INTRODUCTION TO CIVIL ENGINEERING

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Syllabus

Centroid:

- Importance of centroid and centre of gravity, determination of centroid by method of moments, axis of reference, methods of determining the centroid, Numerical examples for locating the centroid of built-up sections (Simple sections).

Transportation Engineering:

- Introduction to Transportation Engineering: Definition and scope, Role in civil engineering and national development, Importance of transportation in economic growth and mobility.
- Highway Engineering Basics: Types of roads (NH, SH, MDR, rural roads) Pavement types: Flexible vs rigid.
- Basic road components: carriageway, shoulders, medians, footpaths, Surface Characteristics, Cross Sectional elements, Camber, Road hierarchy and layout, Common traffic signs and road markings.

TRANSPORTATION ENGINEERING

- **Road:** A road is a thoroughfare, route or way on land between two places, which typically has been paved or otherwise improved to allow travel by some conveyance, including a horse, cart, or motor vehicle.

- **Highway:** A highway is a public road, especially a major road connecting two or more destinations. Any interconnected set of highways can be variously referred to as a "highway system", a "highway network", or a "highway transportation system". Each country has its own national highway system.

TRANSPORTATION ENGINEERING

Role of transportation

- Transportation contributes to the economic, industrial, social and cultural development of any country. whether it is agricultural or industrial product needs to be transported at various stages from production to distribution.
- At the production stage, transportation is required for carrying raw materials like seeds, manure, coal, steel, machines, component parts, etc.
- At the distribution stage, transportation is required from the production centres like the farms and factories to the marketing centres and later to the retailers and to the consumers.
- In-adequate transportation facilities affect the process of socio-economic and cultural development of the country.

TRANSPORTATION ENGINEERING

Role of transportation

- Development of adequate transportation system in a country indicates its economic growth and progress in social development.
- The main objective of a good transportation system is to provide safe, economical, efficient - transportation facility for the travel of passengers and transportation of goods.

TRANSPORTATION ENGINEERING

Economic Activity and Transport

- The importance of transportation in economic activity has its effect on meeting the demand for goods and also by enhancing the efficiency of production and distribution.
- Increased productivity of various items such as agricultural and industrial products and their distribution through efficient transportation system can lower the cost of the products.
- The cost of transportation substantially influences the consumer price of the commodities.

TRANSPORTATION ENGINEERING

Social Effects of Transportation

- Population have always settled along the transportation routes such as road side, river shore and near railway stations and sea ports.
- Developments have also taken place along the routes where transportation facilities are available, such as the road sides.
- Attempts are being made to decentralize the population centres away from the sides of the main transportation routes. Thus town planning patterns are changing.

HIGHWAY ENGINEERING

The four major modes of transportation are:

1. Roadways or highways
2. Railways
3. Airways
4. Waterways

HIGHWAY ENGINEERING

1. Roadways or Highways

- Roadways or highways refer to the network of roads, streets, and highways that facilitate the movement of vehicles such as cars, trucks, buses, and motorcycles. They are the most commonly used mode of transportation, connecting urban and rural areas.

- **Advantages:**
  - Accessibility
  - Flexibility
  - Cost-Effective
  - Support to Other Modes

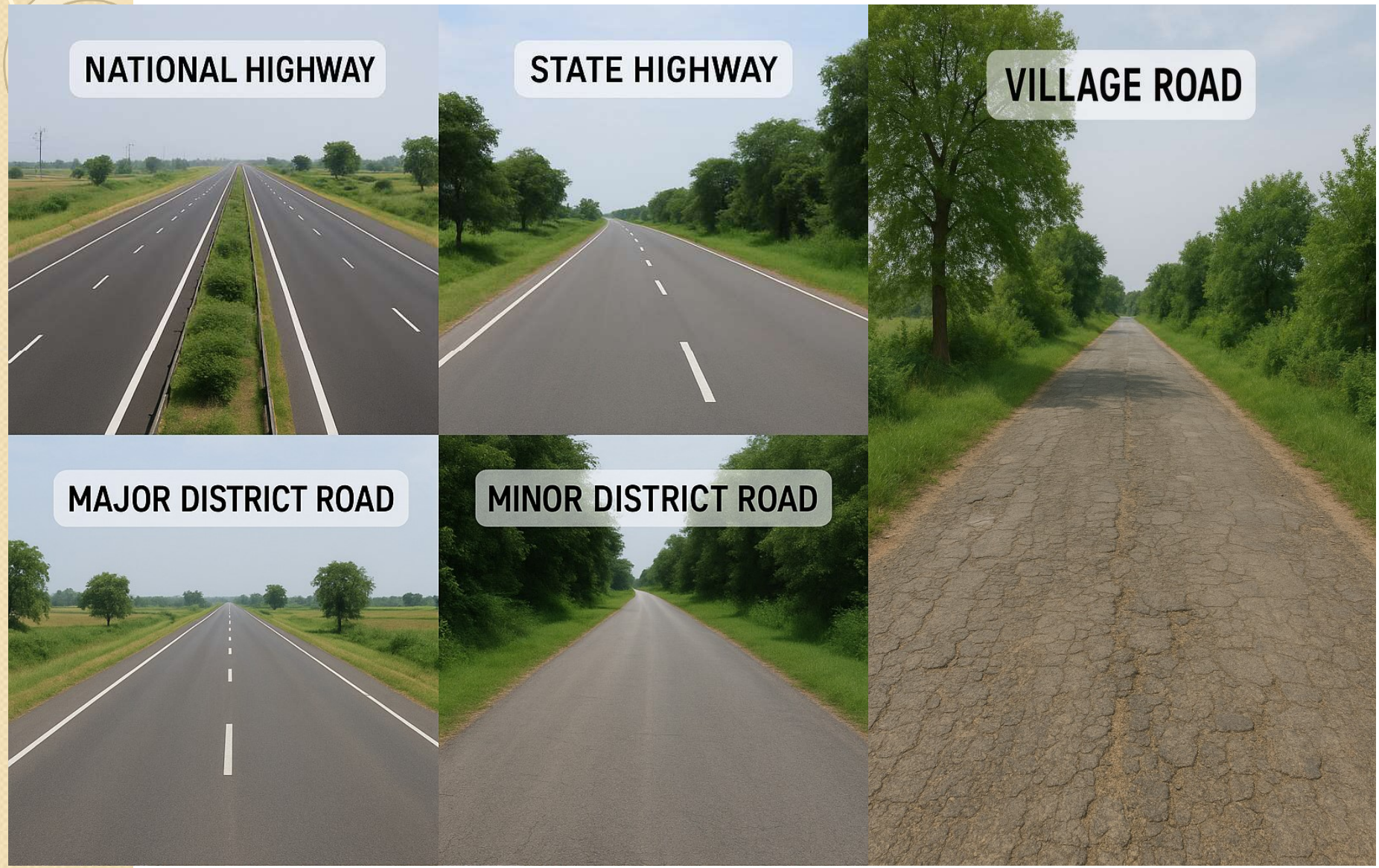
HIGHWAY ENGINEERING

1. Roadways or Highways

- **Challenges:**
  - Traffic Congestion
  - Maintenance
  - Environmental Impact
- **Examples:**
  - National highways in the INDIA like NH66
  - India's Golden Quadrilateral highway network
- **Significance:** Roadways are crucial for regional connectivity and play a vital role in the economy by enabling the efficient movement of goods and people.

HIGHWAY ENGINEERING

Classification of Roads: Based on location and Function



HIGHWAY ENGINEERING

Classification of Roads: **Based on location and Function**

The Nagpur Road Plan classified the roads in India into

i. **National Highways (NH):** The NH connects the capital cities of the states and the capital cities to the port. The roads connecting the neighboring countries are also called as NH. The NH are at least 2 lanes of traffic about 7.5m d wide. The NH are having concrete or bituminous surfacing.

ii. **State Highways (SH):** SH are the main roads within the state and connect important towns and cities of state. The width of state highways is generally 7.5m.

HIGHWAY ENGINEERING

Classification of Roads: Based on location and Function

iii. **Major District Roads (MDR):** These roads connect the areas of production and markets with either a SH or railway. The MDR should have at least metaled single lane carriage way (i.e., 3.8m) wide. The roads carry mixed traffic.

iv. **Other District Roads (ODR):** these roads connect the village to other village or the nearest district road, with ghat, river etc. these roads have a single lane and carry mixed traffic.

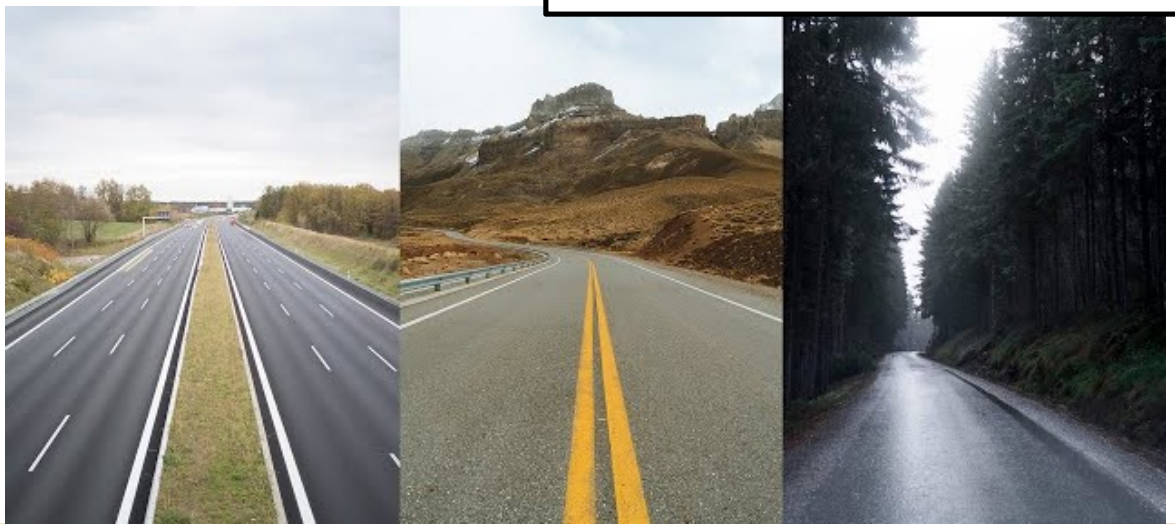
v. **Village Roads (VR):** these roads, like other district roads, connect the village or village or nearby district road. The roads carry mixed traffic.

HIGHWAY ENGINEERING

The road classification system was modified in the third 20-year development plan. The roads are now classified into three classes and are as follows

1. Primary System
   i. Expressways
   ii. National Highways (NH)

2. Secondary System
   i. State Highways (SH)
   ii. Major District Roads (MDR)
3. Tertiary System
   i. Other District Roads (ODR)
   ii. Village Roads



HIGHWAY ENGINEERING

- The road system within urban areas are classified as Urban Roads and will form a separate category of roads taken care by respective urban authorities.

a) Arterial roads

b) Sub-arterial roads

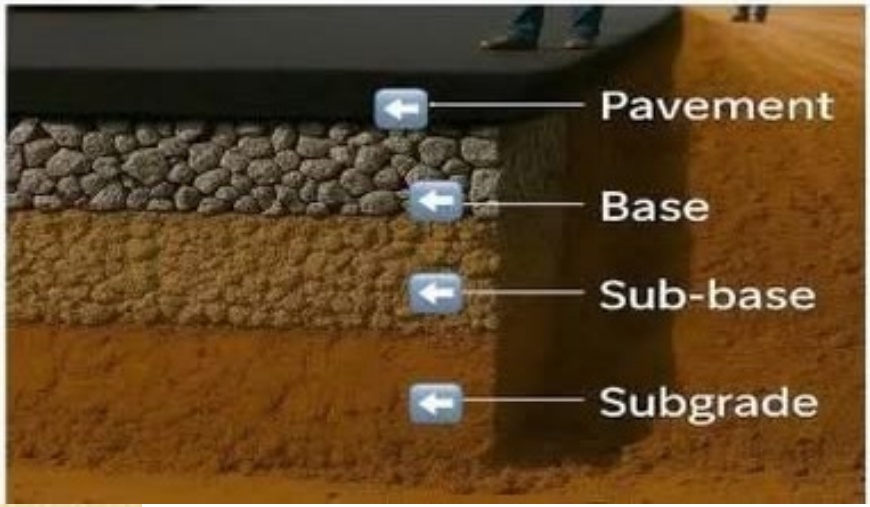
c) Collector Streets

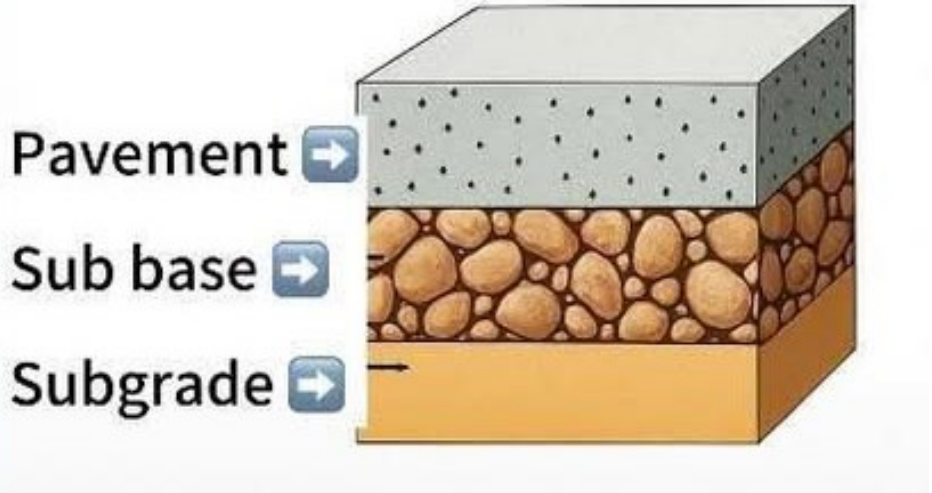
d) Local Streets

a) Arterial and Sub-arterial roads are primarily for through traffic on a continuous route, but sub-arterials have a lower level of traffic mobility than the arterials.

b) Collector streets provide access to arterial streets and they collect and distribute traffic from and to local streets which provide access to abutting property.

HIGHWAY ENGINEERING





HIGHWAY ENGINEERING

Flexible Pavement	Rigid Pavement
Low initial cost.	High initial cost.
The wheel load is transferred by grain to grain mechanism.	The load is distributed by the slab action mechanism.
Have low flexural strength.	Have sufficient flexural Strength.
Less durable.	More durable.
Short service life, usually 15 years.	Long service life, more than 30 years.
Joints are not required.	Essentially require joints.
Have many layers of materials.	Have only one layer.
Require frequent repairing.	Do not require frequent repairing.
High repairing and maintenance costs.	Low repairing and maintenance costs.
Damaged by oil and chemicals.	No damage by oil and other chemicals like greece.
Design based on subgrade strength.	Design based on flexural strength.
Temperature variations do not produce stresses.	Temperature variations produce heavy stresses.
Deformation in the sub-grade is transferred to the upper layers.	Deformation in the sub-grade is transferred to the subsequence Layers

HIGHWAY ENGINEERING

Flexible Pavement	Rigid Pavement
The thickness is more.	The thickness is less.
Constructed using bituminous materials like asphalt.	Constructed using portland cement.
Can be opened to traffic shortly after construction.	Require curing, which delays the opening to traffic.
Provides poor night visibility due to the color of asphalt.	Concrete offers good night visibility.
Suitable for all types of traffic.	Noisy under iron-wheeled traffic.
Easy to lay, locate or repair	Difficult
underground pipes below flexible pavements.	Difficult to repair underground pipes below rigid pavements.
No glare due to sunlight.	Glare due to reflected sunlight.
Stage development is practicable.	Stage development is not practicable.
Require good subgrade.	Good subgrade is not necessary.
Normal skill and less supervision are required.	Skilled workers are required.

HIGHWAY CROSS SECTION ELEMENTS

1.Carriageway

2.Shoulder

3.Roadway width

4.Right of way

5.Building line

6.Control line

7.Median

8.Camber/ cross slope

9.Crown

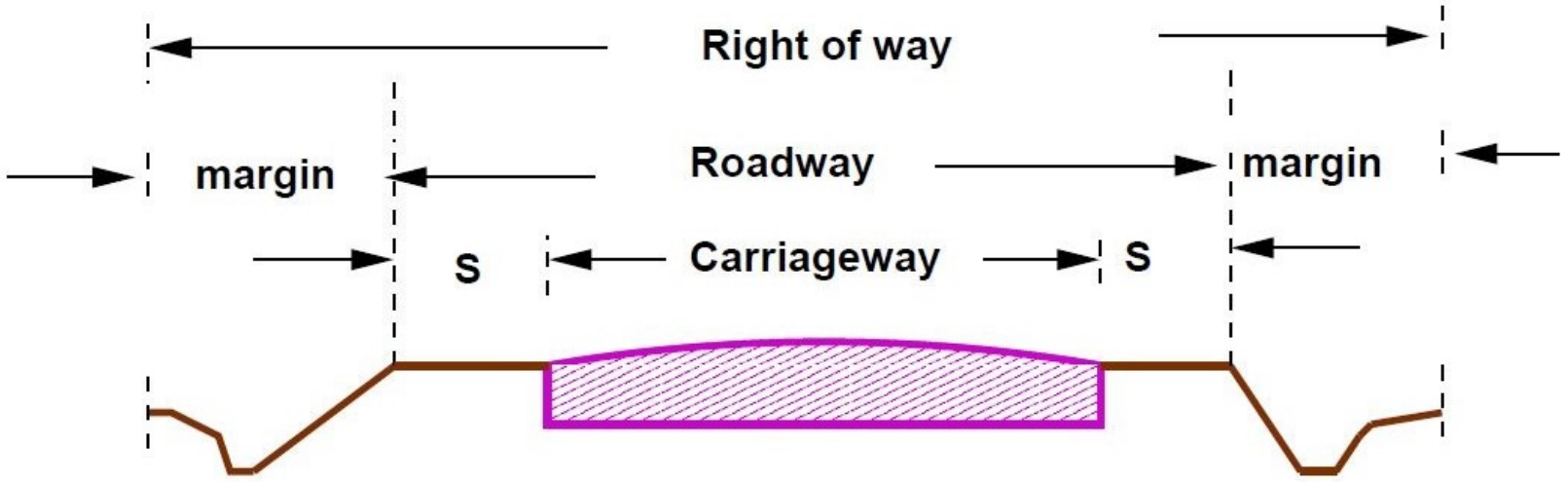
10.Side slope

11.Kerb

12.Guard rail

13.Side drain

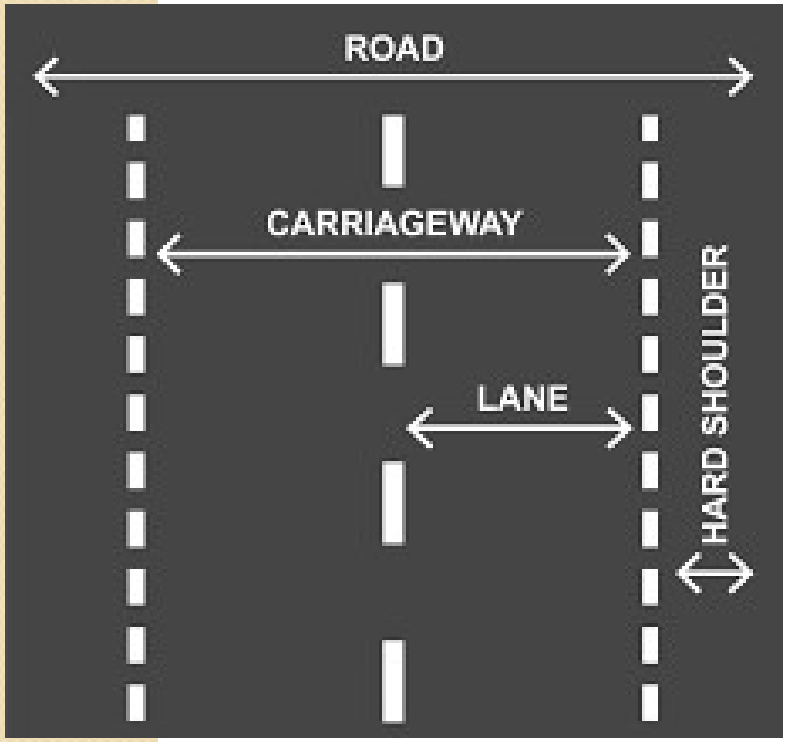
14.Other facilities



HIGHWAY CROSS SECTION ELEMENTS

Carriage Way

- It is the travel way which is used for movement of vehicle, it takes the vehicular loading.
- It may be cement concrete road or bituminous pavement.

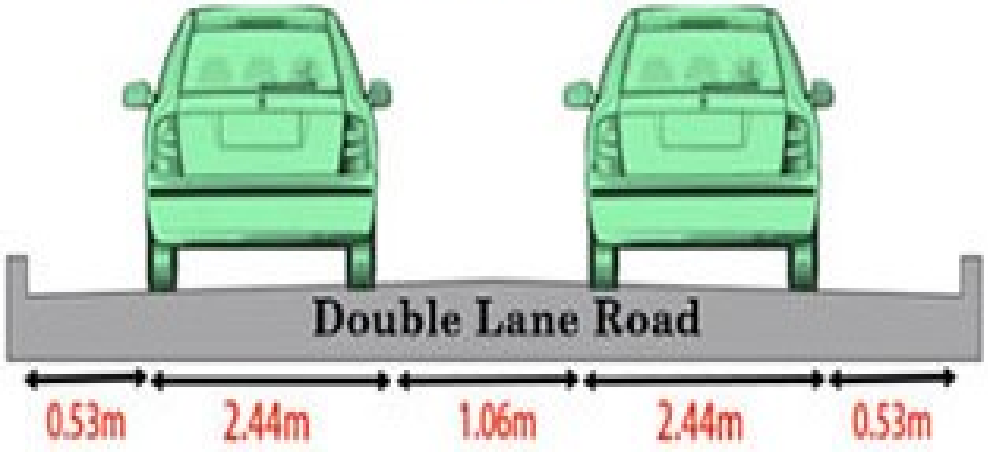


- Width of carriageway is determined on the basis of the width of `the vehicle and the minimum side clearance for safety.
- As per IRC specification, the maximum width of vehicle is 2.44m,minimum clearance of 0.68 in case of single lane and 1.02m in case of double lane

HIGHWAY CROSS SECTION ELEMENTS

Carriage Way

Carriage way Type	Carriage way Width
Single Lane	3.75
Two Lane, No kerbs	7.0
Two Lane, Raised kerbs	7.5
Intermediate Carriage	5.5
Multi-Lane	3.5



HIGHWAY CROSS SECTION ELEMENTS

Shoulder

- It is provided along the road edge to serve as an emergency lane for vehicle.
- It act as a service lane for vehicles that have broken down.
- The minimum shoulder width of 4.6 m so that a truck stationed at the side of the shoulder would have a clearance of 1.85m from the pavement edge.
- IRC recommended the minimum shoulder width is 2.5 m
- It should have sufficient load bearing capacity even in wet weather.

- The surface of the should be rougher than the traffic lanes so that vehicles are discouraged to use the shoulder as a regular traffic.
- The color should be different from that of the pavement so as to be distinct.

HIGHWAY CROSS SECTION ELEMENTS

Median

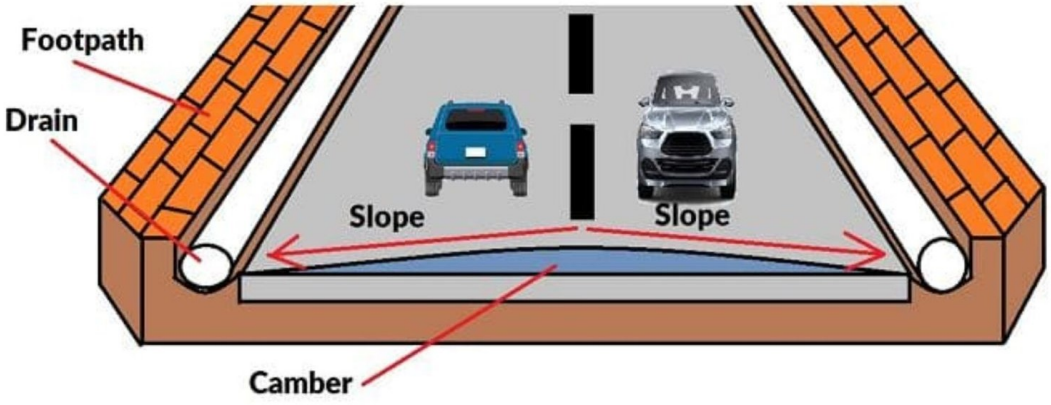
- The main function is to prevent head on collision between the vehicle moving in opposite direction.
- Channelize traffic into streams at intersection.
- Segregate slow traffic and to protect pedestrians.

- IRC recommends a minimum desirable width of 5 m and may be reduce to 3 m where land is restricted.
- The minimum width of median in urban area is 1.2m.

HIGHWAY CROSS SECTION ELEMENTS

Camber

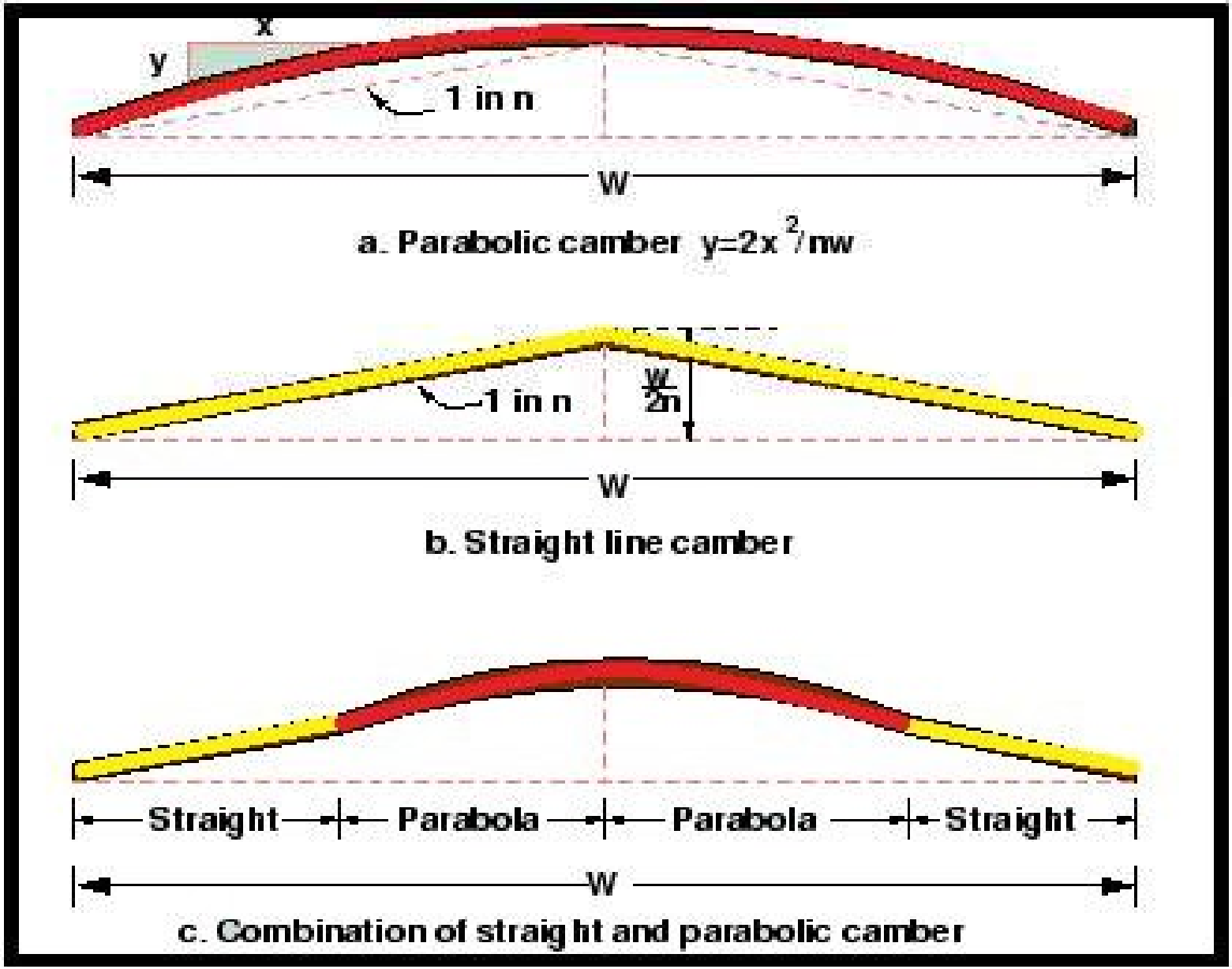
- Camber is the cross slope provided to raise middle of the road surface in the transverse direction to drain of rain water from road surface. The objectives of providing camber are:
- Surface protection especially for gravel and bituminous roads
- Sub-grade protection by proper drainage
- Quick drying of pavement which in turn increases safety
- Too steep slope is undesirable for it will erode the surface. Camber is measured in 1 in n or n% (Eg. 1 in 50 or 2%) and the value depends on the type of pavement surface.



- The common types of camber are parabolic, straight, or combination of them.

HIGHWAY CROSS SECTION ELEMENTS

Camber



HIGHWAY CROSS SECTION ELEMENTS

Camber

Sr.No	Type Of Road Surface	Range of camber in areas of	
		Heavy rainfall	Low rainfall
1	Cement concrete and thick bituminous surface	1 in 50 or 2 %	1 in 60 or 1.7 %
2	Thin bituminous surface	1 in 40 or 2.5%	1 in 50 or 2 %
3	Water bound macadam and gravel pavement	1 in 33 or 3%	1 in 40 or 2.5 %
4	Earth road	1 in 25 or 4%	1 in 33 or 3 %

Types of traffic Signs

According to the U.N, protocol the international system of traffic signs comprises of the following classes:

a) Danger signs, also known as warning signs or cautionary signs.

b) Signs giving definite instruction, also known as regulatory signs. These are further subdivide into:

   1. Prohibitory signs.
   2. Mandatory signs.

c) Information signs, further subdivided into:

   1. Indication signs.
   2. Advance direction signs and direction signs.
   3. Place and route identification signs.

Danger signs (Warning Signs or Cautionary Signs)

- Danger signs are used when it is deemed necessary to warn traffic of existing or potentially hazardous conditions on or adjacent to a highway or street. Warning signs are of great help in ensuring safety of traffic.
- The U.N. Protocol recommends an equilateral triangle with one point upwards. The side of the triangle.
- As per the I.R.C. Standard, is 900 mm for a standard size and 600 mm for a reduced size.
- These signs have a red border and the symbols indicated Therein are in black colour against a white background.

Prohibitory Signs:

The prohibitory signs give definite negative instructions prohibiting the motorist from making particular manoeuvres. They might be following types:

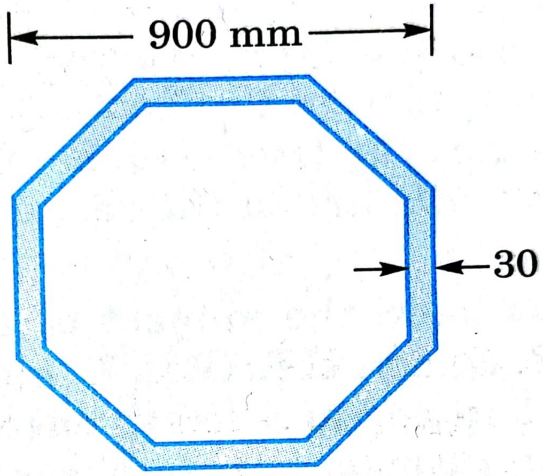
- Movement prohibition, such as prohibition of certain turns, prohibition of entry, prohibition of overtaking, one-way traffic, exclusion of certain types of vehicles or all vehicles etc.
- waiting restriction signs, such as prohibited waiting etc.
- Restrictions on dimensions, weight or speed of vehicle.

Prohibitory Signs:

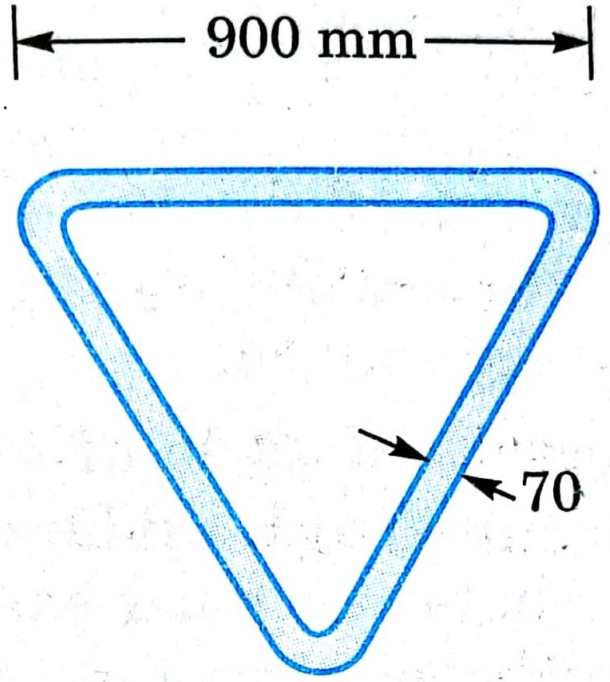
- According to the I.R.C. Standards the prohibitory signs are of a circular shape, with a diameter of 0.60 m for signs of the standard size and 0.40 m for the reduced size.
- The signs have a red border. The colour of the background is white for speed control, blue for waiting and parking restrictions, and blue for direction control and other signs.
- The symbols are in black colour for prohibitory signs and white in colour for direction control signs.

Mandatory signs

- Mandatory signs are part of regulatory signs and are intended to convey definite positive instruction when it is desired that motorists take some positive action.
- The tow most important signs are the
  - **STOP** sign
  - **YIELD** or **GIVE** way sign.

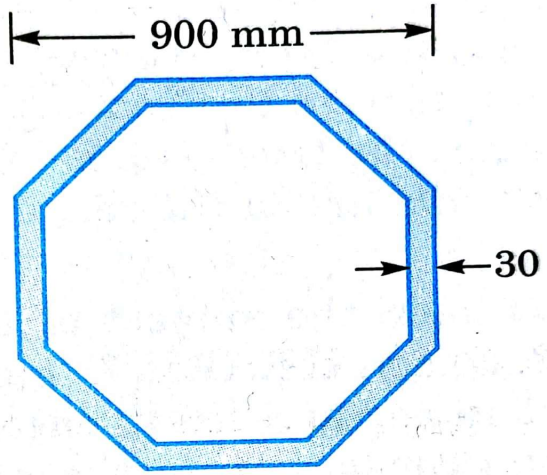


Stop sign

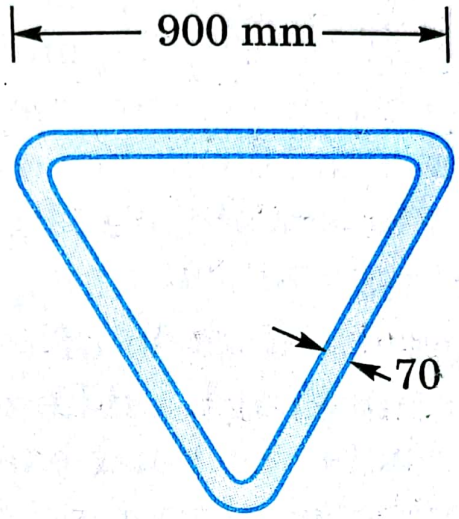


Yield or Give way sign

Mandatory signs



Stop sign



Yield or Give way sign

- Octagon with a white border and red background, the side of The octagon being 900 mm for the standard sized sign, and 600 mm for the Smaller sized sign.
- It shall be used in combination with a definition plate carrying the Message STOP.
- Downward pointing equilateral triangle having a red boarder and a white background standard size is 900mm and the smaller size is 600mm

Informatory signs:

Information signs are intended to guide the motorist along streets and highways, to inform him of intersecting routes, to direct him to cities, towns, villages or other important destinations, to identify nearby rivers and streams, parks, forests and historical sites, and generally to give him such information as will help him along his way in the most simple, direct manner possible.

Informatory signs:

$$x = \frac{S}{10} + \frac{V}{100}(N + 6) \text{ inches}$$

$$H = \left[\frac{S}{10} + \frac{V}{100}(N + 6)\right] \text{ inches}$$

Where,

x = height of small lower case letters such as x and z

H = height of uppercase letters such as H and I

S = Distance of the sign from the vehicle path in ft.

V = velocity of vehicle in miles/hour

N = Number of names in the sign

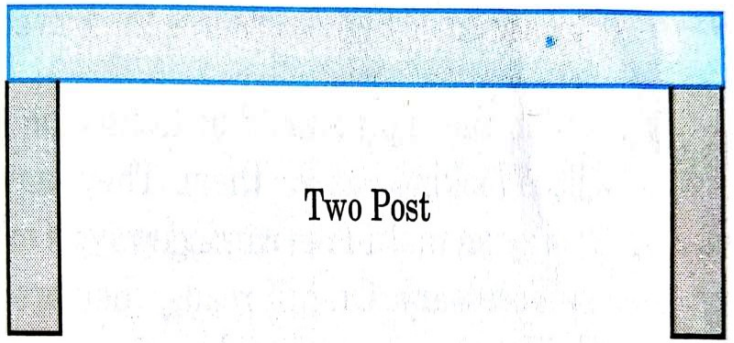
In the above formulae, the speed limit in force may be adopted as the value of V wherever such a limit is in force, and in other cases the design speed may be used as the value of V. The size of letters depends also upon the type of signs.

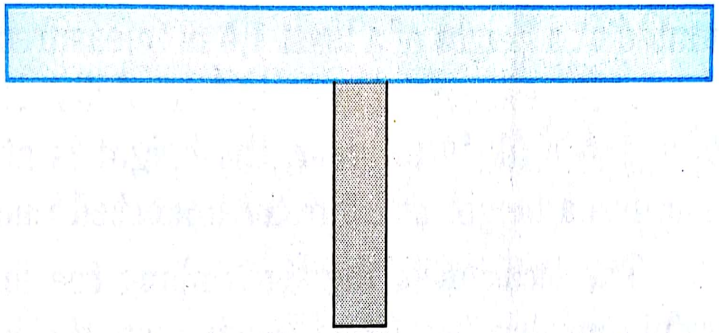
- For advance direction signs on rural roads, the letter size may be 8 to 15cm.
- In urban areas, the letter Size is 8 to 10 cm.
- For overhead signs, the letter size is in the range of 20 to 25cm; the numerical are slightly larger and are in the range of 25-30cm .

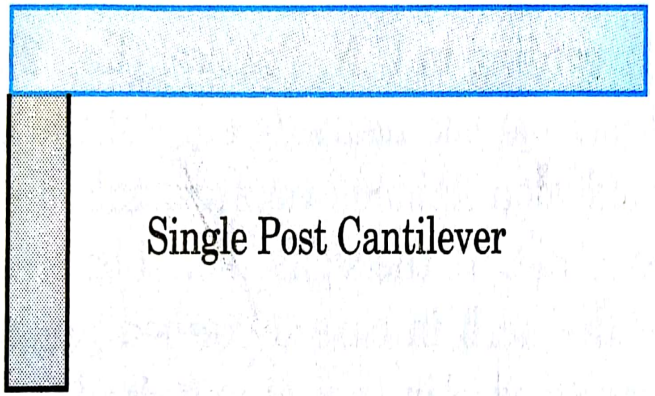
Overhead signs

Overhead signs are provided at locations where the following

- Insufficient space for ground mounted signs.
- Traffic volume at or near capacity.
- Three or more lanes.
- Restricted sight distance.
- Multi-lane exits.
- High speed traffic.




Single post butter-fly type



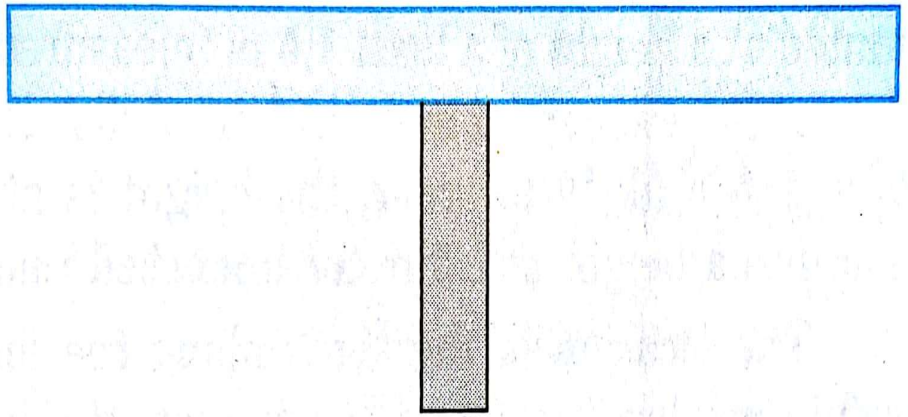
Overhead signs

- Considerations exist The existence of any or more of the conditions listed does not automatically justify the use of overhead signs.
- Some of the elements listed above can be made less critical by close coordination between design and operation.
- The height of the panel ranges from 125 cm to 305 cm, depending upon the number of lines and messages.
- The letter size is in the range of 25-30 cm.
- The maximum panel length is about 7m.
- The vertical clearance needed in India is 5.5 m.

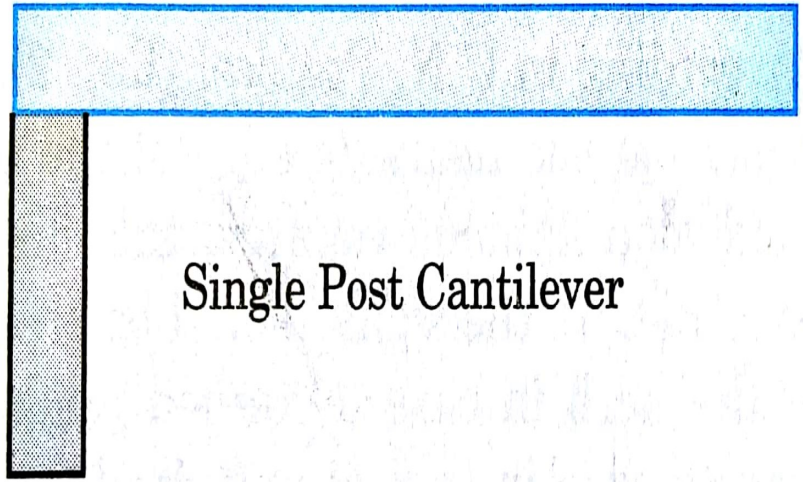
Overhead signs

The support system can be any one of the following:

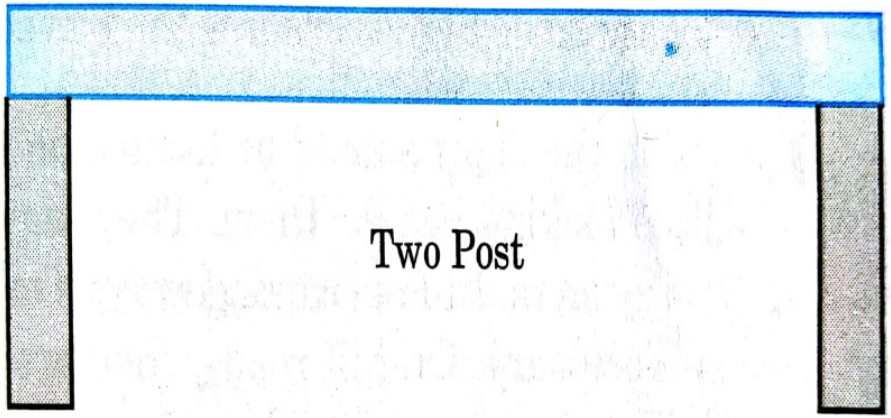
1. Cantilever with one post
2. Butterfly with one post
3. Two post unit



Single post butter-fly type

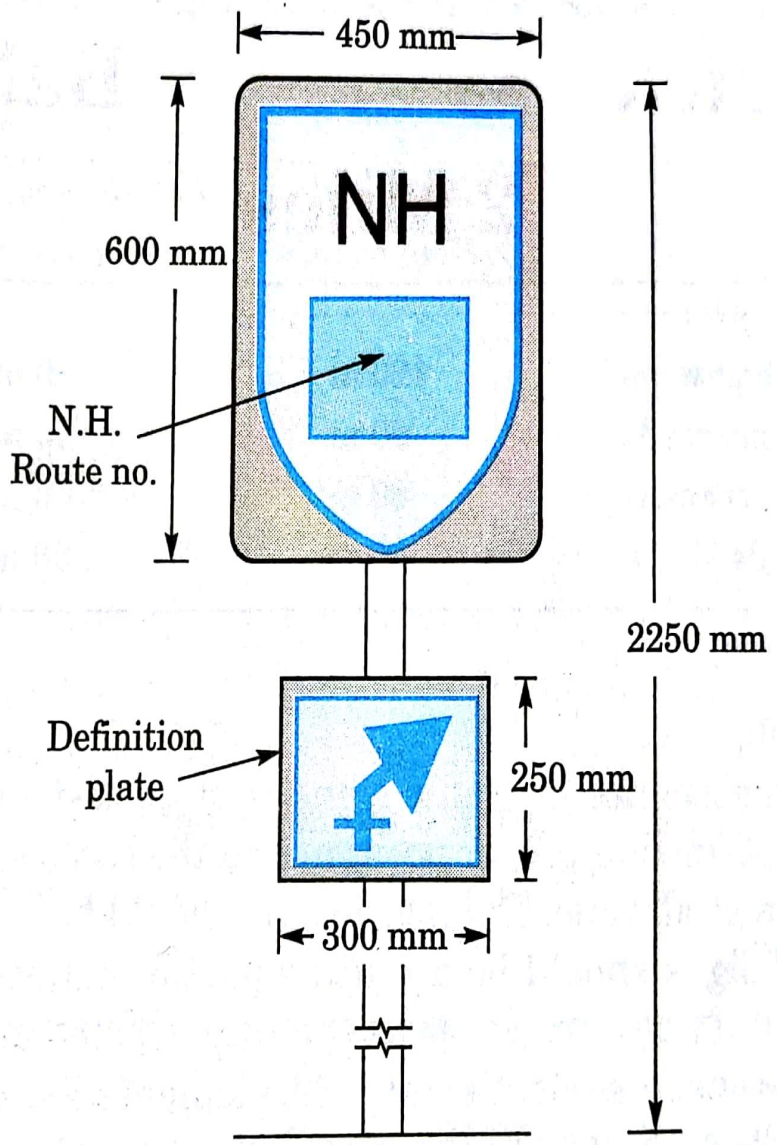


Single Post Cantilever



Two Post

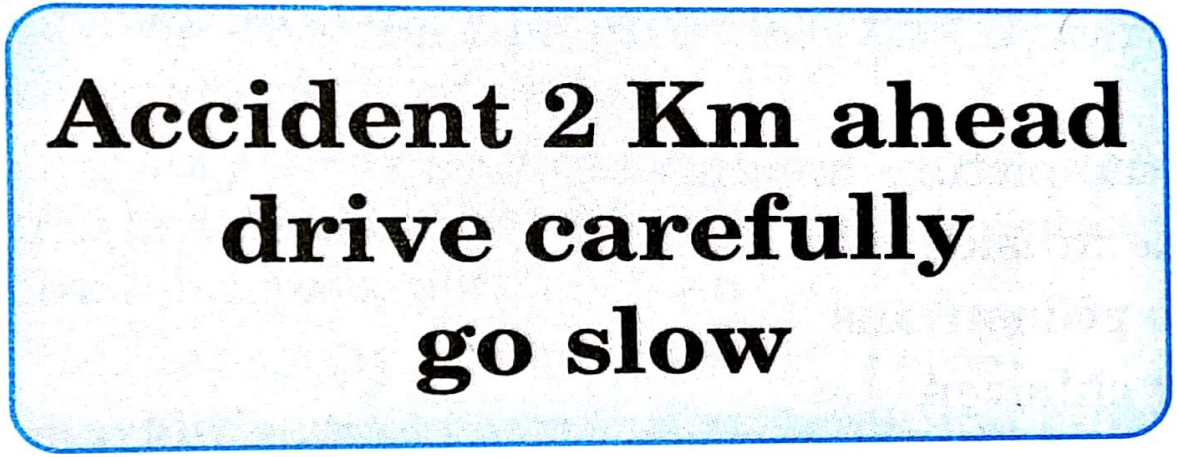
Route Marker Signs



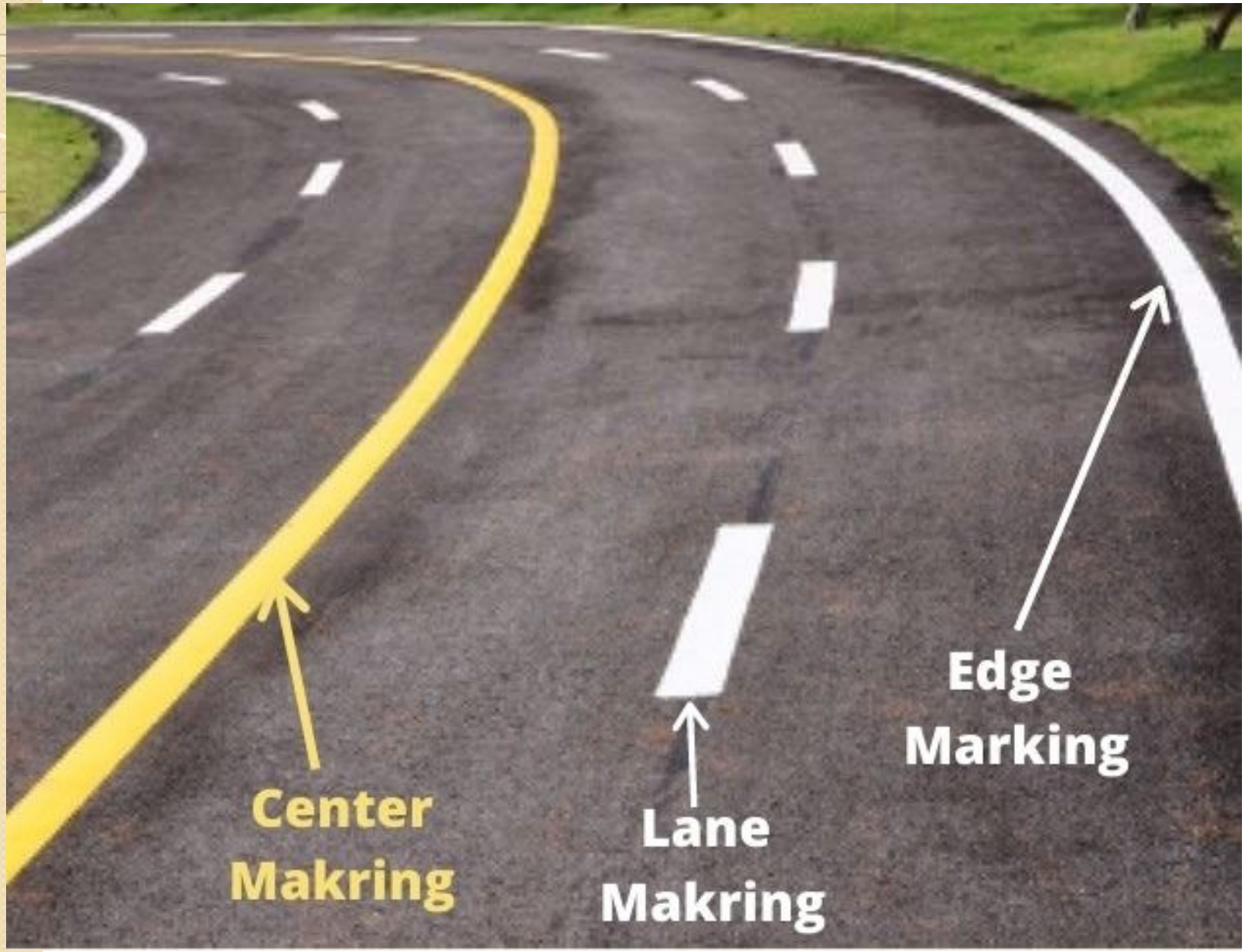
- The design for Route Marker Signs for National Highways has been Standardised in India
- The I.R.C. shall consists of shield painted on a rectangular plate 450 mm * 600 mm.
- The sign has a yellow background and the lettering and border are in black.

Variable Message Signs

- Variable Message Signs (VMS), also known as Dynamic Message Signs (DMS) are signs, which display information which can be changed whenever needed by means of control at a centralised location.
- They give Traveller information such as severe conditions, incident notification (accident, Road closure), congestion, travel time between destinations.
- VMS display board uses high intensity LEDs, generally yellow in colour. The size of the letters is generally 380 400 mm.



ROAD MARKINGS



ROAD MARKINGS

- Road markings are used as a means of controlling and guiding traffic.
- They are highly important on roads and intersections as they promote road safety and bring about smooth and harmonious flow of traffic along guided paths of travel.
- They also serve to supplement the messages conveyed by road signals and signs. In some cases, they are used alone to convey certain regulation, information or warning that cannot otherwise be effectively made known to the road users.

ROAD MARKINGS

- Despite certain limitations inherent in them, such as obliteration by snow, poor visibility when wet and the need for frequent renewals when painted as surfaces exposed to traffic, road markings have a useful role to play in traffic engineering.
- One advantage with road makings is that they convey the required information to the driver without distracting his attention from the carriageway

Types of Road Markings

Road markings are basically of two types :

I. carriageway markings

II. object markings.

Carriageway markings are of the following categories:

1. Centre line.
2. Traffic lane lines.
3. No-overtaking zone.
4. Pavement edge lines.
5. Carriageway width.
6. Obstruction approach.
7. Stop lines.
8. Pedestrian crossings.
9. Cyclist crossings
10. Route direction arrows etc.
11. Word messages.
12. Markings at approaches to intersections.
13. parking space limits.
14. Bus stops

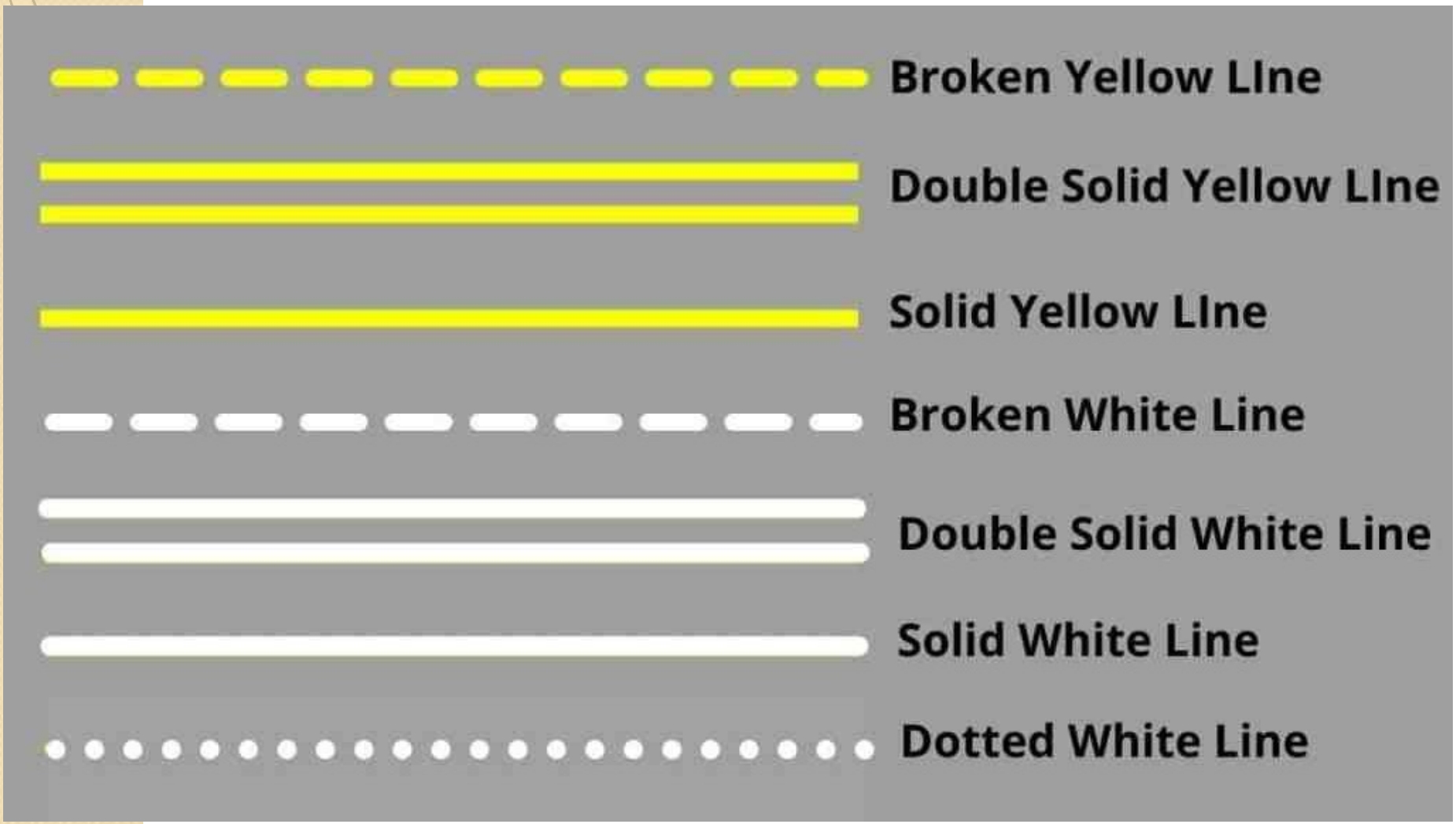
Types of Road Markings

Object markings are of the following categories :

1. Objects within the carriageway.
2. Kerb marking for visibility.
3. Kerb marking for parking restriction.
4. Objects adjacent to the carriageway.

General principles of Longitudinal Pavement Markings

The practice of pavement markings in different countries varies. However, some general principles of longitudinal pavement markings are common in many countries.



General principles of Longitudinal Pavement Markings

The practice of pavement markings in different countries varies. However, some general principles of longitudinal pavement markings are common in many countries.

Some of these are

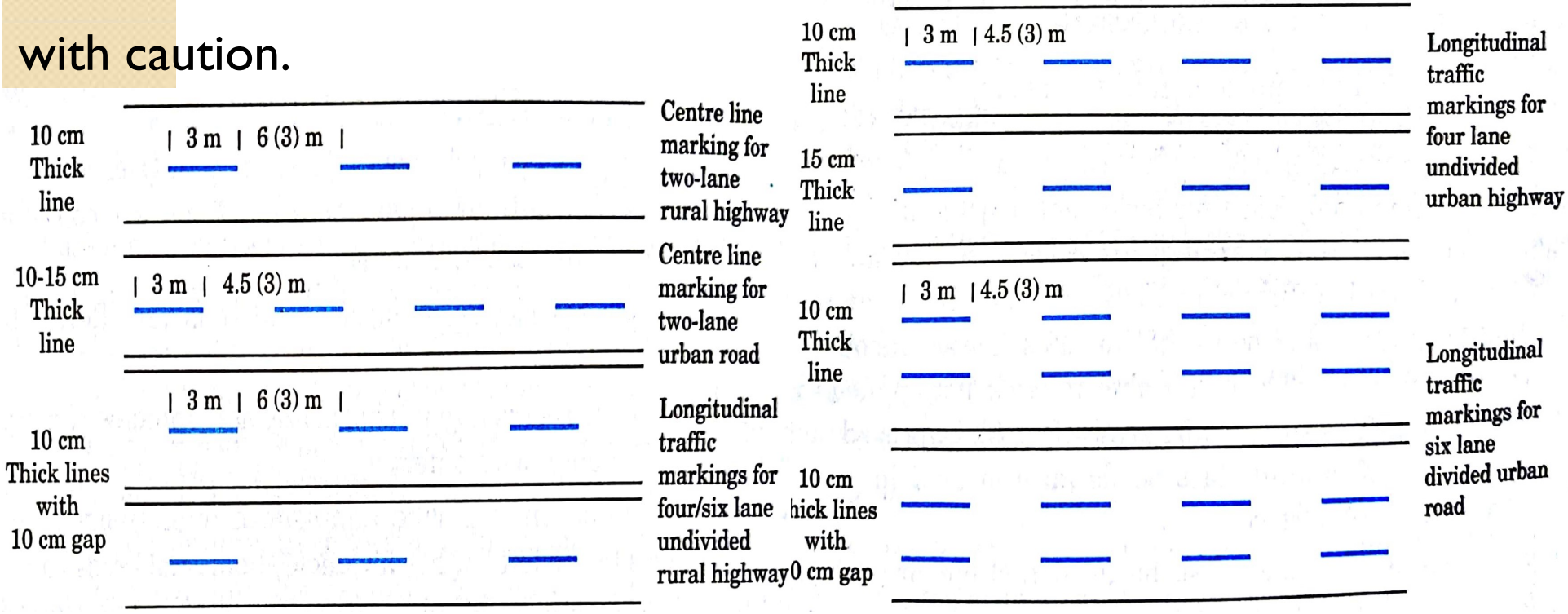
1. Solid lines are restrictive in nature and it is an offence to cross or straddle such a line.
2. Broken lines are restrictive in character, and vehicles can cross such a line provided this can be done with safety.
3. When a combination of a solid and broken lines is used, in countries Where the traffic moves to the left (right), a vehicle should not cross the continuous line adjacent to and to the left (right) of a broken line on the right (left) of the lane in which it is moving:
4. Double lines indicate maximum restrictions

General principles of Longitudinal Pavement Markings

Colour	Uses
White	All carriageway marking except those intended for parking restrictions
Yellow	I. Marking intended for parking restrictions II. Continuous center and barrier line markings
Alternative Bands of White and Black	Kerb and object markings

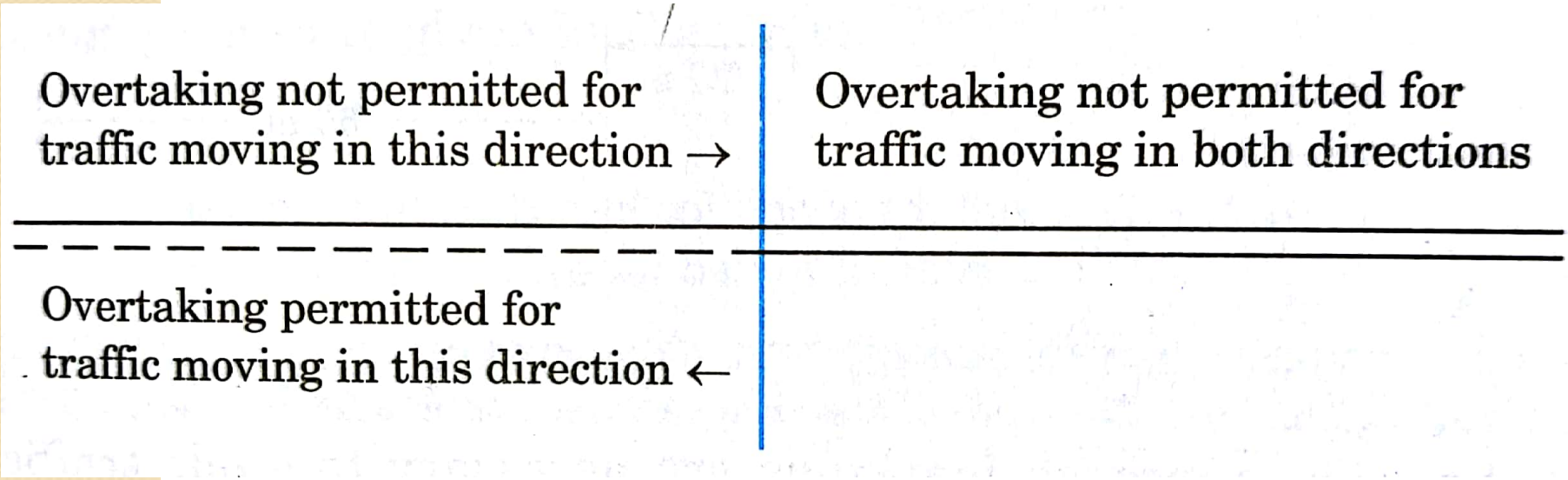
Traffic Lane Lines

The division of the carriageway into separate lanes for traffic travelling in the same direction on either side of the centre-line or median strip helps to promote travel in proper lanes and curb the meandering tendency of the drivers, thus promoting safety and ensuring maximum capacity Traffic lane lines are broken lines which permit lane changing with caution.



No Overtaking Zone Markings

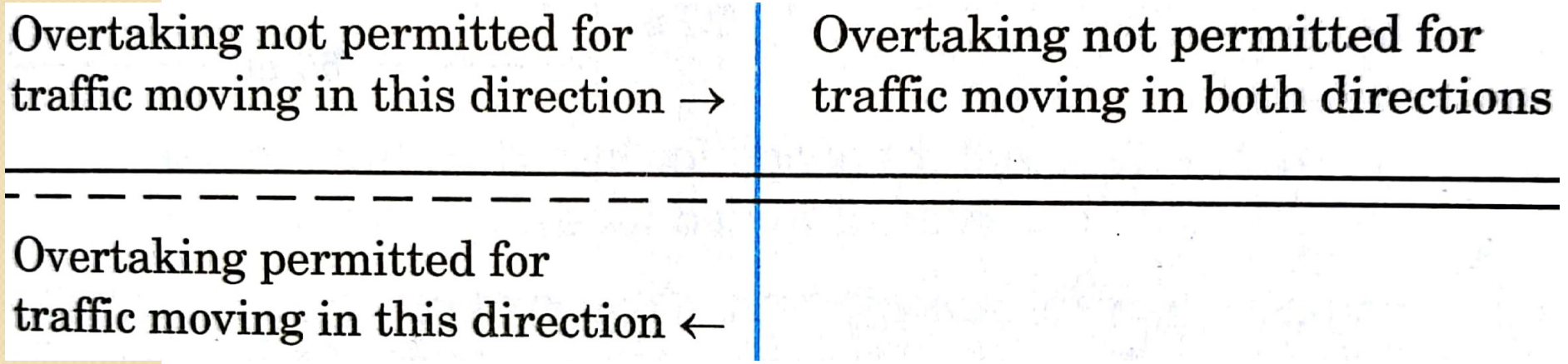
No overtaking zone makings are provided on summit curves, horizontal curves and elsewhere in two and three lane highways where overtaking and passing manoeuvres must be prohibited because of non-availability of safe overtaking sight distances or other hazardous conditions.



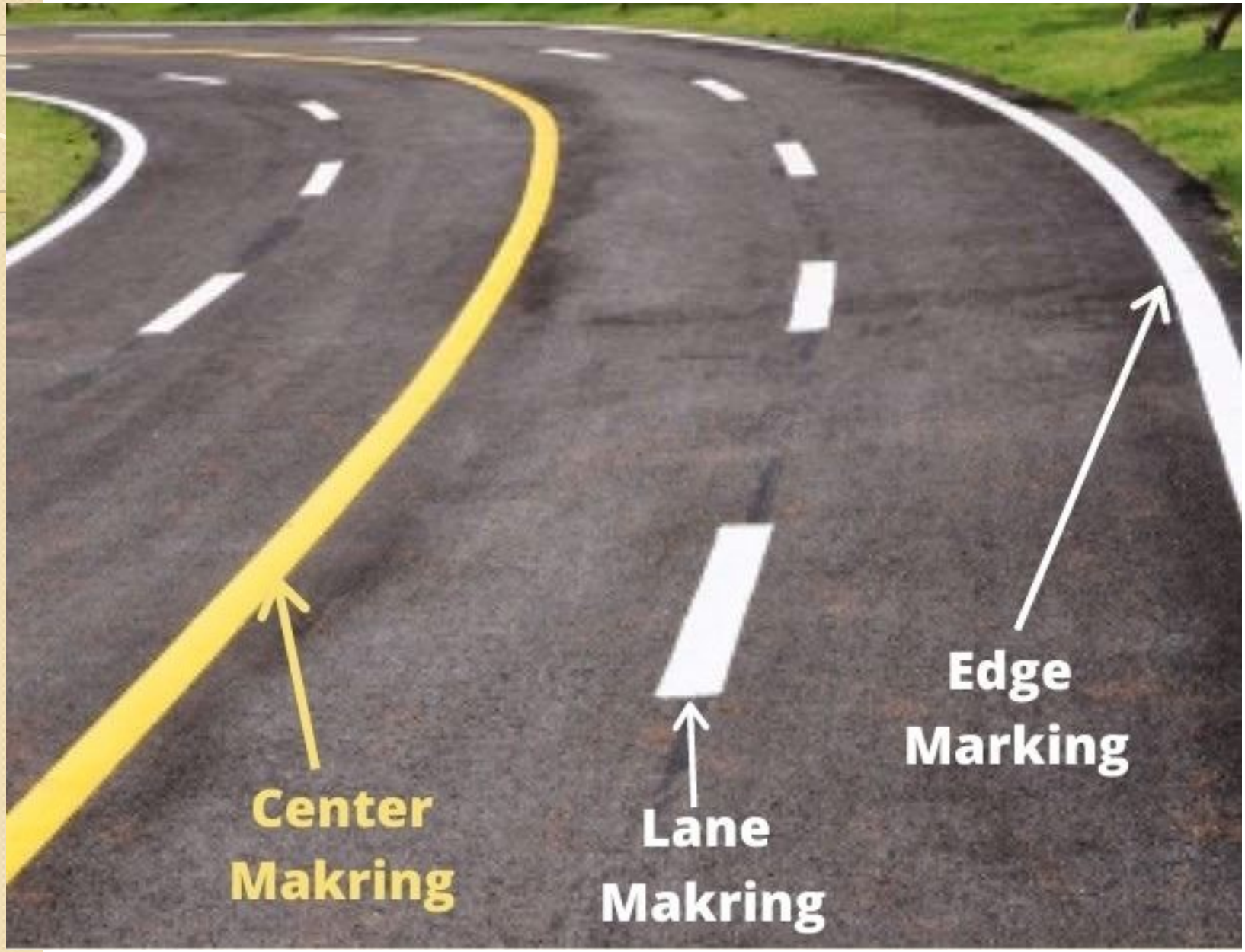
No Overtaking Zone Markings

The marking for a "no overtaking" zone consists of a combination line

- The combination line consists of a double line, the left hand Element of which shall be a solid barrier line.
- The right hand element will be either a normal broken centre line or solid barrier line governing the traffic from the opposite direction. Where a solid barrier line is to the right of the broken line, the overtaking restriction shall apply only to the opposite traffic.
- If both the lines are solid lines, no overtaking is permitted in both the directions.



Pavement Edge Lines



Pavement Edge Lines

- Pavement edge lines are used to indicate the edges of carriageways which have no kerbs.
- They serve as a visual guidance for the drivers, indicating to them the limits up-to which the driver can safely venture.
- They especially are useful during adverse weather and poor visibility.
- Where the paved shoulder is of a lesser structural strength than the main pavement, the edge lines are used to promote travel on the main pavement itself.
- Edge lines are in the form of a single continuous line placed about 15cm from the edge. The width of the line is 15-20 cm.