads which could provide maximum utility and could be constructed with in available resources during the plan period.

3. To divide overall plan into phases and to decide priorities.

4. To fix up date wise priorities for development of each link based on utility as the main criterion for phasing the road development programme.

5. To plan for future requirement and improvements of roads in view of anticipated developments.

6. To work out financing system.

CLASSIFICATION OF ROADS

Depending on weather

- All weather roads
- Fair weather roads

Depending the type of Carriage way

- Paved roads(WBM)
- Unpaved roads(earth road or gravel road)

Depending upon the pavement surfacing

- Surfaced roads(bituminous or cement concrete road)
- Un surfaced roads

METHODS OF CLASSIFICATION OF ROADS

Based on the Traffic Volume- Based on vehicles per day

- Heavy
- Medium &
- Low volume roads

Based on Load transported or Tonnage

Class 1 or Class 2 etc or Class A , B etc Tonnes per day

Based on location and function (Nagpur road plan)

- National highway (NH)
- State highway (SH)
- Major district road (MDR)
- Other district road (ODR)
- Village road (VR)

EXPRESSWAYS

- Heavy traffic at high speed (120km/hr)
- Land Width (90m)
- Full access control
- Connects major points of traffic generation
- No slow moving traffic allowed
- No loading, unloading, parking.

The Mumbai-Pune Expressway as seen from Khandala

National Highways

- NH are the main highways running through the length and breadth of India, connecting major parts,foreign highways,capital of large states and large industrial and tourist centres including roads required for strategic movements for the defence of India.
- The national highways have a total length of 70,548 kms. Indian highways cover 2% of the total road network of India and carry 40% of the total traffic.
- The highway connecting Delhi-Ambala-Amritsar is denoted as NH-1, whereas a bifurcation of this highway beyond Jalandar to Srinagar and Uri is denoted NH-1-A
- The longest highway in India is NH7 which stretches from Varansi in Uttar Pradesh to Kanyakumari in the southern most point of Indian mainland.

National Highways

CONT…

- The shortest highway is NH47A which stretches from Ernakulam to Kochi and covers total length of 4 Kms.

- **Golden Quadrilateral – (5,846 K Kolkata-Chennai-Mumbai**
  - NH-2 Delhi- Kol (1453 km)
  - NH 4,7&46 Che-Mum (1290k
  - NH5&6 Kol- Che (1684 m)
  - NH 8 Del- Mum (1419 km)

STATE HIGHWAYS

- They are the arterial roads of a state, connecting up with the national highways of adjacent states, district head quarters and important cities within the state.
- Serve as the main arteries for traffic to & from district roads.
- Total length of all SH in the country is 1,37,119 Kms.
- NH and SH have same design speed and geometric design specifications.

MAJOR DISTRICT ROADS

- Important roads with in a district serving areas of production and markets , connecting those with each other or with the major highways of a district.

- India has a total of 4,70,000 kms of MDR.
- Speed 60-80kmph

OTHER DISTRICT ROADS

- Serving rural areas of production and providing them with outlet to market centers, taluk head quarters or other important roads like MDR or SH.
- Speed 50-60kmph

Village roads

- Roads connecting villages or group of villages with each other or to the nearest road of a higher category like ODR or MDR.
- India has 26,50,000 kms of ODR+VR out of the total 33,15,231 kms of all type of roads.
- Speed-40-50kmph

BASED ON MODIFIED SYSTEM OF ROAD CLASSIFICATION AS PER THIRD 20 YEAR ROAD DEVELOPMENT PLAN

- **Primary system**
  - Expressways
  - National Highways
- **Secondary**
  - SH
  - MDR
- **Tertiary**
  - ODR
  - VR

Urban Road Classification

- Arterial Roads
- Sub Arterial
- Collector streets
- Local Street

ARTERIAL ROADS

- Primarily for through and heavy/important traffic inside the city
- No frontage access, no standing vehicle, very little cross traffic.
- Join central business district with outside residential areas
- Design Speed : 80km/hr
- Land width : 50 – 60m
- Divided roads with full or partial parking
- Pedestrian allowed to walk only at intersection

SUB ARTERIAL ROAD

- Bus stops but no standing vehicle.
- Less traffic than arterial streets
- Parking, loading, unloading usually restricted and controlled
- Spacing for CBD : 0.5km
- Design speed : 60 km/hr
- Land width : 30 – 40 m

COLLECTOR STREET

- Collects and distributes traffic from local streets to arterial roads.
- Provides access to residential properties.
- Located in residential, business and industrial areas.
- Full access allowed.
- Few parking restrictions except for peak hours
- Design speed : 50km/hr
- Land Width : 20-30m

LOCAL STREET

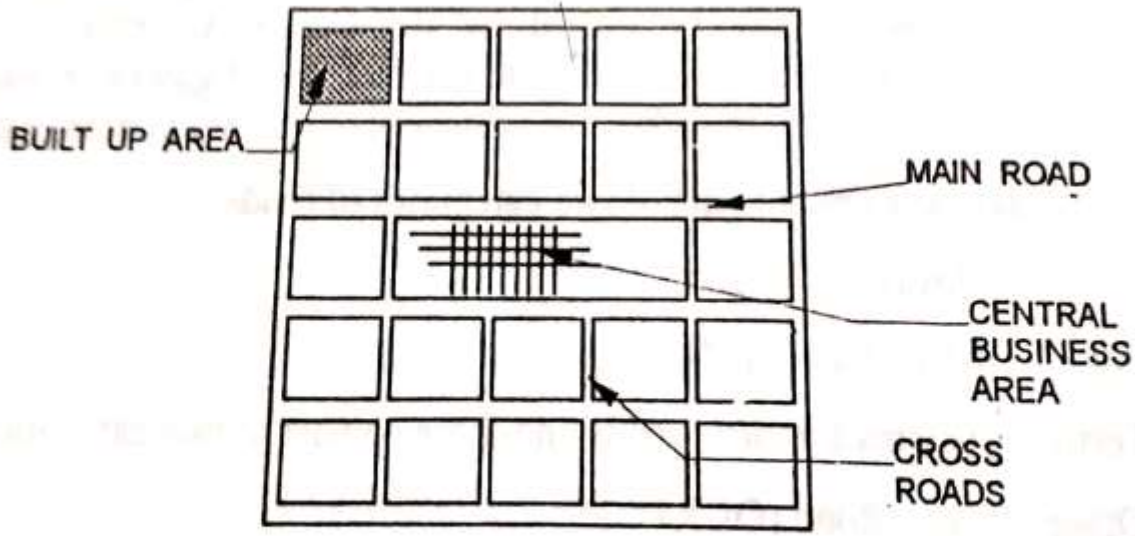
- Design Speed : 30km/hr.
- Land Width : 10 – 20m.
- Primary access to residence, business or other abutting property
- Less volume of traffic at slow speed
- Unrestricted parking, pedestrian movements. (with frontage access, parked vehicle, bus stops and no waiting restrictions)

ROAD PATTERNS

- Rectangular or Block patterns
- Radial or Star and block pattern
- Radial or Star and Circular pattern
- Radial or Star and grid pattern
- Hexagonal Pattern
- Minimum travel Pattern

1. Rectangular or Block pattern: In this pattern, the whole area is divided into rectangular blocks of plots, with streets intersecting at right angles. The main road which passes through the center of the area should be sufficiently wide and other branch roads may be comparatively narrow. The main road is provided a direct approach to outside the city.

- **Advantages:**
- The rectangular plots may be further divided into small rectangular blocks for construction of buildings placed back to back, having roads on their front.
- The construction and maintenance of roads of this pattern is comparatively easier.
- **Limitations:**
- This pattern is not very much inconvenient because at the intersections, the vehicles face each other. **Example:** Chandigarh has rectangular pattern



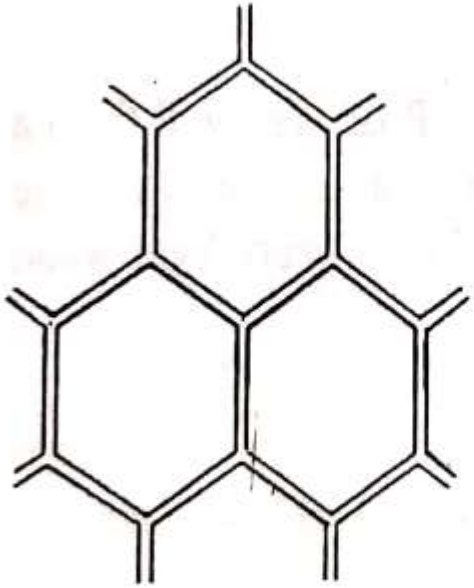
(a) Rectangular or block pattern

2. Radial or Star and block Pattern: In this pattern, the entire area is divided into a network of roads radiating from the business outwardly. In between radiating main roads, the built-up area may be planned with rectangular block.

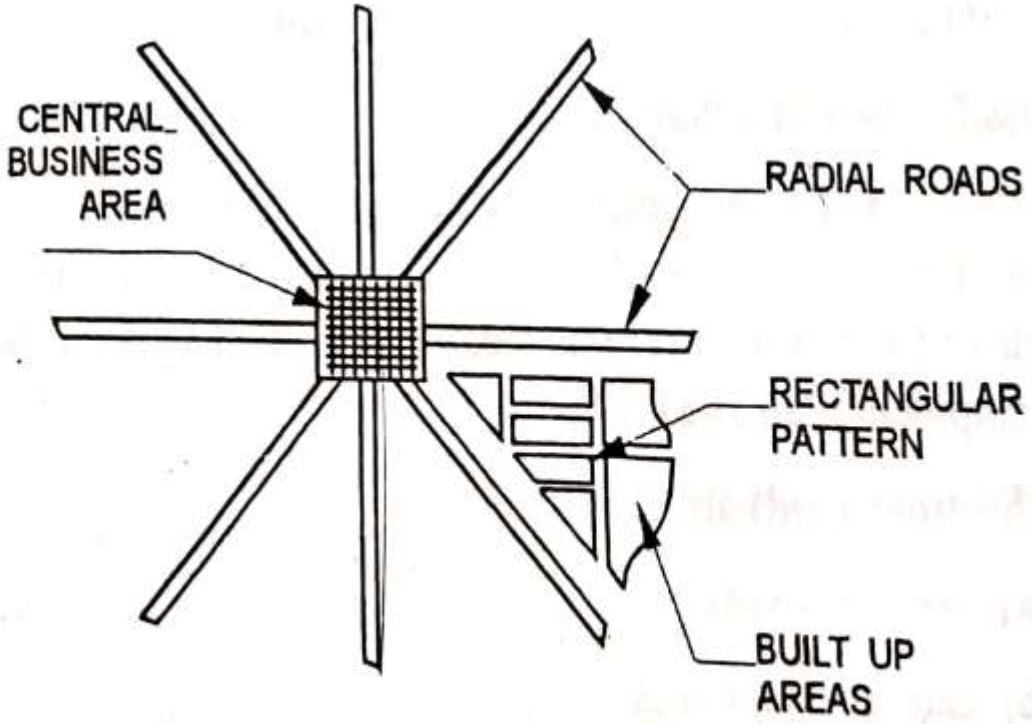
Advantages

- Reduces level of congestion
- If one is block then other side traffic can move.
- Vehicles face each other less than block pattern.

3. **Hexagonal Pattern:** In this pattern, the entire area is provided with a network of roads formatting hexagonal figures. At each corner of the hexagon, three roads meet the built-up area boundary by the sides of the hexagons is further divided in suitable sizes.



(b) Hexagonal pattern



(c) Radial or star and block pattern

Fig. 2.2 Different road patterns (cont...)

4. Radial or Star and Circular Pattern: In this system, the main radial roads radiating from central business area are connected together with concentric roads.

In these areas, boundary by adjacent radial roads and corresponding circular roads, the built-up area is planned with a **curved block system.**

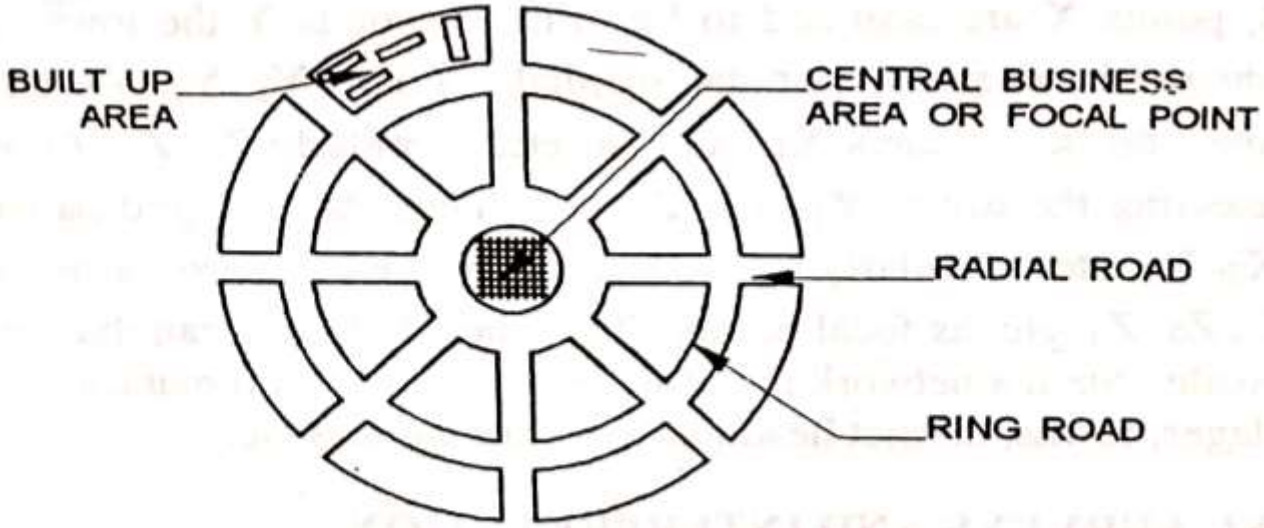
Advantages

- Potentially serious crashes essentially are eliminated because vehicles travel in the same direction.
- Installing circular pattern in place of traffic signals can also reduce the likelihood of rear- end crashes.
- Removing the reason for drivers to speed up as they approach green lights and by reducing abrupt stops at red lights.
- Because roundabouts improve the efficiency of traffic flow, they also reduce vehicle emissions and fuel consumption.

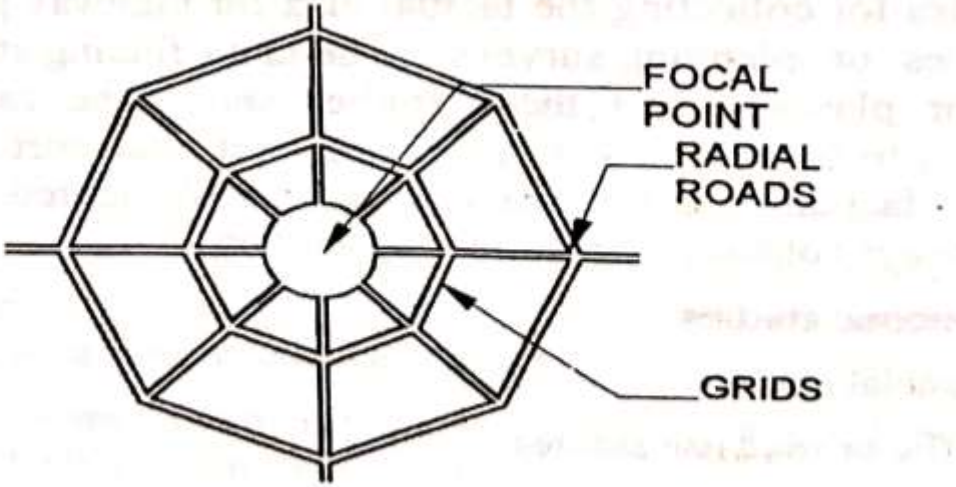
5. Radial or Star and Grid Pattern: Change in direction, and because street patterns are the most enduring physical element of any layout, it could potentially contribute to systematic site planning and, consequently, deserves a closer look.

Though the network is entirely interconnected, north-south movement becomes circuitous, indirect, and inconvenient, making driving an unlikely choice and vividly illustrating that interconnectedness by itself is insufficient to facilitate movement.

- **Examples:** The Nagpur road plan formulae were prepared on the assumption of Grid pattern.



(d) Radial or star and circular pattern



(e) Radial or star and grid pattern

PHASES OF HIGHWAY PLANNING

Highway Planning includes the following phases:

- Assessment of road length requirement for an area
- Preparation of master plan showing the phasing of plan in five year plans or annual plans.

PLANNING SURVEYS and INTERPRETATION

The field surveys thus required for collecting the factual data may be called as planning survey or fact finding surveys:

The planning surveys consists of the following studies

i) Economical Studies

ii) Financial studies

iii) Traffic or road use studies

iv) Engineering studies.

Economic Studies:

Useful in estimating the requirements, cost involved for the proposed highway improvement programme and the economic justification.

The details to be collected includes:

1. Total population and classified distribution of different population groups based on occupation, income, ect.., in each village, town or other locality.
2. Trend of population growth of various population groups.
3. Agriculture and industrial products and their listing in classified groups, areawise.
4. Industrial and agricultural development , and future trends.
5. Existing Facilities with regard to communication, education, banks, hospitals , post office, recreation facilities. Etc
6. Per Capita income.

Financial Studies:

Various financial aspects such as sources of income, various types of revenues from duties and taxes on products, road transport, vehicle registration etc., and to assess the way in which funds for project may be mobilized.

The details to be collected are :

1. Sources of income and estimated revenue from different types of taxation including revenue from road transport sector
2. Std of living of diff population groups and the trend in changes.
3. Resourcesa at local level, toll taxes, vehicle registration and fines.
4. Anticipated development in the area and generated income.
5. Future trends in financial as[ects.

Traffic or road user studies:

Traffic surveys to be carried out to collect details like

- Classified traffic volume in veh/day, AADT, peak and design hourly traffic volumes
- O-D studies based on Home interview method
- Traffic flow patterns
- Mass transportation facilities
- Accidents, their causes and cost analysis
- Future trend and growth in traffic volume and goods traffic, trend in traffic engineering
- Growth of passenger trips and trend in the choice of modes

Engineering studies:

The eng studies include;

- Topographic survey
- Soil surveys
- Location and classification of existing roads
- Assessment of various other developments in the area that are likely due to proposed highway development
- Road life studies
- Special problems in drainage, construction and maintenance of roads

PREPARATION OF PLANS

The following 4 typical drawing are prepared showing the various details of the area

- PLAN 1-General area plan showing almost all existing features viz, topography, exiting road networks, drainage structures, river, villages with population, agricultural area etc..
- PLAN 2-The distribution of population groups in accordance with the categories made in the appropriate plan
- PLAN 3-Shows the location of places with their respective quantities of productivity
- PLAN 4-Shows existing road network with traffic flows and studies. Proposed new and alternative routes.

INTERPRETATION OF RESULTS OF PLANNING SURVEYS

- To arrive at the optimum road network with maximum utility among alternative proposals.
- To fix up the priority of the construction projects and phase the development plan
- To assess the actual road use by studying traffic flow patterns.
- Based on the studies, structural and geometric features are constructed.
- Comparisons of the areas may be obtained on the basis of their economic activities.
- By appropriate statistical analysis, the data obtained in fact finding surveys may be analyzed for the future trends in development of an area.

Preparation of master plan

Master plan -final road development plan for the study area

Target Road Lengths: It is fixed for the country on the basis of area or population and productivity or any other criteria and same is taken as guide for deciding total lengths of road system

Nagpur road plan – 16km per 100 sqkm

Bombay road plan- 32km per 100 sqkm

Lucknow road plan – 82 km per 100 sqkm

Stages in the preparation of master plan:

- ✓ Data Collection: It includes data regarding existing land use, industrial and agricultural growth, population, traffic flow, topography, future trends.
- ✓ Preparation of draft plan and invite suggestions and comments from public and experts.
- ✓ Revision of draft plan in view of the discussions and comments from experts and public.
- ✓ Comparison of various alternate proposals of road system and finding out the sequence in which the master plan will be implemented.

SATURATION SYSTEM:

optimum road length is calculated for area based on the concept of obtaining maximum utility per unit length of road. Hence this system is called saturation system or maximum utility system.

- The factors which are taken for obtaining the utility per unit length of road are:

1.Population served by the road network

2.Productivity served by the net work

a. Agricultural products

b. Industrial products

- Since the area under consideration may consist of villages and towns with different populations, it grouped into some ranges and assigned some values of utility units.

Example:

- Population less than 500, utility unit = 0.25
- Population 501-1000, utility unit = 0.50
- Population 1001to 2000, utility unit = 1.00 per village
- Population 2001 – 5000, utility unit = 2.00 etc..

Similarly,

the agriculture products for tonnes productivity, utility units = 1
Industrial products for tonnes productivity, utility units =10 etc.

- The various steps to be taken to obtain maximum utility per unit length are:
- 1.**Population factors or units:** Since, the area under consideration consists of villages and towns with different population these are grouped into some convenient population range and some reasoning values of utility units to each range of population serve are assigned.
- **Productivity Factors or units:** The total agricultural and industrial products served by each road system are worked out and the productivity served may be assigned appropriate values of utility units per unit weight.
- **Optimum Road length**: Based on the master plan the targeted road length is fixed for the country on the basis of area or population and production or both. And the same may be taken as a guide to decide the total length of the road system in each proposal.

- **Utility units per unit length of road:**

- The total utility units served by each road system are found by adding the population units and productive units.
- The total units obtained are divided by the total road length of each system to obtain the utility rate per unit length of road.
- The proposal which gives maximum utility per unit length may be chosen as the final road system with optimum road length based on maximum utility by this method.

2.4.5 Phasing of Road Programme

After deciding the optimum road length for a plan period the final step is the phasing of the road development plan by fixing up the priorities for the construction of different road links.

The road network to be constructed and improved in the plan period is decided while finalising the master plan of the road development project. The plan period may be of long term, like that of the 20-year road development plan or of shorter period like five year plans. But whatever be the plan period, it is necessary to phase the road development programme from financial considerations or the expected flow of funds. In other words, it is necessary to fix up the priorities for the construction of each road link out of the entire road net work development programme so as to decide which link should be taken up first and which one next and so on. The phasing may also be done for each annual budget year by fixing up the priorities.

Here again the priority for each road link may be decided scientifically based on maximum utility criteria. The utility per unit length of each road link is worked out based on population and productivity served by the respective road. Then each link of the net work is listed in the order of priority based on utility per unit length of the road.

An imaginary area with existing roads is shown in Fig. 2.4. There are four alternate plan proposals P, Q, R and S with different road length by adding extra road links to the existing roads in the area and the details of the population and products served are given below:

Proposal	Total road length, km	Number of towns and villages served with population range				Total agriculture & industrial products served, thousand
		1001 – 2000	2001 – 5000	5001 – 10000	> 10000	
P	300	160	80	30	6	200
Q	400	200	90	60	8	270
R	500	240	110	70	10	315
S	550	248	112	73	12	335

Work out the utility per unit length of each system and indicate which system is considered to be optimum with maximum utility per unit length. Assume utility units of 0.25, 0.5, 1.0 and 2.5 respectively for villages served with population ranges (1001 – 2000), (2001 – 5000), (5001 – 10,000) and higher than 10,001.

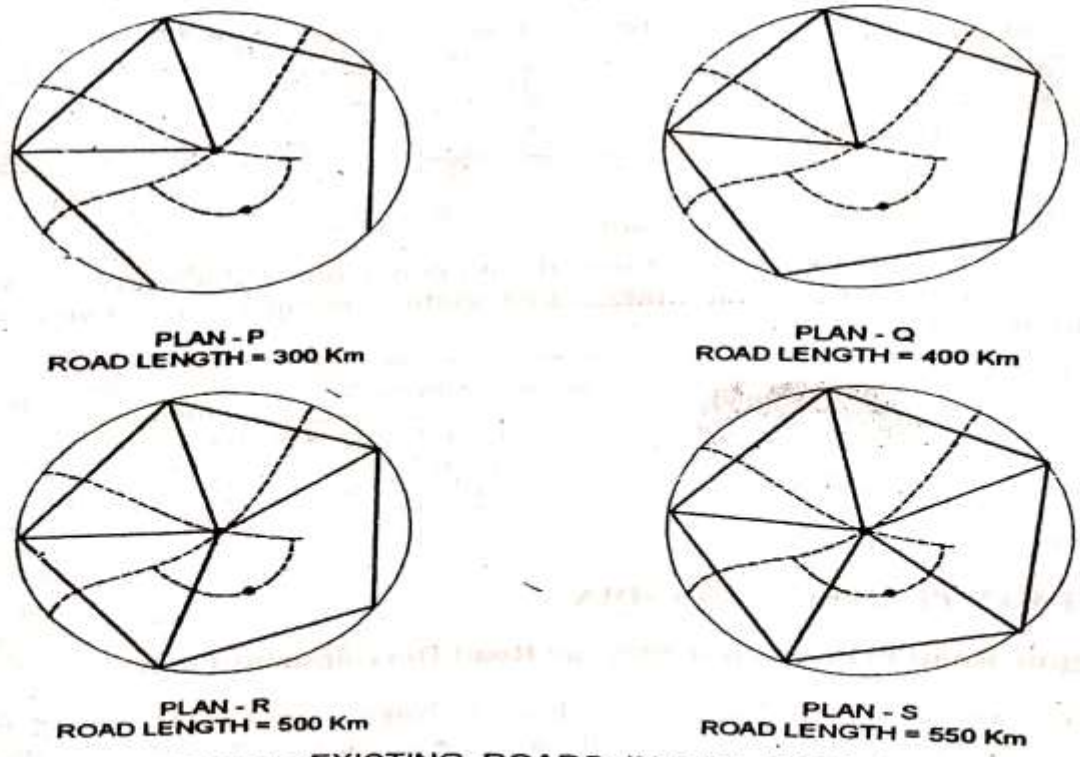


Fig. 2.4 Saturation system (Example 2.1)

Solution

Road plan proposal	Road length, km	No. of towns & villages served with population served in thousand				Total units		Utility per unit length	Priority based on utility
		1 – 2	2 – 5	5 – 10	> 10	Population	Productivity		
P	300	160 × 0.25	80 × 0.5	30 × 1	6 × 2.5	125	200	325/300 = 1.083	II
Q	400	200 × 0.25	90 × 0.5	60 × 1	8 × 2.5	175	270	445/400 = 1.112	I
R	500	240 × 0.25	110 ×0.5	70 × 1	10 × 2.5	210	315	525/500 = 1.050	III
S	550	248 × 0.25	112 ×0.5	73 × 1	12 × 2.5	221	335	556/550 = 1.010	IV

From the above table it is seen that the plan proposal Q with total road length of 400 km has maximum utility per unit length of road = 1.112 (based on population and productivity). Therefore the optimum road length in this area is 400 km.

Three new roads A, B and C are to be completed in a district during a five year plan period. Using the data given below work out the order of priority for phasing the plan programme by the principle of maximum utility per unit length. Adopt utility unit of 1.0 for serving a village with population range 2000 to 5000, or for catering for 1000 t of agricultural products or 100 t of industrial products. Assume other data suitably.

Road	Length km	No. of villages served population			Productivity, 1000 tonnes	
		< 2000	2000 – 5000	> 5000	Agricultural	Industrial
A	15	10	8	3	15	1.2
B	12	16	3	1	11	0.0
C	18	20	10	2	20	0.8

Solution

The following utility units are assumed:

0.5, 1.0 and 2.0 units for villages served with population < 2000, 2000 – 5000 and > 5000 respectively. 1.0 unit for 1,000 t of agricultural products and 10 units for 1000 t of industrial products served.

Road	Length, km	Total utility units served by the road	Utility per unit length	Priority
A	15	$10 \times 0.5 + 8 \times 1 + 3 \times 2 + 15 \times 1 + 1.2 \times 10 = 46$	$46/15 = 3.07$	I
B	12	$16 \times 0.5 + 3 \times 1 + 1 \times 2 + 11 \times 1 + 0 = 24$	$24/12 = 2.0$	III
C	18	$20 \times 0.5 + 10 \times 1 + 2 \times 2 + 20 \times 1 + 0.8 \times 10 = 52$	$52/18 = 2.89$	II

Therefore order of priority is A, C and B.

16. There are five alternate proposals of road plans for a backward district. The details are given below. Justify with reasons which proposal is the best assuming, utility units of 0.5, 1.0, 2, 4 and 8 for the five population ranges and utility units of 1.0 and 5 per 1000 t of agricultural and industrial products served.

Proposal	Total road length, km	Number of towns and villages served with population range					Productivity in thousand tonnes	
		<2000	2001 – 5000	50001–10000	10000–20000	>20000	Agriculture	Industrial
P	500	100	150	40	20	3	150	20
Q	600	200	250	68	28	3	220	25
R	700	270	350	82	36	4	300	35
S	800	280	410	91	41	4	400	42
T	900	290	430	96	44	4	430	45

19. Four new road links A, B, C and D are to be constructed during a five-year plan period. Suggest the order of priority for phasing the road construction programme based on maximum utility approach. Assume utility units of 0.5, 1.0, 2 and 4 for the four population ranges and 2, 2 and 5 units per 1000 t of agricultural, raw material and industrial products from the following data:

Road link	Length km	No. of villages served with population range				Productivity served, t		
		< 500	501 –1000	1001 – 2000	>2000	Agricultural	Raw material	Industrial 1 product
A	75	30	15	10	3	8000	3000	1000
B	35	20	8	6	3	5000	1000	1600
C	40	15	6	5	5	6000	2000	3200
D	50	40	4	3	2	3000	7000	500

THIRD TWENTY YEAR ROAD DEVELOPMENT PLAN (1981-2001) (LUCKNOW PLAN)

- It was finalized and the plan document was published by the year 1984. The major objectives are:
- The future road development should be based on the revised classification of road system consisting of Primary, Secondary and Tertiary road system.
- The road network should be developed so as to preserve the rural oriented economy and to develop small towns with all the essential facilities.
- All the villages with population of 500 should be connected by all weather roads.
- The overall density of road is increased to 82km per 100 sq.km
- The 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 NH.

- Expressway should be constructed along major traffic corridors to provide fast travel.
- Roads should also be built in less industrialized areas the attract the growth of industries.
- Long term master plans for road development should be prepared at various levels.
- All towns and villages with population over 1500 should be connected by Major district Roads and villages with population 1000 to 1500 by ODR.
- There should be improvements in environmental quality and road safety.

FORMULAE

- Length of NH (km) = area of the region/ 50
- Length of SH (km)

1. By area, SH (km) = area of the region/ 25

2. Based on no. Of towns, SH (km) = 62.5 x no. Of towns – NH

Adopt length of SH (higher of the two criteria)

- Length of MDR, in the District

1. Based on area, MDR (km) = area of the region/12.5

2. Based on number of towns, MDR(km) = 90 x number of towns

Provide length of MDR (higher of the two criteria)

- Total length of all categories of roads may be assumed to provide an overall density of road length equal to 82km per 100 sq.km area by the year 2001.
- NH + SH + MDR + ODR + VR (km) = area of the region x (82/100)
  Therefore length of ODR + VR (km) = Total Length – (NH + SH + MDR)

Example:

1. The area of a certain district in India is 13400 sq.km and there are 12 towns as per 1981 census. Determine the lengths of different catergories of roads to be provided in this district by the year 2001.

Solution:

1.Length of NH, km=13400/50=268km

2.Length of SH:

a) by Area,SH,km=13400/25=536km

b) by Area and No. of towns,SH,km=62.5x12-13400/50=482km

Adopt length of SH(Higher of the two criteria)=536km

3.Length of MDR, in the District:

a) by Area,MDR,km=13400/12.5=1072km

b) by No. of towns,MDR,km=90x12=1080km

Provide length of MDR(higher of two criteria)=1080km

4.Total Length of all Categories of roads may be assumed to provide an overall density of road length equal to 82km per 100sq.km area by the year 2001

NH+SH+MDR+ODR+VR=13400x82/100=10988km

Length of NH+SH+MDR=268+536+1080km

Therefore length of Rural roads Consisting of ODR+VR=10988-1884=9104km

a)Primary system of NH=268km

b)Secondary system consisting of SH=536 and MDR=1080,total length=1616km

c) Tertiary system of rural roads consisting of ODR and VR=of Length=9104km

d) Total road length=10,988km

2. Determine the length of different categories of roads in a state in India by the year 2001, using third road development formula and the following data :

Total area of the state = 80000sq.km

Total no. of towns as per 1981 census = 86

Overall road density aimed at= 82 km per 100 sq.km area.

FOURTH TWENTY YEAR ROAD DEVELOPMENT PLAN (2001-2021) VISION: 2021

It is to be recognized that even after the habitations eligible under PMGSY are fully covered. There is still left with a large number (about 1.68 lakh) unconnected habitations of lower size population. To serve the last person and the remotest village.

OBJECTIVES

I. The road network as on May 2007 stands at 3.3 million km. Of this, rural roads comprise around 2.7 million km, i.e. about 85 percent. Overall village accessibility stood at 54 percent in the year 2000.

II. Emphasis is continuing in social development sectors so as to improve the quality of life and alleviate poverty

III. The objective has to be to provide full connectivity to all habitations including provision of bridges and culverts. Accordingly, the following vision for new connectivity has been recommended.

a) Habitations with population above 1000 (500 in case of hill, NE states, deserts and tribal areas) by the year 2009-10

b) Habitations with population above 500 (250 in case of hill, NE states, deserts and tribal areas)by year 2014-15

c) Habitations with population above 250 by the year 2021-22

iv) The Central Government has also introduced the concept of a Core Network, which is defined as the network that is essential to provide one basic access to each habitation.

v) Proper drainage and design standards were made for rural roads .Many management rule, powers to different authorities and other standard data book was set and prepared by NRRDA (National Rural Road Development Authority).

vi) Importance was given to the use of advanced and latest equipment in road constructions to facilitate the economics

vii)The Government also needs to develop independent think-tanks and academicians on various aspects of rural roads like engineering, safety, environmental issues, socio-economic impact, etc

viii) Action should be taken by each state to formulate a 5-year Action Plan in the light of recommendations of the Vision document

SALIENT FEATURES OF VISION 2021

i) The Road Development Plan Vision: 2021 was prepared with the full involvement of the highway profession both within the government and the private sector and represents an expression of the intent for highway development in the two decades from 2001.

ii) This Vision addressed concerns such as the need for mobilization of financial resources including augmentation of road fund, toll financing, private sector participation, capacity augmentation of main highways, strengthening of pavement to cope with movement of heavy commercial vehicles, undertaking massive program me of construction of village roads and preservation of existing road assets.

iii) Aspects such as road safety, social and environment concerns and energy efficiency have also been highlighted.

iv) The vision document laid down targets for main roads but did not specify the length of the rural road network. Instead, stress was laid on preparation of proper district level master plans to optimize the network.

v)Target Roads Lengths by the year 2021:

a. Expressways 10,000 km

b. National Highways 80,000 km

c. State Highways 160,000 km

d. Major District Roads 320,000 km

PRADHAN MANTRI GRAM SADAK YOJANA (PMGSY)

i) The Government of India launched in December 2000, the programme of village connectivity known as **Pradhan Mantri Gram Sadak Yojana** (**PMGSY**) with the objective of connecting all unconnected habitations having a population of 500 and above with all- weather roads.

ii) The population threshold is relaxed to 250 in case of hill, tribal and desert areas. In departure from the earlier programmes of rural road development, the PMGSY is a hundred percent funded programme of the central government.

iii) The **Ministry of Rural Development (MoRD)** has been entrusted with the task of implementing this programme. The **National Rural Development Agency (NRRDA)** – an arm of the Ministry provides management and technical support to this programme.

iii) The **Ministry of Rural Development (MoRD)** has been entrusted with the task of implementing this programme. The **National Rural Development Agency (NRRDA)** – an arm of the Ministry provides management and technical support to this programme.

iv) The Ministry of Rural Development has already brought out dedicated specifications for rural roads and Standard Data Book with the support of the Indian Roads Congress. This has helped in setting national standards and specifications for rural roads at national level for uniform implementation at local level duly taking into account different terrain, soil and traffic conditions in the country.

v) As per the current guidelines, the PMGSY covers all habitations above 500 population to be provided with all-weather rural roads. In case of hills, deserts and tribal areas, the threshold is relaxed and over all habitations above 250 population.

CONT…

vi) It is estimated that about 1.79 lakh unconnected habitations need to be taken up under the PMGSY programme. This would involve new construction in a length of about 375,000 km at an estimated cost of Rs. 78,000 crore and improvements of 372,000 km at an estimated cost of Rs. 59,000 crore.

vii) Up to the end of December, 2006, a total of about 83,000 habitations have been covered and rural road works for an amount of Rs.38,387 crore have been sanctioned

NHAI:

"The National Highways Authority of India was constituted by an act of Parliament, the National Highways Authority of India Act, 1988. It is responsible for the development, maintenance and management of National Highways entrusted to it and for matters connected or incidental thereto. The Authority was operationalized in February, 1995 with the appointment of full time Chairman and other Members. "

National Highways Authority of India (NHAI) is mandated to implement National Highways Development Project (NHDP) which is

1. India's Largest ever highways project
2. World class roads with uninterrupted traffic flow

CONT..

The National Highways have a total length of 71,772 km to serve as the arterial network of the country. The development of National Highways is the responsibility of the Government of India. The Government of India has launched major initiatives to upgrade and strengthen National Highways through various phases of National Highways Development project (NHDP), which are briefly as under: NHDP Phase I : NHDP Phase I was approved by Cabinet Committee on Economic Affairs (CCEA) in December 2000 at an estimated cost of Rs.30,000 crore comprises mostly of GQ (5,846 km) and NS-EW Corridor (981km), port connectivity (356 km) and others (315 km).

NHDP Phase II : NHDP Phase II was approved by CCEA in December 2003 at an estimated cost of Rs.34,339 crore (2002 prices) comprises mostly NS-EW Corridor (6,161 km) and other National Highways of 486 km length, the total length being 6,647 km. The total length of Phase II is 6,647 km.

NHDP Phase-III: Government approved on 5.3.2005 up gradation and 4 laning of 4,035 km of National Highways on BOT basis at an estimated cost of Rs. 22,207 crores (2004 prices). Government approved in April 2007 upgradation and 4 laning at 8074 km at an estimated cost of Rs. 54,339 crore.
NHDP Phase IV: CCEA has approved on 5.10.2006 six laning of 6,500 km of existing 4 lane highways under NHDP Phase V (on DBFO basis). Six laning of 6,500 km includes 5,700 km of GQ and other stretches.

NHDP Phase V: CCEA has approved on November 2006 for 1000 km of expressways at an estimated cost of Rs. 16680 crs . NHDP Phase VII: CCEA has approved on December 2007 for 700 km of Ring Roads, Bypasses and flyovers and selected stretches at an estimated cost of Rs. 16680 crs

THE KARNATAKA STATE HIGHWAYS IMPROVEMENT PROJECT (KSHIP):

- It is an initiative of the Public Works Department of the Government of Karnataka for improvement of road network of the state with World Bank assistance.
- The Public Works Department carried out Strategic Option Study (SOS) during 1996 on a road network of 13,362 kms comprising State Highways and Major District Roads and the study identified 2888 kms of roads for prioritized improvements.
- The World Bank have extended Technical Assistance (T.A.) Loan of US $ 3.2 million for project preparation through the Department of Economic Affairs of Ministry of Finance, Government of India for taking up the Project Coordinating Consultancy (PCC) Services to investigate and prepare detailed project report on the 2888 kms and Institutional Development Strategy (IDS) Study.
- The works relating to upgrading and widening of 992 Km will be implemented in eight contract packages under International Competitive Bidding (ICB), where the contract values range from Rs.35 crores to Rs.205 crores. The work relating to rehabilitation and upgradation contracts of smaller value ranging from Rs.3 Crores to Rs.38 Crores will be procured under National Competitive Bidding (NCB).

KARNATAKA ROAD DEVELOPMENT CORPORATION (KRDCL)

i) It was incorporated on 21st of July 1999 as a wholly owned Government of Karnataka Company as per the Provisions of the Company's Act, 1956.

ii) KRDCL is a company under the Public Works, Ports & Inland Water Transport Department.

iii) This Company was established to promote surface infrastructure by taking up Road Works, Bridges etc., and to improve road network by taking up construction widening and strengthening of roads, construction of bridges, maintenance of roads etc., and to take up projects on BOT, BOOT, BOLT.

iv) Since inception Karnataka Road Development Corporation Limited has strived to improve the road network and to establish connectivity to all the nook & corner of the State.