INTRODUCTION TO HIGHWAY ENGINEERING

PREPARED BY

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Modes of Transportation

* The modes of transport describes the way goods are transported
* There are basically five different modes;
  - Rail
  - Road
  - Air
  - Water

Railway

For heavy and large loads over long land journeys

Advantages	Disadvantages
Lowest overall cost per unit weight	Routes between fixed terminals
Railway is the safest form of transport	They cannot stop at intermediary points
Can be most effective when linked into multimodal system	Rail transport cannot provide door to door service

Roadway

The most common mode of transport and it is used at least somewhere in almost all supply chains.

Advantages	Disadvantages
Main benefit: flexibility	Difficulty in monitoring exact location
Travel speed	Dependence on fuel price
Use extensive road networks	Frequent Maintenance
Door to Door Facility	Less Duerable
Easy to monitor location of goods	

Water way

It is used for big volumes for international traffic

Advantages	Disadvantages
For heavy and bulky goods	For longer distances
For products with long lead times	Travel time is more
Cheaper traffic means	Door to Door Facility not possible
Construction cost is less	
Maintenance is less	

Air way

Urgent, perishable goods or high value are transported by air.

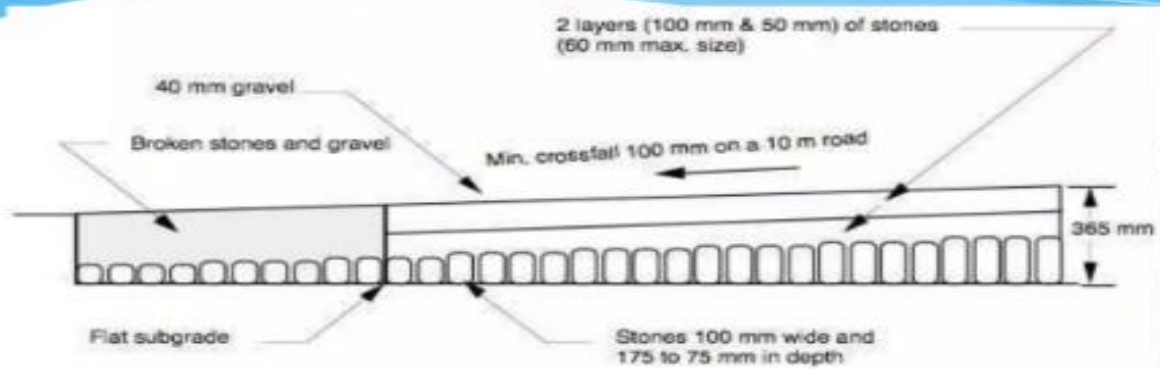
Advantages	Disadvantages
Speed of delivery	Door to Door Facility not possible
Travel time is very fast	Very Costly
Suitable for very long Distance	Fuel Consumption is high
	Wt Limit during travel

History of Roads in India

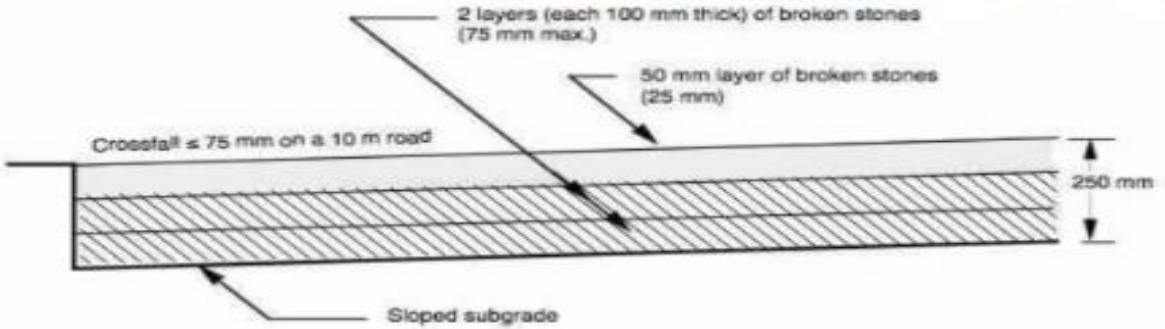
5

- Ancient civilizations
  - existence of planned roads in India as old as 2500-3500 BC
- Mauryan period(Arthashastra written by Kautilya)
  - contained rules for regulations for traffic, depths of roads for various purposes, and punishments for obstructing traffic
- Mughal period
  - Roads linked North-West and the Eastern areas through gangetic plains
- British period
  - Grand-Trunk road connecting North and South
  - Neglect the road system in India
  - Military and administrative purpose only
  - Introduction of railways
  - Feeder roads to the railways

Cross Section Of Early Roads



Telford Pavement



Macadam Pavement

Development of Road in India:-

1. Jayakar Committee (1927)

- Central government should take the proper charge from local governments
- Gave more stress on long term planning programme, for a period of 20 years (hence called twenty year plan)
- One of the recommendations paved the way for the establishment of a semi-social technical body called Indian

2. Indian Road Congress (IRC) (HRB) -1934

- The committee suggested imposition of additional taxation on motor transport which includes duty on motor spirit, vehicle taxation, license fees for vehicles plying for hire, called Central road fund in 1929

3. Central Road Research Institute (CRRI)-1950

- dedicated research organization was constituted to carry out

4. Central Road Fund 1929

- Extra levy (Tax) of 2.64 paisa per liter.
- 20 % as Central reserve & 80 % is alloted for development
- Now,revised cess is Rs.2/- per litre of petrol and HSD (High Speed Diesel)

5. Motor Vehicle Act 1939

- Control of drivers
- Vehicle ownership
- Vehicle operations on roads & traffic streams
- Revised in 1988

6.National Highway Act 1956:

- Declared selected highways as "National Highways
- To enter into any land for surveys
- To acquire land and take possession for the development of national highways
- Revised in 1988 and NHAI started operating on Feb 1995

Road Development in India

- National Highway Development Projects
- Pradhan Mantri Gram Sadak Yojana
- Road Development Plan : Vision 2021
- Rural Road Development Plan : Vision 2025

Modern Development in Indian Road

A. 1st 20 Year Plan (Nagpur road Plan)1943 –1963

- It Was first attempt to prepare a co-ordinated road development programme in a planned manner.
- Roads were divided into four classes:

National highways, State highways, Major district roads, Other district roads & Village roads

- Committee planned to construct 2 lakh kms of road across the country within 20 years.
- Recommended the construction of star and grid pattern of roads throughout the country.
- Road length should be increased so as to give a road density of 16kms per 100 sq.km

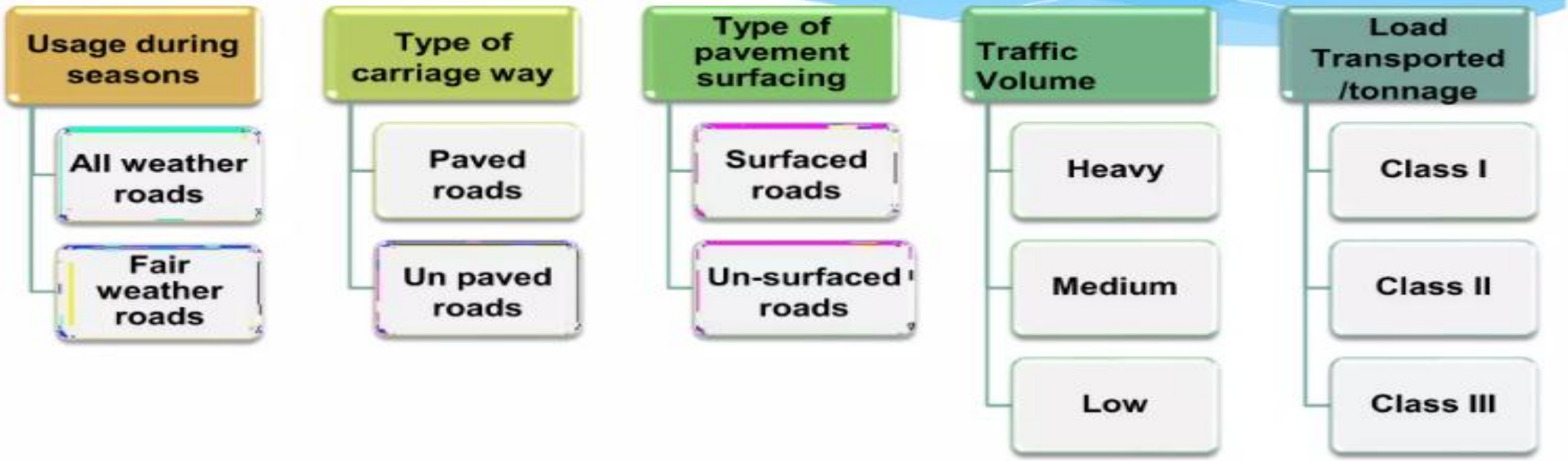
B. 2 nd 20year Plan Bombay road congress(1961-1981)

- Total road length targeted to construct was about 10 lakhs.
- Rural roads were given specific attention by introducing scientific method of construction
- Suggested that the length of the road should be increased so as to give a road density of 32kms/100 sq.km
- Construction of 1600 km of expressways was also then included in the plan.

C. Lucknow road Plan (1981 – 2001) 3rd 20 Year Plan

- In this plan roads are classified in to : Primary, Secondary and Tertiary System.
- Aimed at a road length of 12 lakh kilometres by the year 1981 resulting in a road density of 82kms/100 sq.km
- All villages having population over 500 should be connected by all weather roads
- 2000km Expressway have been constructed in this road plan.

Classification of Roads:



As per Nagpur Road Plan:

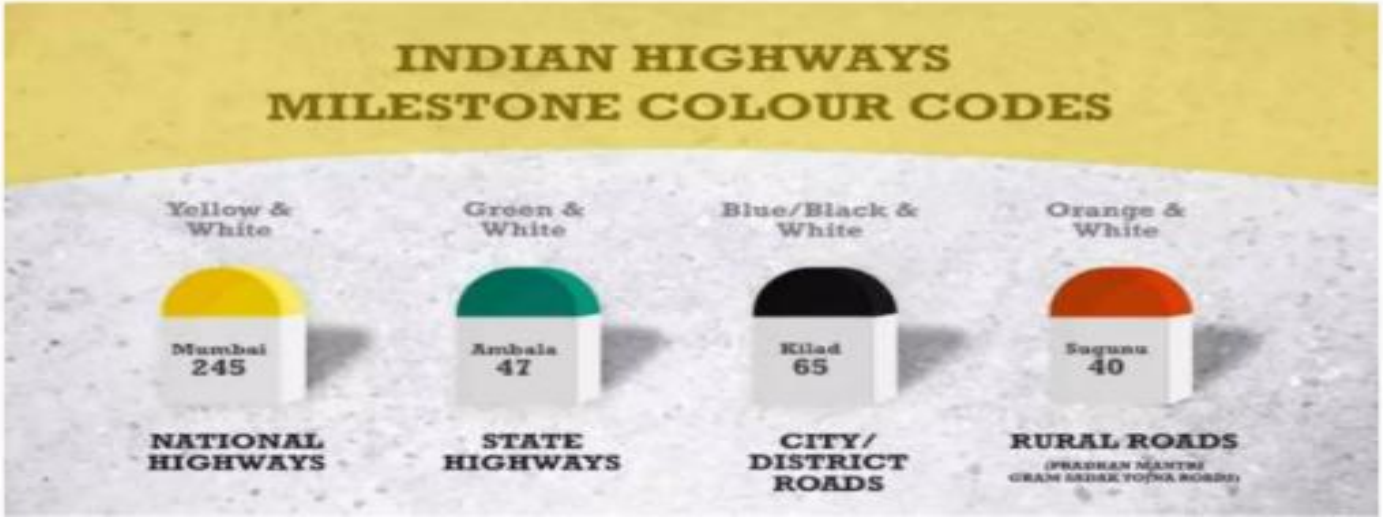
NH : National Highway

SH : State Highway

MDR : Major District Road

ODR : Other District Road

VR : Village Road



NH : National Highway

- These are main highways running through the length and breadth of India , joining major parts, capital of states, large industrial centers including roads required for strategic movements are known as National Highways.
- The responsibility of construction and maintenance of these roads under the central government.
- These are minimum 2 lane road.
- The minimum width of road is 7.5m.
- NHAI keep control on maintenance of these roads.
- "Golden Quadrilateral" is on of famous scheme of NH read which connects (DELHI-KOLKATA-CHENNAI-MUBAI)

- NH covers 2% of total road network and it carries almost 40% traffic of country

SH : State Highway

- The highways linking up with the national highways of states, district and important cities is called as states highway.
- Design specifications and design speed for NH and SH are same.
- The responsibility of construction and maintenance of these roads under the state government.
- The minimum it is 2 lane road.
- The minimum width of road is 7.5m.

MDR : Major District Road

- The important roads within a district serving areas of production and markets and connecting these places with each other or main highways are called as major district road
- The responsibility of construction and maintenance of these roads under the district authorities.
- These are minimum 2 lanes roads.
- The minimum width of road is 5m.

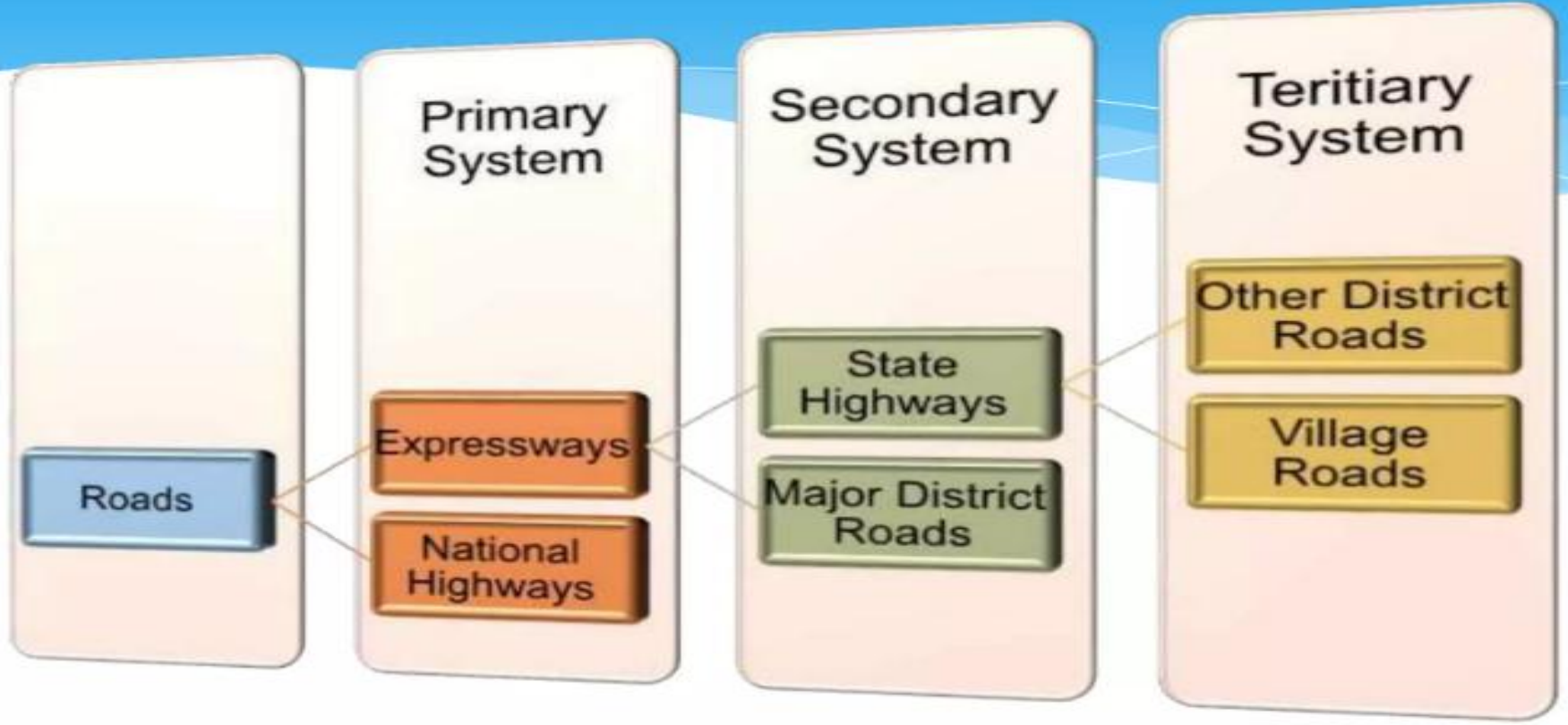
ODR : Other District Road

- The roads serving rural areas of production and providing them with outlet to market centers, tahsil block, railway stations are known as other district roads.
- Lower design specification than MDR.
- The responsibility of construction and maintenance of these roads under the local district authorities.

VR : Village Road

- The roads connecting villages or group of villages with each other are called as village roads.
- Important for rural area development .
- These are single lane roads.
- The maintenance is under Local Panchayat.
- Minimum width of road is 3m.

As per Third (Lucknow)Road Plan:



Classification of road as per Lucknow Road Plan:

- **Primary Road System**
  - Expressway – 2000 km : Based on some project formulation
  - National Highways: concept of 100 km Square grids
  - Total Length of Road in Country = 4.75 * (Road Density km/Km2)* Area(Km2)
  - Length of the NH in country, km = Area of State(Km2)/ 50
- **Secondary System: length of SH**
  - NH and SH should pass through every town and urban area: 3364 towns in the country (Based on census data: 1981)
  - By Total Area, SH , Length (km) = Area of the state/ 25 (Double of NH)
  - By total number of towns: {(62.5 * no of towns in the state) – (Area of state/ 50)}

Length of MDR,

- Major District Roads

  Total length of MDR in the country = 3,00,000 km

  By Total Area, MDR , Length (km) = Area of the state/ 12.5 (Double of SH)

  By total number of towns in state : {(90*no of towns in the state)}

Classification of Road as per Material

1. **Earthen Road**
2. **Water Bound Macadam (WBM) ROAD**
3. **Bitumen Road**
4. **Concrete Road**

1. Earthen road:

- These are kuccha roads in which earth is the main constituent of road and probably provided in village area.

Classification of Road as per Material

2. Water Bound Macadam (WBM) ROAD :-

- Consists of broken stones with size 25 mm to 75 mm are laid in three layers.
- Bottom layer is laid of bigger sized stones.
- This type of road is also provided in village area.
- Combination of bituminous and concrete roads.

The construction of WBM road is carried out in following stages.

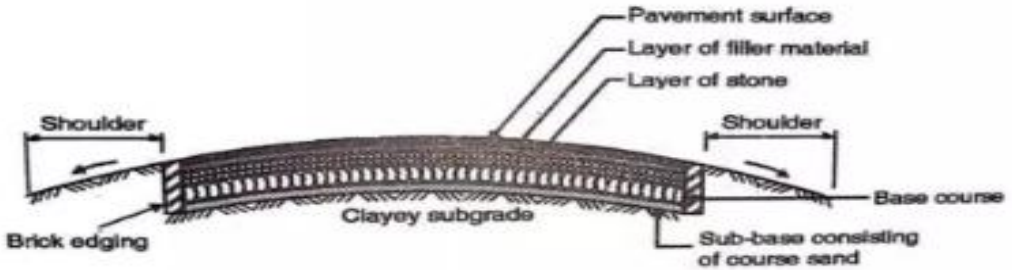
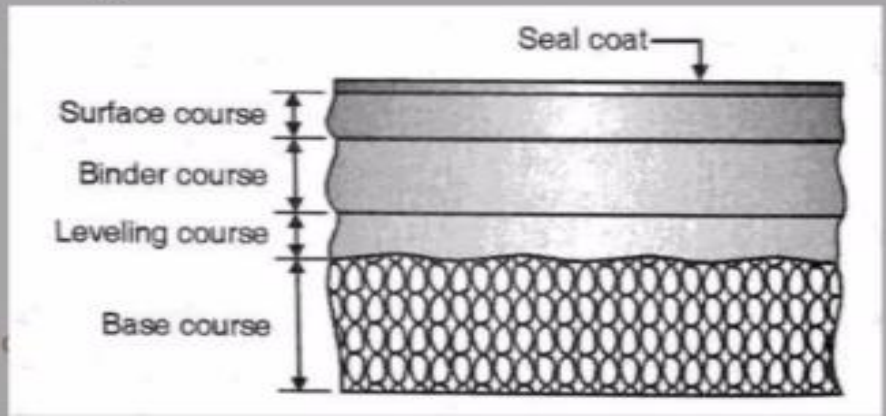


Fig. 6.4.1 : A water bound macadam road

Classification of Road as per Material

3. Bitumen Road

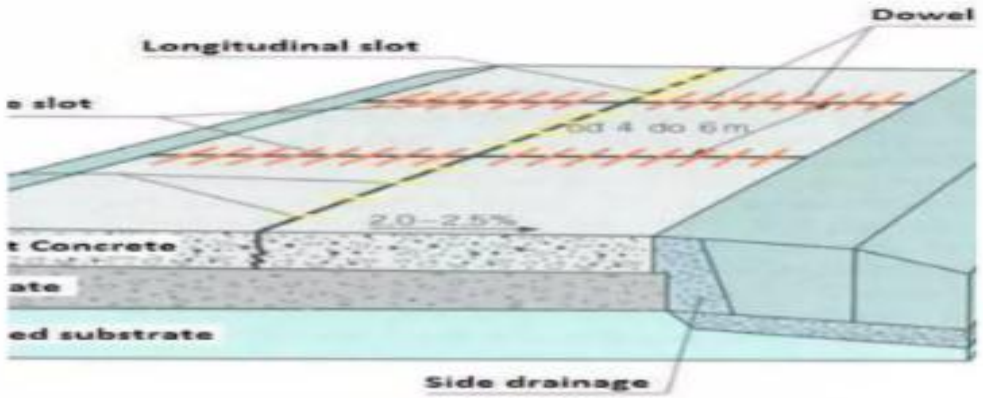
- Structure is flexible pavement.
- W.B.M. surface is prepared and small stones are provided; size is 16 mm to 20 mm with bitumen and thickness is 30 mm to 40 mm.
- Bitumen act as binder.
- Life span is short and durability is less.
- Possibility of developing corrugations due to heavy traffic.
- Repair easy but maintenance cost is more.



Classification of Road as per Material

4. Concrete Road

- Structure of rigid pavement.
- Life span is long and durability is more.
- No possibility of developing corrugations due to rigid pavement.
- Repair work is difficult and maintenance cost is quite low.



Classification of Road as per Traffic Volume

- According to IRC the roads are classified depending upon Traffic volume are as fallows:

Sr. No.	Types of Road	Vehicles per day
1	Very heavy traffic roads	Above 600
2	Heavy traffic roads	251 to 600
3	Medium traffic roads	70 to 250
4	Light traffic roads	Below 70

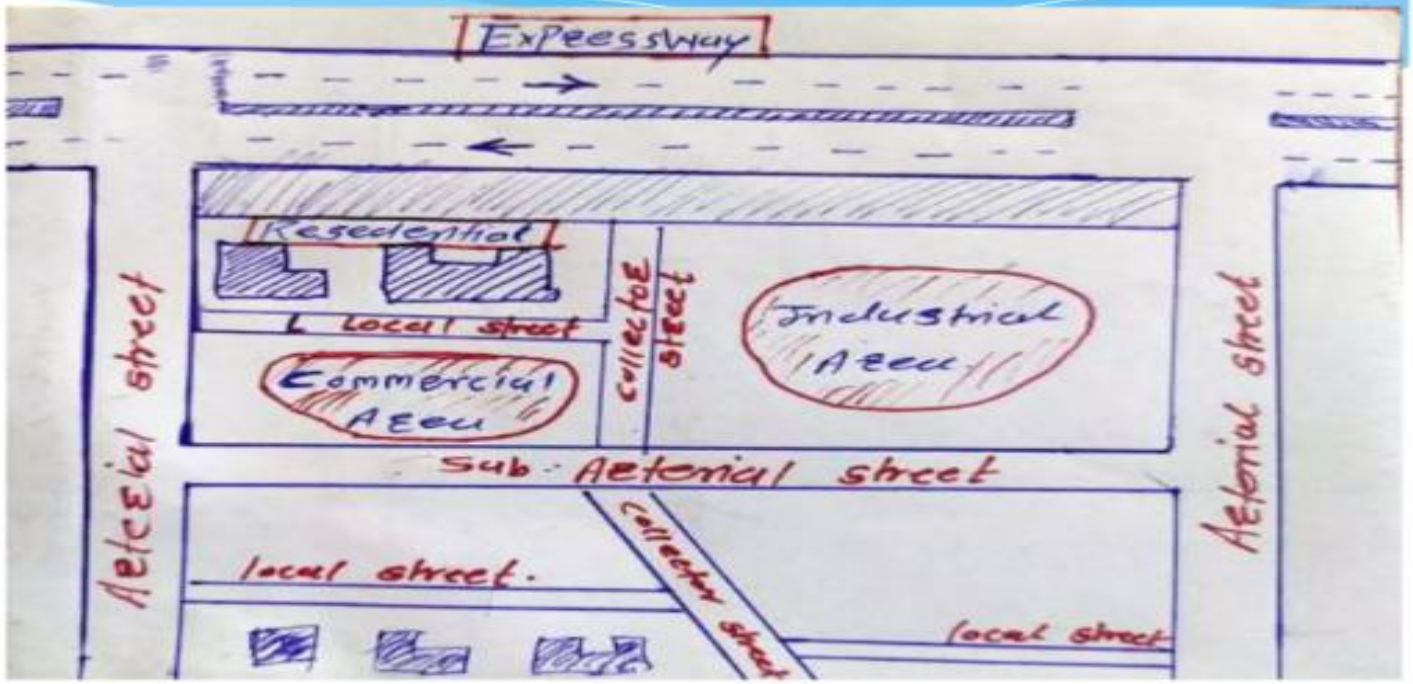
Classification of Road as per Load Capacity

- According to IRC the roads are classified depending upon Load carrying Capacity are as fallows:

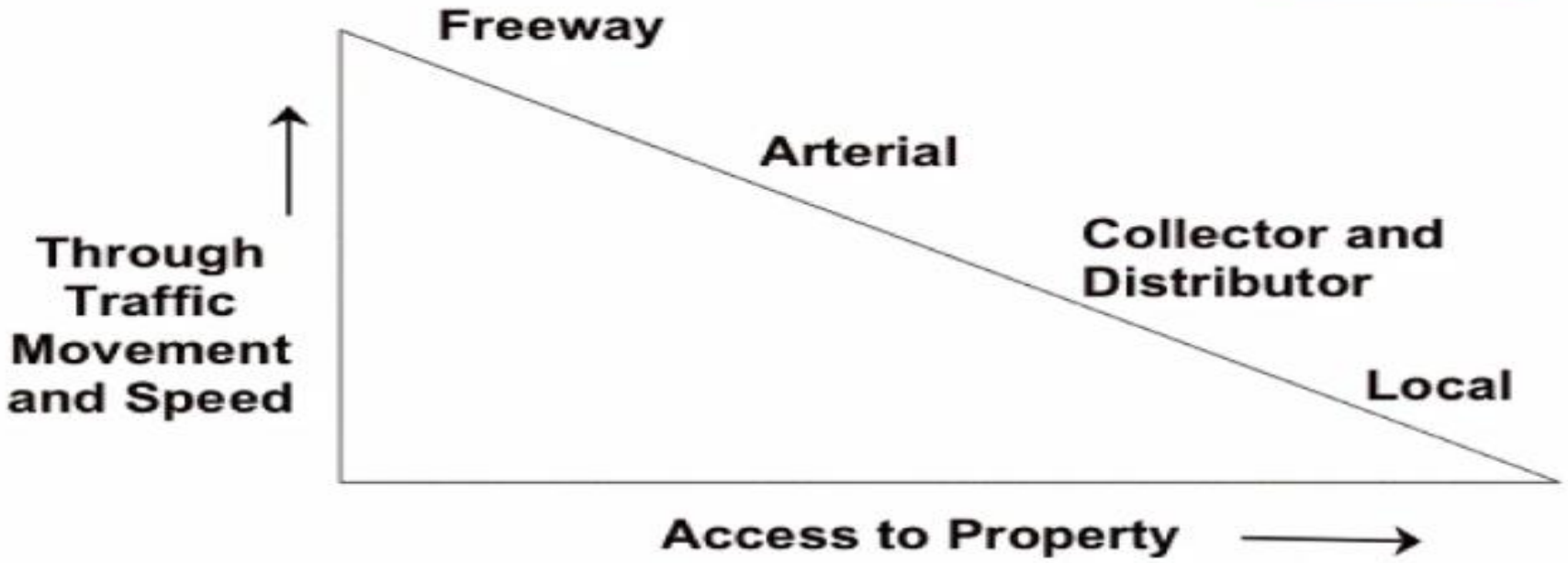
Sr. No.	Types of Road	Tonnage /Day
1	Very heavy traffic roads	Above 1524
2	Heavy traffic roads	1017 to 1524
3	Medium traffic roads	508 to 1017
4	Light traffic roads	Below 508

Classification of Urban Road:

- Expressways
- Arterial Streets
- Sub-Arterial Streets
- Collector's Streets
- Local Streets



Classification of Urban Road:



Classification of Urban Road:

1. Expressway:-

- For speedy and heavy traffic
- Pedestrians are not allowed.
- Complete separation of opposite moving vehicles.
- Crossing and Sharp Curves Strictly Avoided
- Design Speed = 100kmph.

2. Arterial Streets:-

- For the heavy/important traffic inside the city
- Pedestrians are allowed to cross only at intersections.
- Parking, loading, unloading prohibited.
- Connect city traffic to Expressway.
- Makes connectivity between central city and outside industry.
- Design Speed = 80kmph

Classification of Urban Road:

3. Sub-Arterial Streets:-

- Less traffic as compared to arterial roads.
- Pedestrians are allowed to cross road only at intersections.
- Loading and Parking are not allowed.
- They connects important town centers.
- Intersections are provided with signals.

4. Collector Streets:-

- It serves the traffic from local street to sub-arterial street.
- Full access are allowed along side of road.
- Situated in commercial ,residential, industrial area.
- Few parking restriction during peak hr.

Classification of Urban Road:

5. Local Street:-

- It provide open access to properties along sides of road.
- Not carry heavy traffic.
- Slow moving traffic.
- Parking and loading unloading are allowed.
- Pedestrians are allowed to move.

Urban Road Patterns

- Rectangular or Block Pattern
- Hexagonal Pattern
- Radial Pattern.
  1. Star and Block Pattern
  2. Star and Circular Pattern
  3. Star And Grid Patterns

1.Rectangular or Block 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.

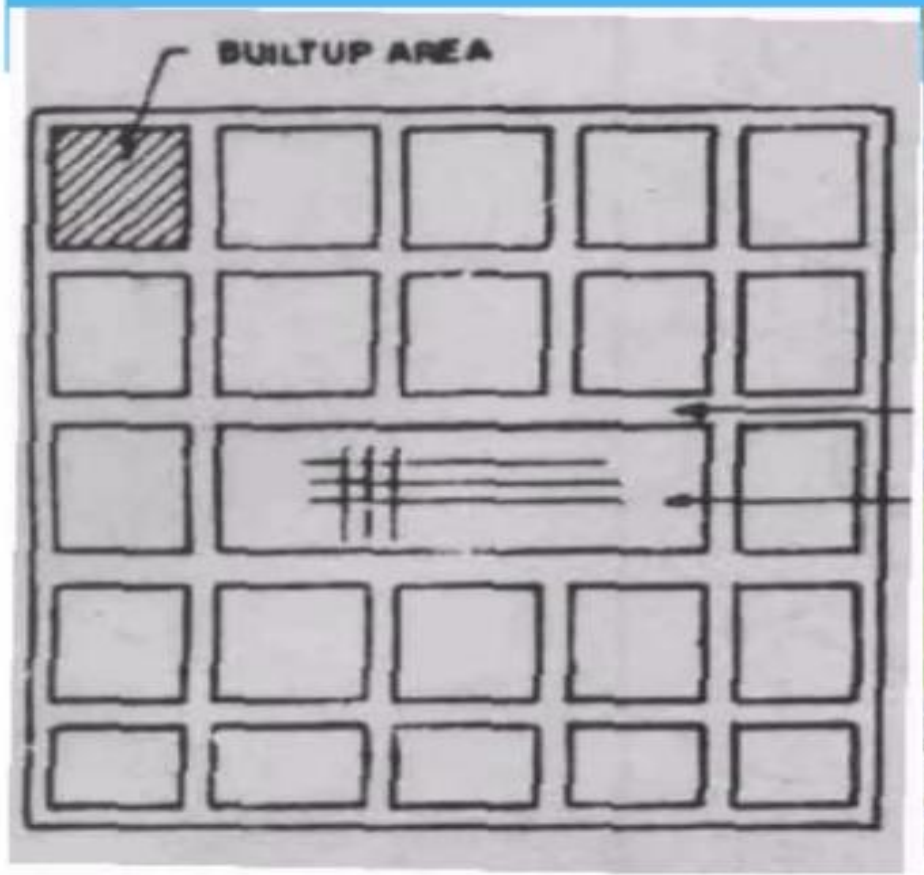
Advantages:-

- Rectangular block can be further divided in to small blocks for future development.
- Construction and Maintenance Easier.

Disadvantages:-

- As there is more no of intersections at right angle so chances of accident more.

1.Rectangular or Block Pattern



Hexagonal Pattern

Hexagonal Pattern

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.

Advantages:

- Three roads meet the built-up area boundary by the sides of the hexagons.

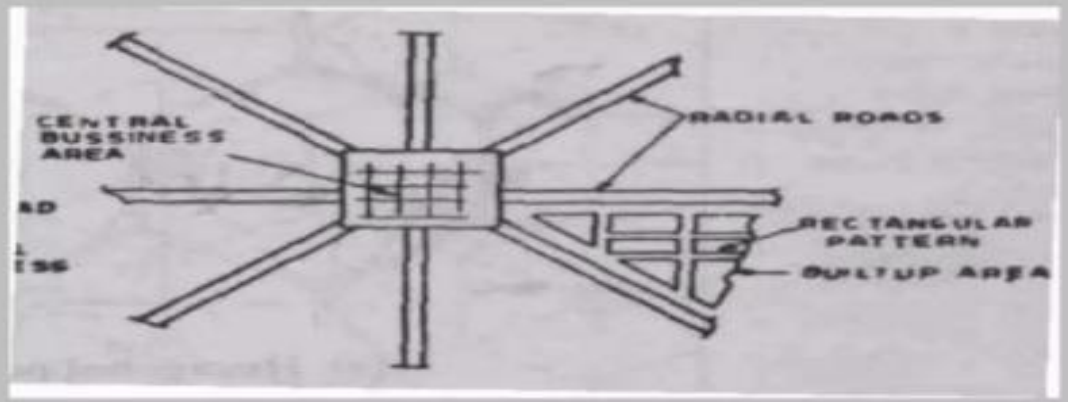
Limitations:

- Traffic signs, pavement markings, and lighting should be adequate so that drivers are aware that they should reduce their travel speed.

Radial Pattern.

1. Star and Block Pattern:-

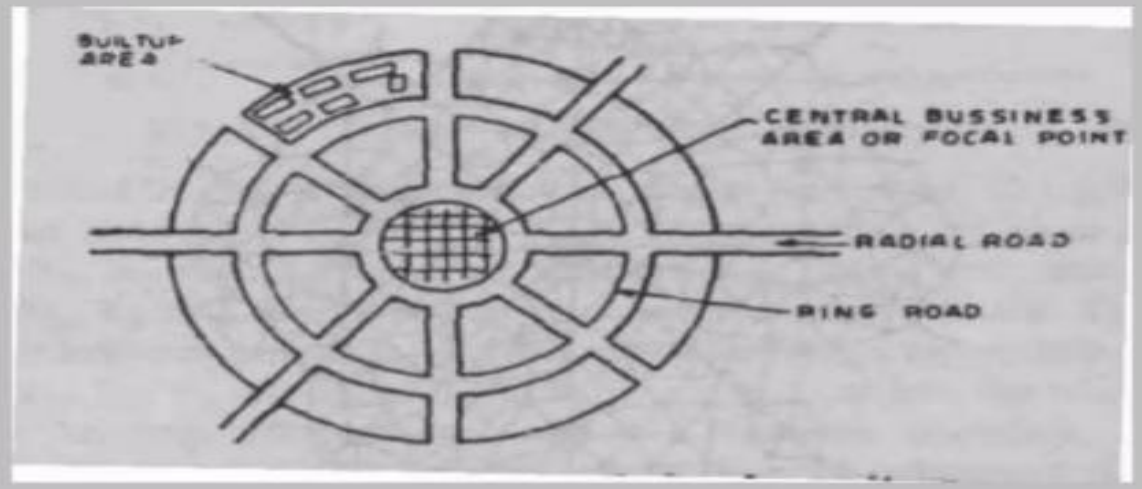
- In this pattern, the entire area is divided into a network of roads radiating from the business outwardly.
- In between radiating main roads, the built-up area may be planned with rectangular block.
- Reduces level of congestion at the primary bottleneck location.
- Vehicles face each other less than block pattern.



Radial Pattern.

2. Star and Circular Pattern:-

- In this system, the main radial roads and 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.



Radial Pattern.

3. Star and Grid Pattern:-

- It is a combination of radial and grid pattern.
- A radial network of roads radiate from the center outwardly.
- Radial streets are interconnected by providing grid pattern in between the main streets.
- Improve land use efficiency and unit density.
- The Nagpur road plan formulae were prepared on the assumption of Grid pattern.

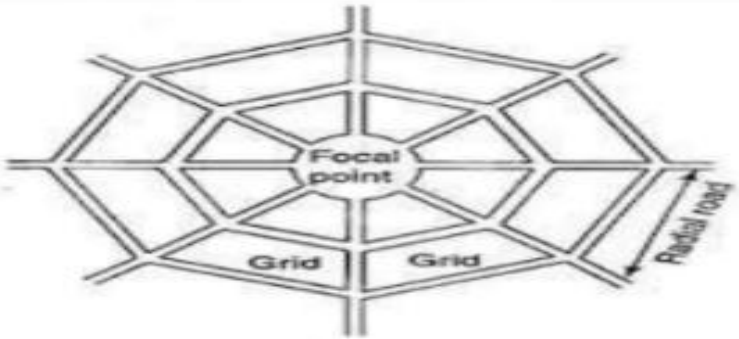
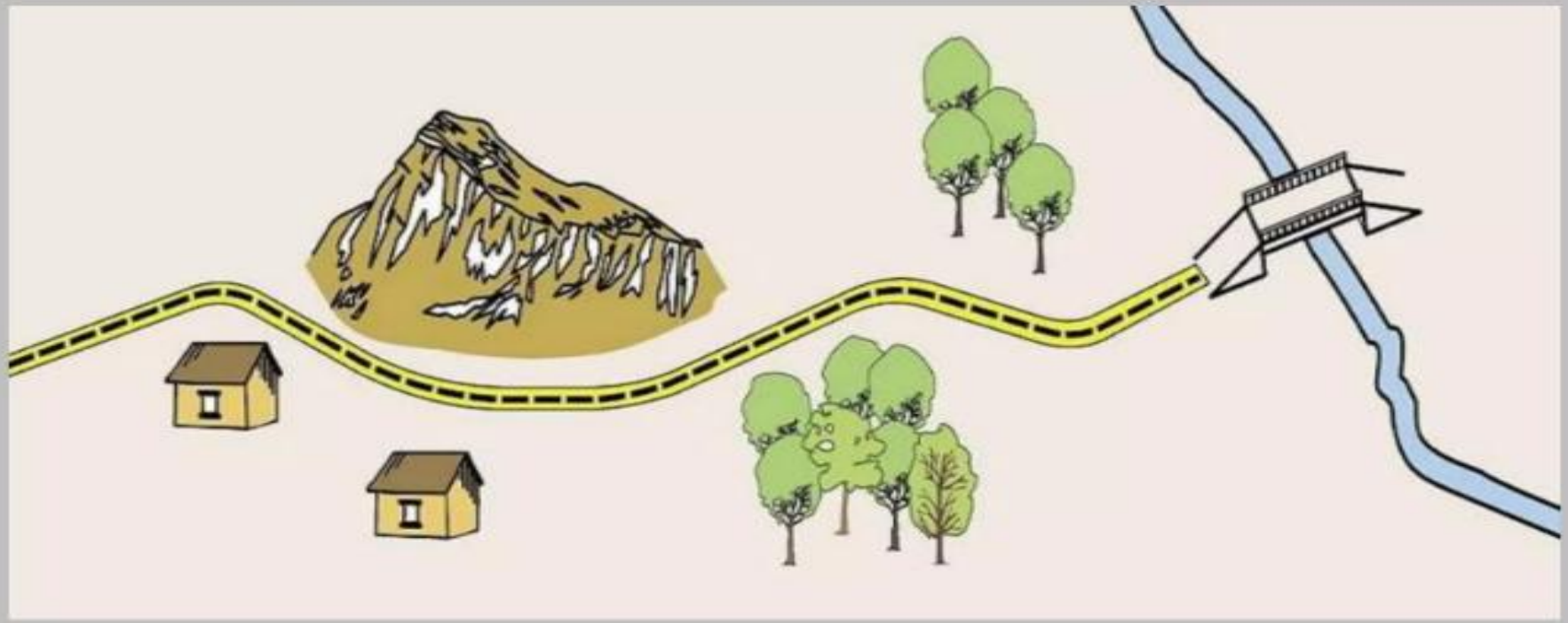


FIG. 1.7 *Road pattern — star and circular type*

Road Alignment

The position or layout of the centre line of the highway on the ground is called the alignment.



Requirment of Good Alignment

- **Short:-**

The alignment of road road connecting two stations must be short.

- **Easy:**

The alignment must be easy to construct and maintain and also it should be easy for vehicle operation.

- **Safe:**

It should be safe in case of designing the horizontal and vertical curves.

- **Economical:**

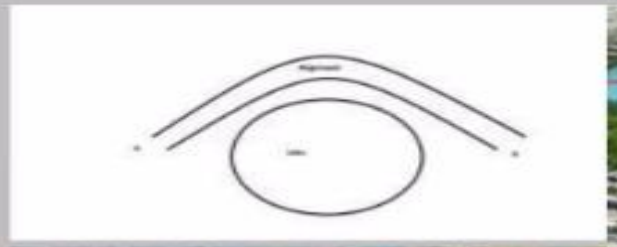
The alignment should be selected in such a way that it is economical during construction.

Factors Controlling Alignment

Following are the factors which affect the alignment of road.

1) Obligatory Points:

- These are the points through which alignment is passing.
- The Alignment of should crosses minimum Obligatory Points.
- Following are the Obligatory Points:
  - Hills
  - Rivers
  - City/ Village
  - Historical Monuments
  - Temples/ Church
  - School and Hospitals



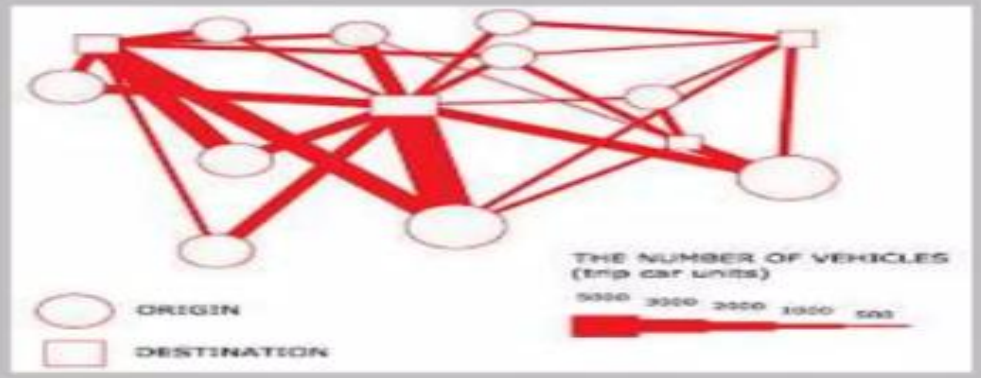
Factors Controlling Alignment

2) Geometric design features :

- To Facilitate easy grade and curvature
- To Avoid sudden changes in sight distance, especially near crossings.
- To Avoid sharp horizontal curves.
- To Avoid road intersections near bend or at the top or bottom of a hill.

3) Traffic:

- The traffic trend or direction is affect the alignment of road.
- So that traffic survey should be carried out.



- Alignment should be laid such that maximum traffic is to be covered.

Factors Controlling Alignment

4) Topographical control points:

- The alignment, where possible should avoid passing through

1. Marshy and low lying land with poor drainage
2. Unstable hilly features
3. Flood prone areas
4. Avalanche prone areas

5) Materials and constructional features:

- Deep cutting should be avoided
- Earth work is to be balanced; quantities for filling and excavation
- Alignment should preferably be through better soil area to minimize pavement thickness
- Location may be near sources of embankment and pavement materials

Factors Controlling Alignment

6) Economic Factors:

- Capital cost
- Maintenance Cost
- Operational cost
- Road User Cost
- Embankment and deep cuttings cost

7) Other Considerations:

- Engineering feasibility
- Environmental consideration
- Social consideration
- Political Acceptability
- Monotony.

Procedure of Fixing Alignment of Road

1. Transferring centerline from map to ground:-

- In this centerline marked in plan is transferred on ground using transit theodolite.

2. Fixing reference points –

- The reference points on both side of alignment are marked permanently on ground, which helps during construction.

3.Plotting curves in alignment –

- The circular or transition curve are plotted using long chord or deflection angle method very accurately The start and end points are also marked with references.

4. Measuring the length of alignment –

- The total length of alignment as per design is finally checked either by using tape or transit theodolite.

Survey or Data collection for Highway Project

1. Natural and man made features.
2. Proposed Geometric Design elements.
3. Number of cross drainage structures.
4. Soil characteristics
5. Source of construction materials.
6. Geological formation, type of rocks.
7. Drainage

Drawing and Report Required in Highway Project

1. Key map
2. Index map
3. Preliminary survey plans
4. Detailed plan and longitudinal section
5. Detailed cross section
6. Land acquisition plans
7. Drawings of cross drainage and other retaining structures
8. Drawings of road intersections.

Engineering Surveys for Highway locatio

- Provisional alignment Identification (Map study)
- Reconnaissance survey
- Preliminary survey
- Final location to determine center line and detailed survey

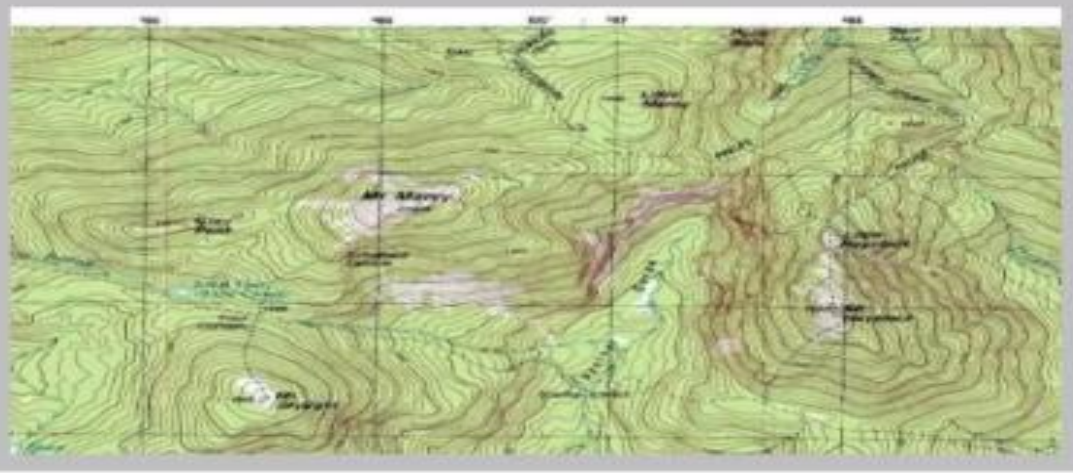
Engineering Surveys for Highway locatio

1. Provisional alignment Identification (Map study)

- Base Map preparation

Topographical map (SoI)
Scale -1: 2,50,000
1: 50,000
1: 25,000

- Shows man made and natural features and contour lines at 15 or 30m interval.
- Shows possible alignments with obligatory points and minimum number of cross drainage structures.



Engineering Surveys for Highway location

2. Reconnaissance survey

- Map updating – to confirm features indicated on map.

- Checking for:

1. Number of cross drainage structures.
2. High Flood Level (HFL)
3. Confirming Length and value of gradient to IRC standards.
4. Soil Characteristics.
5. Geological features.
6. Proximity to source of construction materials- quarries, water sources.

- Prepare a report on merits and demerits and profile map of scale 1:50,000.

Engineering Surveys for Highway locatio

➢ Purposes of reconnaissance survey.

a) To collect the details of obstruction along the route which are not available in the map.
b) To collect geological features of field.
c) To collect information regarding the availability of local construction material, water and labor.
d) To determine the approximate values of gradient, length of gradients and radius of curves of alternate alignments.
e) To locate the obligatory points along the alternative routes.
f) To determine approximate estimate of the total cost of construction of the road along each route.
g) To determine two or three best possible routes.

Engineering Surveys for Highway location

3. Preliminary survey

- Base Plan:

	Hz	Vr
Built up area/hilly terrain	1:1000	1:100
Plain and rolling terrain	1:2500	1:250

- Establish center line
- Incorporation of natural and man made features
- Longitudinal and cross sectional profile (Leveling).
- Other studies:
  Drainage, Hydrological, soil, Traffic and Materials.
- Finalization of the best alignment
  Comparative analysis.
  Choose best alignment among alternatives.
  Design geometric elements.

Engineering Surveys for Highway location

➢ Objects of preliminary survey.

The preliminary survey for any road construction project is done for following objectives

1. To survey various alternative alignments proposed after the reconnaissance and to collect all the necessary physical information and details of topography, drainage and soil.
2. To estimate the quantity of earthwork materials and other construction aspects and to work out cost of alternate proposal.
3. To compare the different proposals in view of the requirement of good alignment..
4. To finalize the best alignment from all consideration.
5 To know number of cross-drainage works and other obligatory points.

Engineering Surveys for Highway location

4. Detailed Survey For Final Location:

- Transferring the alignment on to ground.
- Detail Survey – leveling work for longitudinal and transverse direction.
- Intervals for cross sectional leveling

Plain	50 – 100m
Rolling	50 – 75m
Built up	50m
Hilly	20m

- Soil Profile

HIGHWAY GEOMETRIC DESIGN

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Importance of geometric design

- The geometric design of a highway deals with the dimensions and layout of visible features of the highway such as alignment, sight distance and intersection.
- The main objective of highway design is to provide optimum efficiency in traffic operation with maximum safety at reasonable cost.
- Geometric design of highways deals with following elements :
  - Cross section elements
  - Sight distance considerations
  - Horizontal alignment details
  - Vertical alignment details
  - Intersection elements

Goals of Geometric design :

- Maximize the comfort, safety and economy of facilities.
- Provide efficiency in traffic operation.
- Provide maximum safety at reasonable cost.
- Minimize the environmental impacts.

Factors affecting geometric design :

- Design speed.
- Topography.
- Traffic.
- Environmental factors.
- Economical factors.
- Vehicles properties (dimensions, weight, operating characteristics, etc.).
- Humans (the physical, mental and psychological characteristics of the driver and pedestrians like the reaction time).

Cross-Section of road & its elements :

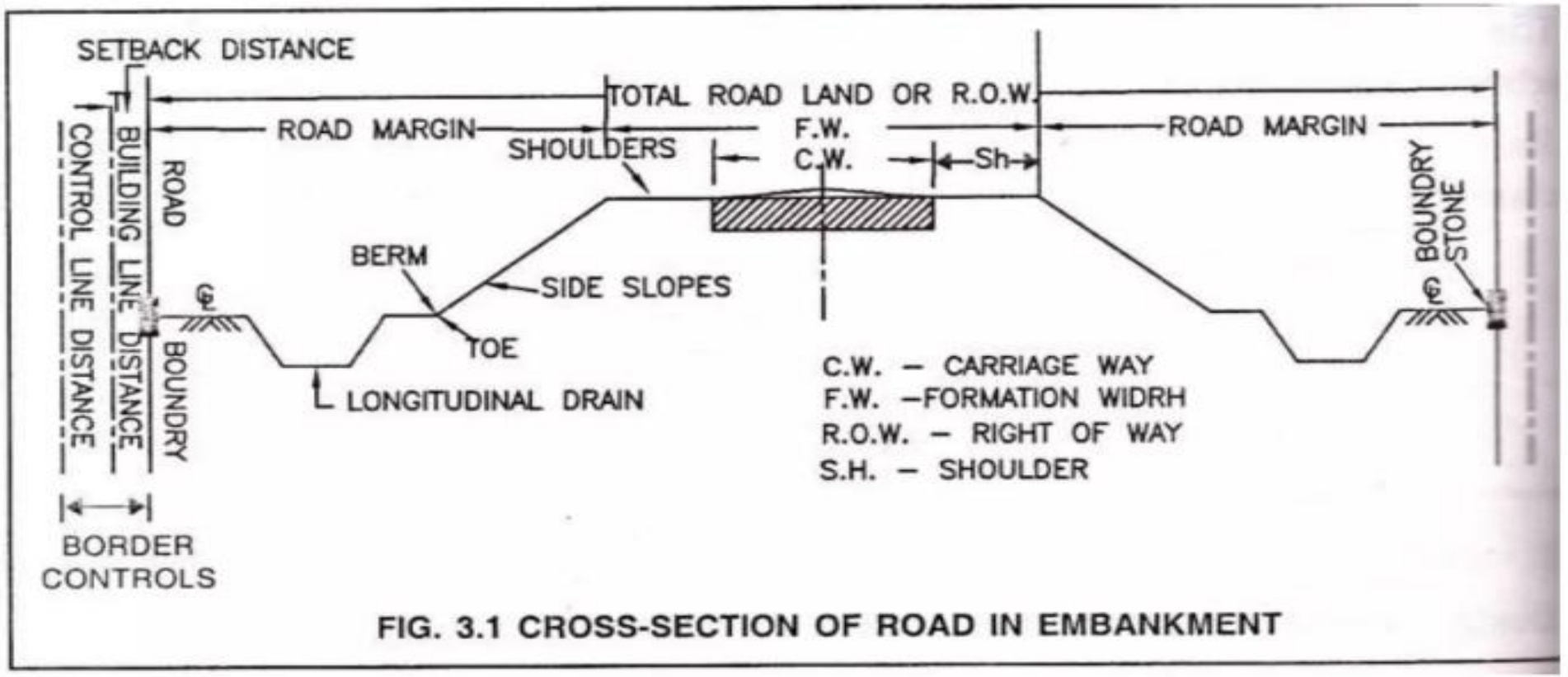
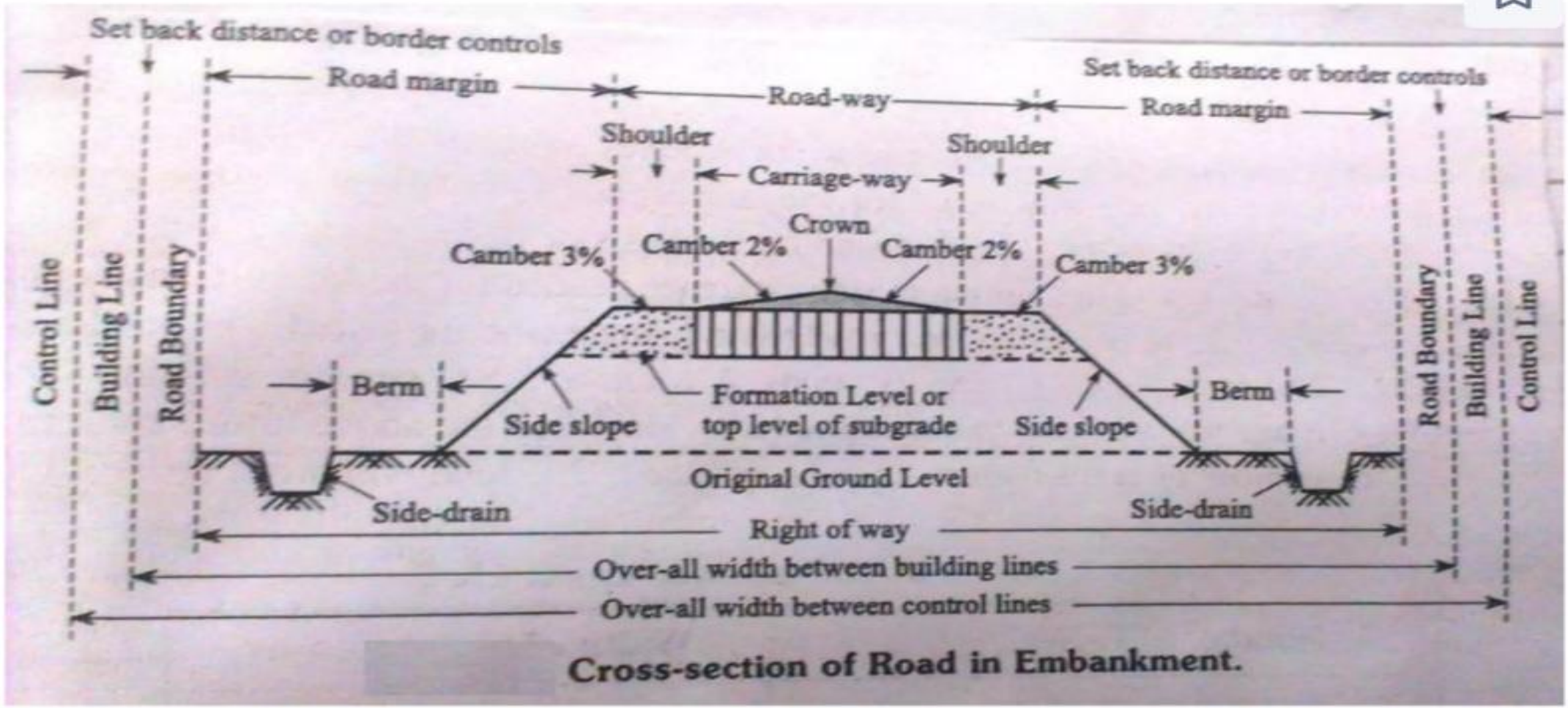


FIG. 3.1 CROSS-SECTION OF ROAD IN EMBANKMENT

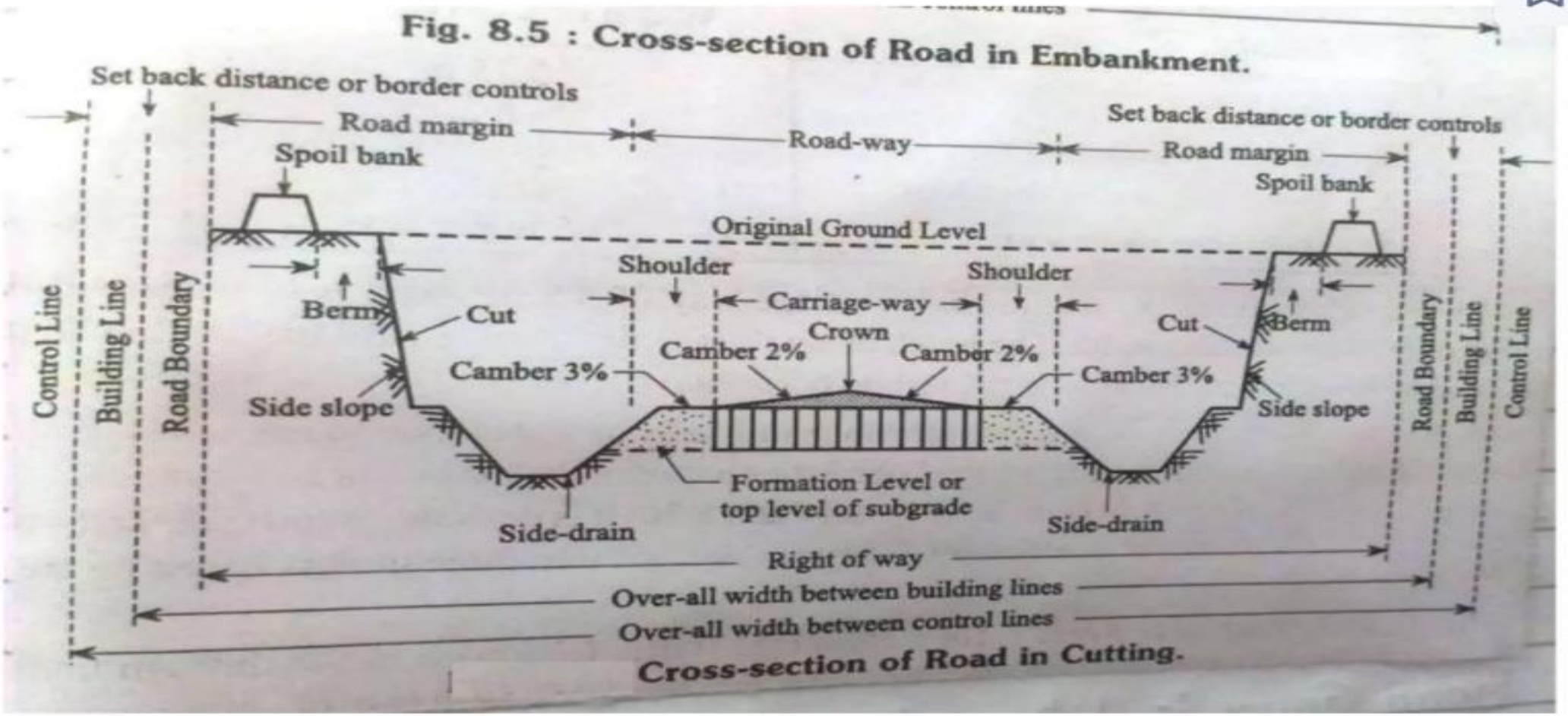
Alignment decision is important because a bad alignment will enhance the construction, maintenance and vehicle operating cost. Once an alignment is fixed and constructed, it is not easy to change it due to increase in cost of adjoining land and construction of costly structures by the roadside.

CROSS SECTION OF ROAD



Cross-section of Road in Embankment.

CROSS SECTION OF ROAD



The Width of pavement way on which vehicles travel is called carriage way .

Road Shoulders :

- Shoulders are provided along the road edge to serve as an emergency lane for vehicles.

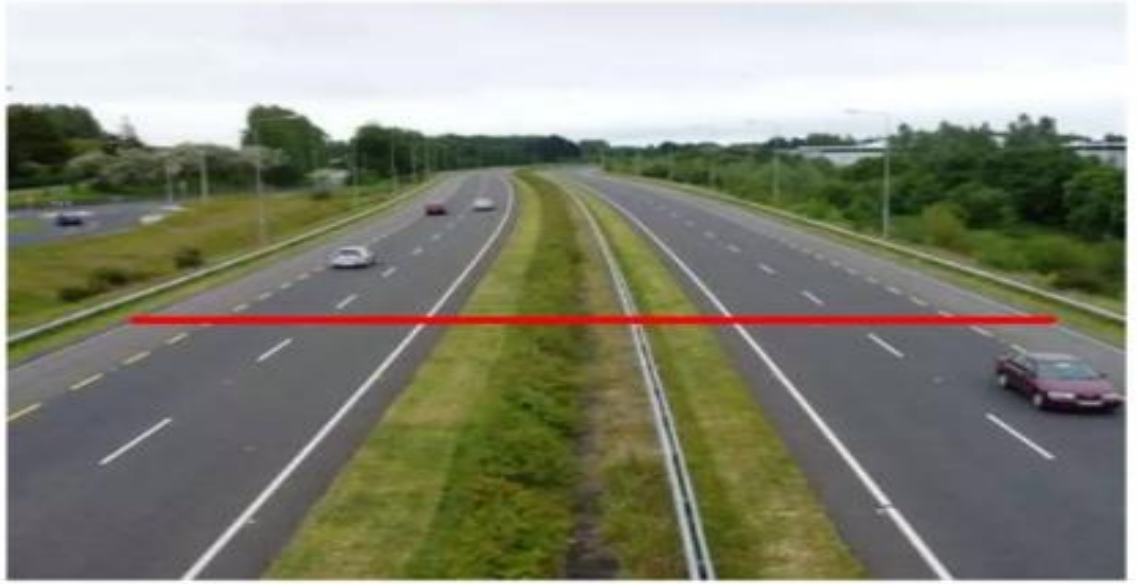
- As per IRC, the min. width of shoulder should be 2.5m.

- Uses :
- Repair of broken down vehicles
- Overtaking operations
- To act as an emergency lane
- For future widening of road
- For temp. diversion of traffic during road repair etc

Formation width :

- Formation width is the top width of the highway embankment or the bottom width of cutting excluding the side drain .
- Formation width = Width of Carr. Way + Width of shoulder

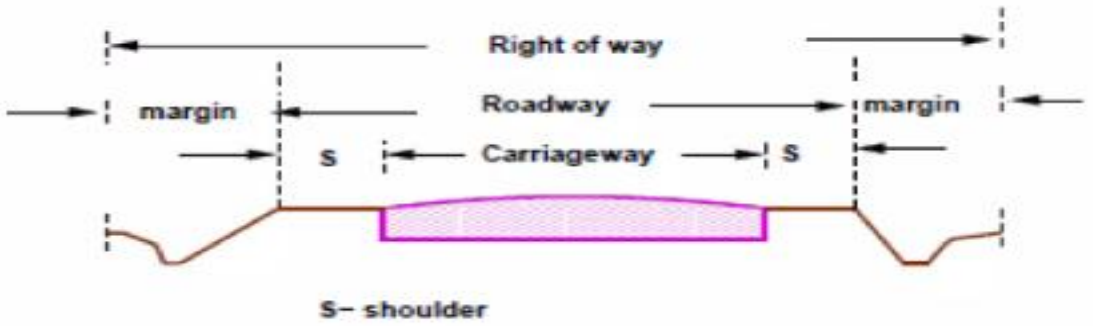
Road classification	Roadway width in m	
	Plain and rolling terrain	Mountainous and steep terrain
NH/SH	12	6.25-8.8
MDR	9	4.75
ODR	7.5-9.0	4.75
VR	7.5	4.0



Right of way :

- Right of way is the area of land acquired for the land, along its alignment.
- It is the distance between boundary stones of road on either side of road.

Road classification	Roadway width in m	
	Plain and rolling terrain	Mountainous and steep terrain
Open areas		
NH/SH	45	24
MDR	25	18
ODR	15	15
VR	12	9
Built-up areas		
NH/SH	30	20
MDR	20	15
ODR	15	12
VR	10	9



Side slope :

- The slope of earthwork in Filling(embankment) or cutting is called sideslope.

Berm :

- The distance between the road toe and inner edge of borrow pit is called berm.
- It prevents the erosion of embankment soil.

Side drain :

- For the drainage of rain water, drains are provided on either side of the road .
- Normally, Side drain are required for road in cutting. For road in embankment side drain is not necessary.

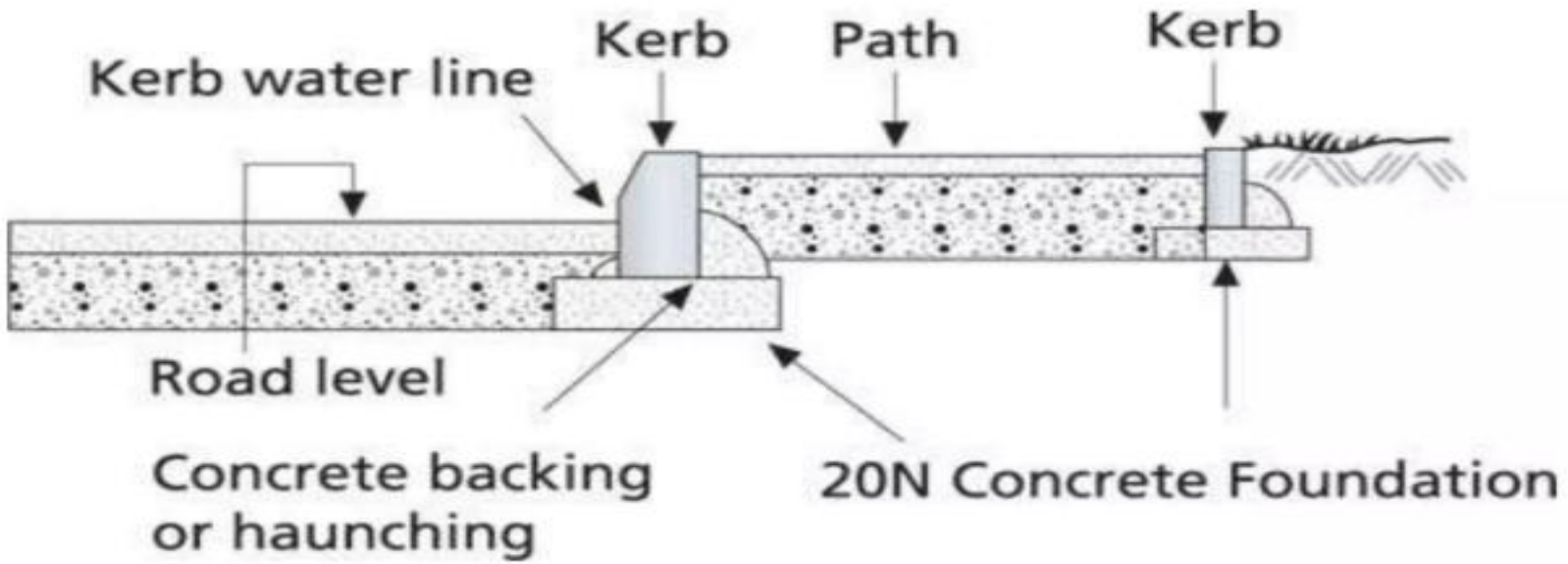
Building line :

- The distance from the centre line of road on either side, within which construction of building is not permitted is called building line.

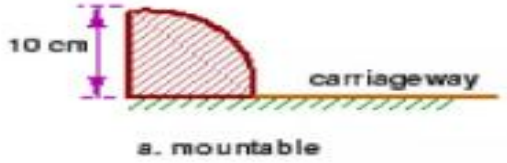
- Purposes :
- For future widening of road
- To reduce the chance of accidents
- To relieve residents from noise pollution
- To prevent disturbance to the traffic by nearby residents

Kerbs :

- *The boundaries between pavement and shoulders or footpath are known as kerbs.*



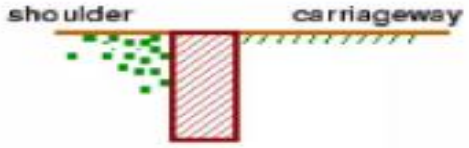
Types of kerbs



a. mountable

b. semi barrier type

c. barrier type



d. submerged

Camber

- Camber or cross slope is the slope provided to the road surface in the transverse direction to drain off rain water from the road surface.
- The rate of camber is usually designated by 1 in n (1 vertical to n horizontal)

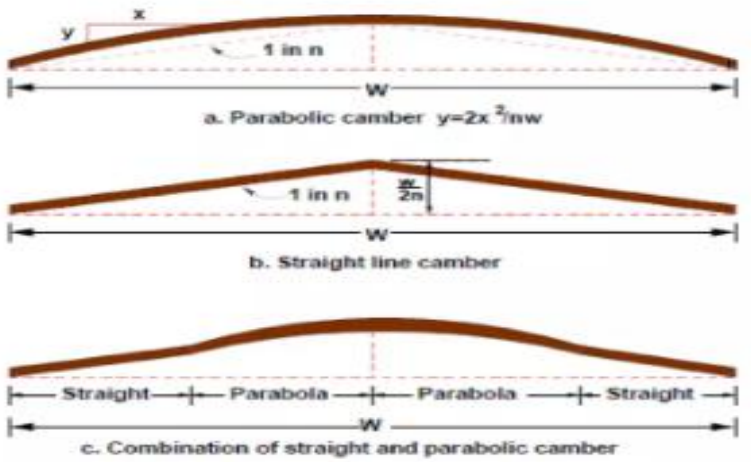
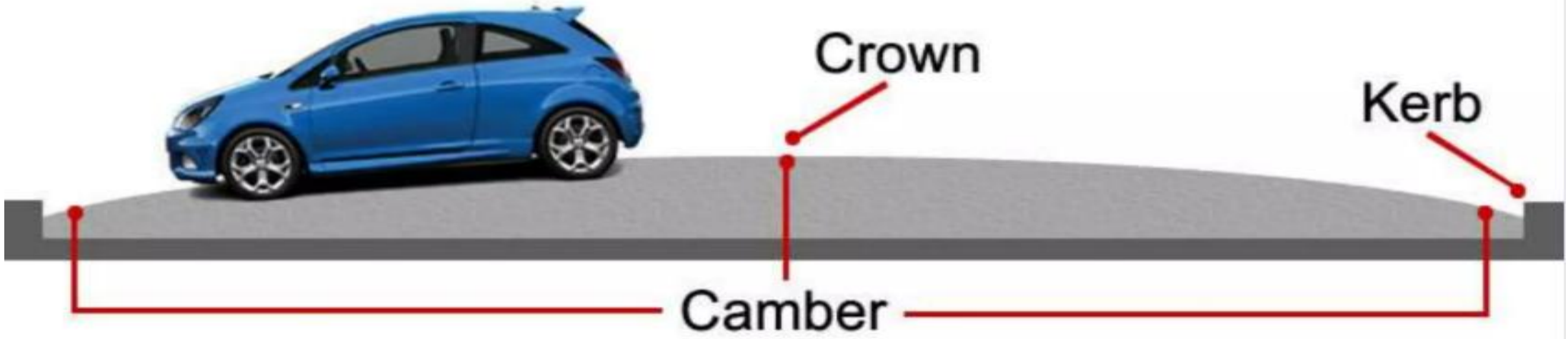


Figure 12:1: Different types of camber

CAMBER

A slight downward curve from the middle to the sides of a surface (such as a road)

- PERCENTAGE OF CAMBER- 2%
- PURPOSE OF CAMBER



Purposes of camber :

- To remove the rain water from the pavement surface as quickly as possible.
- To prevent entry of water into bituminous pavement layers.
- To prevent entry of surface water into subgrade soil through pavement.
- To make pavement surface attractive.

Super elevation :

- It is the slope across pavement surface and is fully developed in the circular curve.

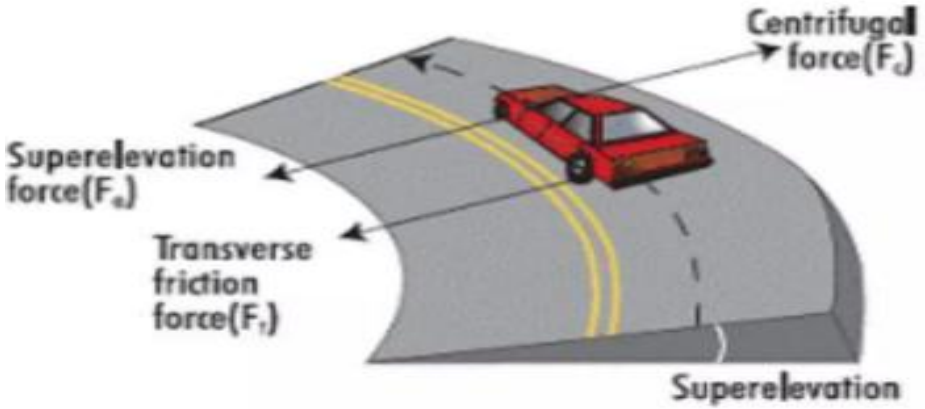
(or)

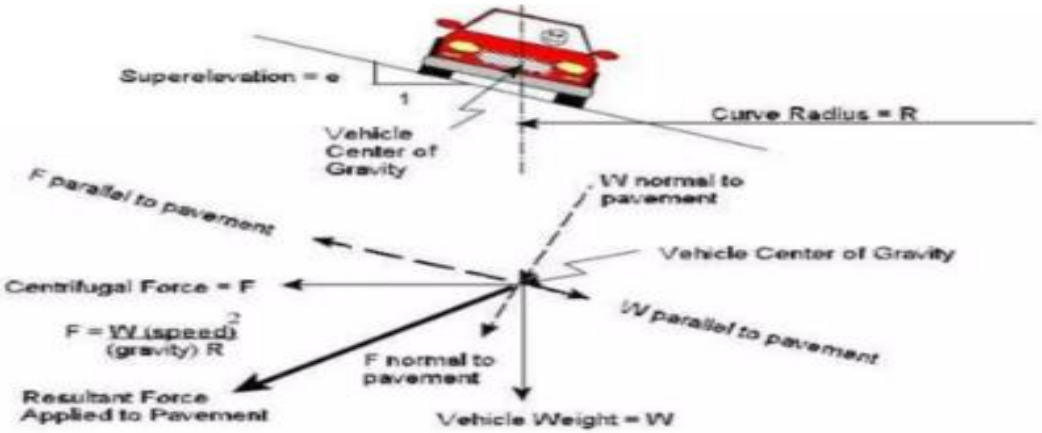
- Super-elevation (banking) is the transverse slope provided at horizontal curve to counteract the centrifugal force, by raising the outer edge of the pavement with respect to the inner edge, throughout the length of the horizontal curve.

- So super elevation helps the vehicle to over come the centrifugal force on the curves on pavements

- The need for super-elevation on road curves, to ensure safety against skidding and over turning with the advent of fast moving traffic.

- In the past, roads were constructed without any regard to super-elevation on curves and had generally a cambered section for drainage purposes. It was later realised then that a vehicle moving on a curve had to overcome a centrifugal force to enable it to follow the curved path instead of a straight line, but, in justice to the early designers of roads, it must be said that there was no fast traffic in those days.





SIGHT DISTANCE

•Sight distance available from a point is the actual distance along the road surface, which a driver from a specified height above the carriageway has visibility of stationary or moving objects.

OR

•It is the length of road visible ahead to the driver at any instance.

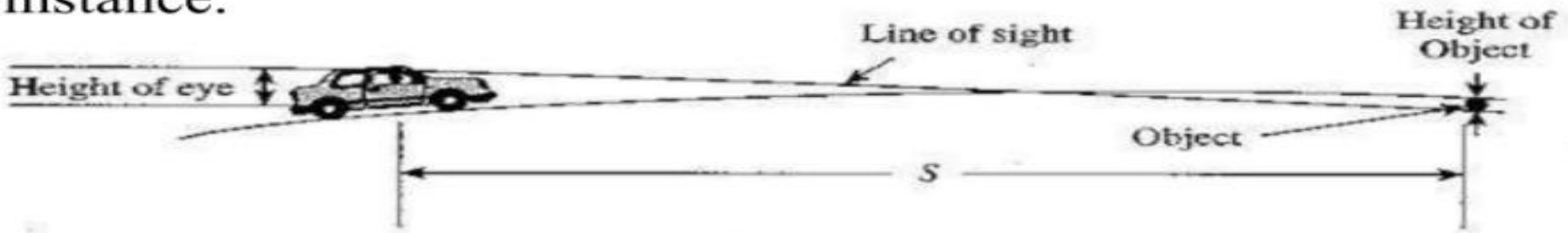
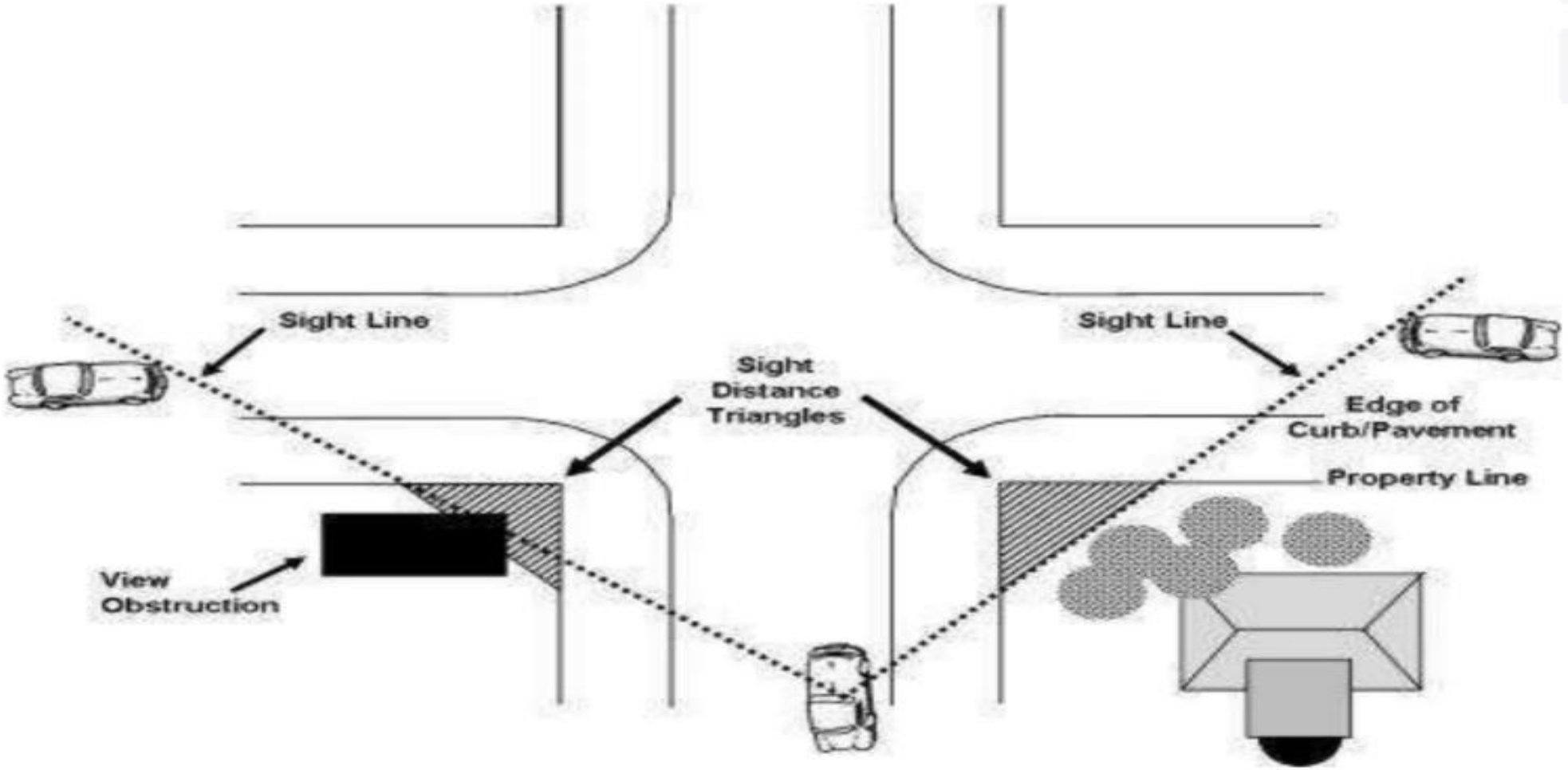


FIGURE 4.8
Stopping sight distance diagram for crest vertical curve.


Sight Line
Sight Line
Sight
Distance
Triangles
Edge of
Curb/Pavement
Property Line
View
Obstruction

Types of sight distance

- **Stopping** or absolute minimum sight distance(SSD)
- Safe **Overtaking** or passing sight distance (OSD)
- Safe sight distance forentering into uncontrolled intersection.
- Intermediate sight distance

Stopping sight distance:

•The minimum sight distance available on a highway at any spot should be of sufficient length to stop a vehicle traveling at design speed, safely without collision with any other obstruction.

Over taking sight distance:

•The minimum distance open to the vision of the driver of a vehicle intending to overtake slow vehicle ahead with safety against the traffic of opposite direction is known as the minimum overtaking sight distance (OSD) or the safe passing sight distance.

.

Intermediate sight distance:

This is defined as twice the stopping sight distance.

When overtaking sight distance can not be provided, intermediate sight distance is provided to give limited overtaking opportunities to fast vehicles.

- Stopping Sight Distance
- SSD is the minimum sight distance available on a highway at any spot having sufficient length to enable the driver to stop a vehicle traveling at design speed, safely without collision with any other obstruction.

- It depends on:
- Feature of road ahead
- Height of driver's eye above the road surface(1.2m)
- Height of the object above the road surface(0.15m

- Criteria for measurement
- •(h)
- h
- HIRC
- •H = 1.2m
- •h = 0.15m

- •Height of driver’s eye above road surface (H)
- •Height of object above road surface(h)

Factors affecting the SSD

- Total reaction time of driver
- Speed of vehicle
- Efficiency of brakes
- Frictional resistance between road and tyre
- Gradient of road

Total reaction time of driver:

- It is the time taken from the instant the object is visible to the driver to the instant the brake is effectively applied, it divide into types

1. Perception time
2. Brake reaction time