

**UNIT I RAILWAY PLANNING**  
**TWO MARKS QUESTIONS AND ANSWERS**

**1.What is meant by traffic survey**

The main aim of the traffic survey is to submit the field data to the authority of the project. The traffic report submitted will be subjected to scrutiny to the engineer, Administration and financial levels.

**2.Why a reconnaissance Should be conducted**

From the preliminary data based on the existing survey maps and aerial photographs a few tentative alignments are conducted

For each preliminary data a reconnaissance survey is taken up with a minimum Expenditure and time Such that the important features are noted down

**3.What are the instruments used in the preliminary Survey**

- 1.Plane table
2. Dumpy level
3. Prismatic compass
4. Theodolite
5. Tachometer

**4.What is a track. List the various components of the track**

A complete track of the railway line at which trains run is commonly referred to as permanent way or simply a track

The components of a track are Sleepers, rails, fittings, Fastening, ballast and the formation

**5. List the requirements of an ideal Rails**

- a) The rail section should be economical
- b) the center of gravity Should be at the middle height
- c) Balanced distribution of metal on the cross section
- d) Adequate Stability Against overturning
- e) Enough vertical and lateral stiffness

**6.How a Section of the rail mentioned? What are the Standard section available on broad gauge in Indian railway**

Rail section is designated by its weight per unit length. Section available on broad gauge are 60kg/m with a rail length of about 13.0 meter

**7.What are the different types of joint used in rails**

Two rails are connected by a joint which forms the weakest part of the track .Based on the position joints are classified into Square and Staggered Joints.

Based on the position of the Sleepers, rail joints are the three types. That are Suspended joint, Supported joint and Bridge Join

**8.list the various effects of the creep**

1. Buckling of the track
2. Change of the gap
3. Distortion of points and crossings
4. Difficulty in changing rails
5. Change of Sleeper position

**9.List any three advantages and disadvantages of the Steel Sleepers****Advantages**

1. Less and simple form of fastening
2. Comparatively large life
3. maintenance and adjustment

**Disadvantages**

1. High initial cost
2. Susceptible to corrosion
3. Not suitable for track circuited areas

**10.What are the basic function of the ballast**

1. Provide a level and hard bed
2. Sleeper are held in position
3. Drains the water immediately
4. Avoid the growth of vegetation
5. resists the displacement in all direction

**11.Define Super-Elevation**

Super-elevation or cant is the difference in height between the outer and inner rails in a curve. This is provided in the field by a gradual lifting of the outer rails While maintaining the inner rail in its original level

**12.What is meant by cant gradient**

Cant gradient expresses the increase of the cant in the given length of transition. For Example a gradient of 1 in 1000 represents a cant of 1mm is in every 1000mm of the transition length.

**13.What is an Ideal Alignment?**

Alignment of the track line comprises of fixing the direction and position of the track in the horizontal and vertical planes. An ideal alignment Should meet certain requirements Serves the basic purposes, form of the part of integrated development of the country, Economical in construction and maintenance, provide comfort and safety and have a scenic beauty

**16 MARKS QUESTIONS AND ANSWERS****1. What is meant by gradient and enumerate the various types of gradient with all the details**

Any departure of the track from the level is known gradient or gradient. Reason for the usage in railway track

- 1.To provide a uniform rate of rise or fall as far as possible
- 2.To reach the various stations located at different elevation
3. To reduce the cost of the earthwork.

**Types of gradient**

- 1.Ruling gradient
- 2.Momentum gradient
- 3.Pusher or helper gradient
- 4.Gradient at Station Yard

**1.Ruling gradient**

The ruling gradient on a section may be defined as a gradient which determines the maximum load that the engine can haul on the section

In determination the ruling of the section may be defined as, it will not only be that the survey of the gradient that will come into play but also the length of the gradient and it's position

**In plain terrain = 1 in 150 to 1 in 200**

**In hilly terrain = 1 in 100 to 1 in 150**

**2. Momentum gradient**

The rising gradient is called as momentum gradient and in such cases a steeper grade than the ruling grade can be adopted

The gradient on the section Which through more severe than the ruling gradient, do not determine the maximum load of the terrain but on account of their favorable position on the track

For example in valleys, a falling gradient is usually followed by a rising gradient

**3. Pusher or helper gradient**

If the grade concentrated in a Specific section such as mountainous section. Instead of limiting the terrain load,

It may operationally easy or even economical to run the terrain on the basis of load that can carry in the remaining portion of the track and arrange for an assisting engine is called pusher or helper gradient

**4. Gradient in Station Yard**

The gradient at Station Yard have to be sufficiently low due to the following reason

- (a) To prevent the movement of Standing vehicle on the track due to the effect of the gravity
- (b) To prevent the additional resistance due to the grade on the Standing Vehicle

## Grade Compensation

In order to avoid the resistance beyond the allowable limit, the gradients are reduced on curves. Then the reduction can be named as Grade compensation

### 2. Enumerate the concept of an grade compensation and also explain the basic formulas used in grade compensation

Due to the rigidity of the Wheel base, it is sometimes found on the Curve that the rails are tilted outwards so that the actual gauge is more than the theoretical value

Wheel Base is defines as the distance between the adjoining Axes which are held in a rigid frames

The maximum value of the rigid wheel base in India on B.G Yard and M.G yard are 610cm and 48 cm respectively

To prevent the tendency the gauge of the track is sometimes widened on Sharpe Curves. The amount of widening of gauges depending upon the radius of the Curve, Gauge and rigid Wheel base on the vehicle

The various formulas are Available for finding out the Extra Width of the gauge required on Curves. Incase, the Extra width Should not Exceed 25mm on 1676mm and 1435mm gauges and 16mm on the M.G. Some rules are mentioned as follows

#### Rule 1.

$$D = (B+L^2)*125 / R$$

Where

D= Extra width of the gauge in mm

B=Rigid Wheel base in mm

L=Lap of the Curve

R=Radius of the Curve

Now, the value of lap of flange in mm is obtained by the Following equation

$$L = 2 [(D+H)*h]^{1/2}$$

Where

D= Diameter of the Wheels in mm

H=Depth of the Wheel flange below in mm

#### Rule 2.

Multiple half of the Wheel base by lap of the flange and when divide this result by the radius of the curvature plus half the gauge

Multiple the gradient by 3000 and the result will be the Extra required in mm. The Wheel base, lab of flange, radius of the curvature and the gauge to be Expressed in meters

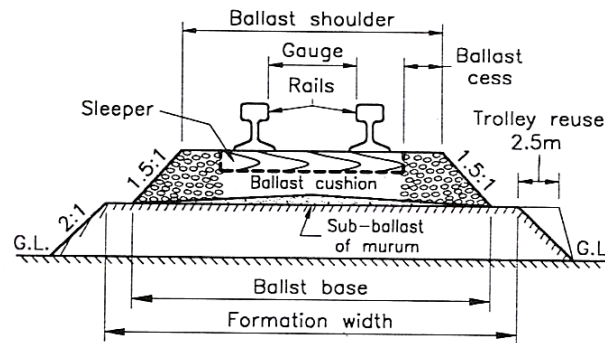
#### Rule 3.

The gauge was widened for a curve of over 3 degrees. But at present the Gauge is not widened up to the curvature of 4.5 degree on the B.G Yard and 5-9 to on M.G in USA the

practice is not to widen the gauge at the rate of 3mm for every 2 degrees of curvature up to a maximum of 19m

### 3. What is meant by permanent way. Explain the basic requirements of an permanent way

The finished completed track of a railway line is commonly known as an permanent way. It is essentially consisting of the following three points



Typical Cross-section of a Permanent Way on Embankment.

That are

1. Rails
2. Sleepers
3. Ballast

The gauge of the track Should be uniform and there Should not be varying gauges. There Should be minimum friction between the Wheel of rolling Stocks and the rails

The gradient provided on the permanent way Should be even and uniform. The design of a permanent way Should be such that the load of the terrain is uniformly distributed over it.

The precautions Should be taken to avoid the occurrences of creep. The rail joint Should be properly designed and maintained

The alignment of the track Should be free from kinks or irregularities. The Special attention Should be given on the design of permanent way on curves

It Should possess Sufficient lateral rigidity and vertical Stiffness. The overall Construction of the permanent way Should be Such that it requires minimum of maintenance

### Requirements of an Ideal Permanent Way

1. The gauge Should be correct and uniform
2. The alignment Should be correct and it Should be free from kinks and irregularities
3. The radii and super elevation and curves Should be properly designed and maintained
4. Drainage System must be performed for enhancing Safety and durability of the track
5. The various components of the track, i.e the rails, fittings, Sleepers, Ballast and formation must be fully satisfy the requirements for Which they have been provided

6. There Should be adequate provision for easy renewals and replacement
7. The track Structure Should be Strong, low initial cost as well as maintenance cost
8. The rail Should be in proper level. In a Straight track ,two rails are must be at the same level.
9. The outer rails should be proper transition at the junction of a straight and a curve

#### **4. What is meant by joints in rails. Explain the various types of joints in railway**

Rail joints are necessary to hold together the adjoining ends of the rails in the correct position, both in the horizontal and vertical planes.

The Strength of the rail joint is only 50% of the Strength of the rail

#### **Requirement of an Ideal Joint**

An ideal or perfect rail Joints is the one Which provides the Same Strength and the Stiffness as the rail Section of the Track

The rail Joint Should be provide Enough Space for Expansion and the Contraction to the Account for the effect of the temperature variables

It Should not allow the rails ends to get battered in any case. The rail joint Should be as Strong and Stiff as the rail Itself

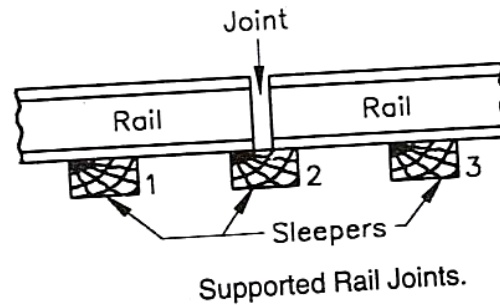
#### **Types of joints**

- 1.Supported rail joint
- 2.Suspended rail joint
- 3.Bridge joint
- 4.Welded rail joint
- 5.Staggered or Broken rail joint
- 6.Square or Even joint
- 7.Base joint
- 8.Compromise joint
- 9.Insulating joint
- 10.Expansion joint

#### **1.Supported rail joint**

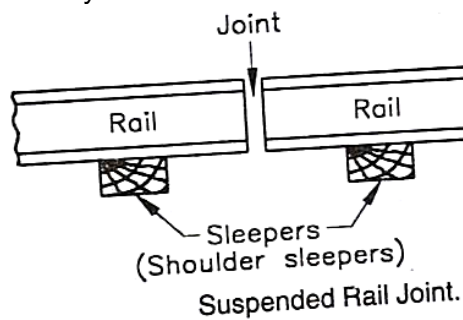
The rail ends rest on the single Sleeper is called joint Sleeper and it is also called Supported joint. these Sleepers are Supported with a long fish plate. i.e. combined and Suspended joint is most commonly objectionable

Undue load comes on central Sleepers and in turn the loose Central Sleepers converts this joint into a weak Joint



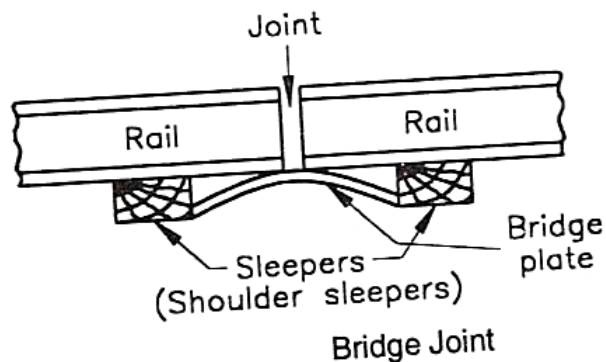
## 2.Suspended rail joint

When rail ends are projected beyond Sleepers may be called Should Sleepers. It is termed as suspended. The type of joint is generally used timber and Steel rough Sleeper on Indian and foreign railways



## 3.Bridge joint

When a rail ends are projected beyond as in case Suspended joint and they are connected by a flat or corrugated plate is called "bridge joint"

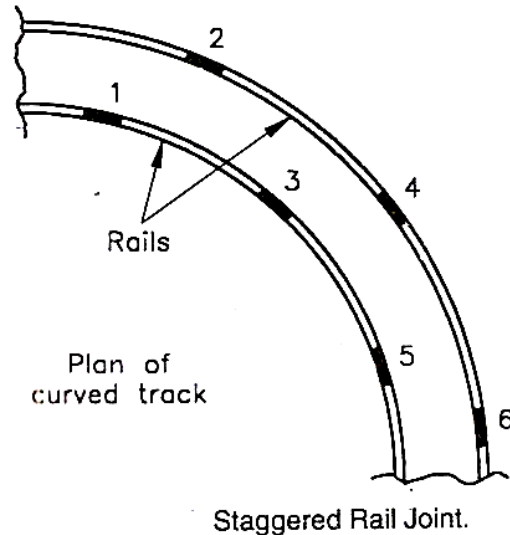


## 4.Welded rail joint

These are the best joints as they fulfill nearly all the requirement of an ideal or perfect joint and it will be discussed in next articles

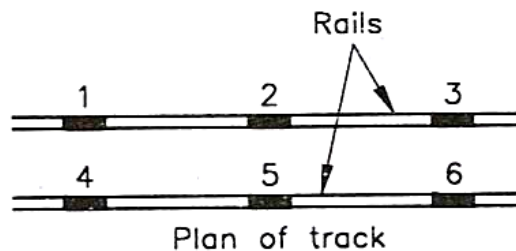
### 5. Staggered or Broken rail joint

In this position of joints on railway on railway track is in the basis of it's nomenclature in this type of joint, the joints on railways track are not directly opposite to the joint of the other rail tracks. this the required definition for the term Broken rail joint



### 6. Square or Even joint

In this also the position of the railway track joint is in the basis of it's nomenclature , the joint of one rail track are directly opposite to the joint in the other railway track. This types are generally used on Straight lines



Square or Even Rail Joint.

### 7. Base joint

In this similar to the Bridge joint with the difference that inner fish plate are of bar type and the other fish plate are of the Special angle types, due to the complication these are not commonly used

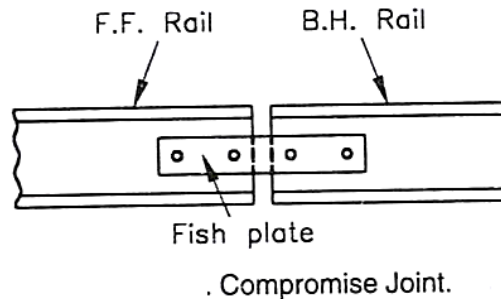
### 8. Compromise joint

Two different rail section are required be joined together, it is done by means of fishplate and it is joint termed as compromise joints



### 9. Insulating joint

When insulating medium is inserted in a rail joint to Stop the flow of current beyond the track circuited part is called insulated joint



5. A 5° curve diverges from a 3° main curve in reverse direction in the layout of B.G Yard. If the Speed on the branch line is restricted 35KMPH .determine the restricted Speed on the main Curve

#### Given Data

$$V = 35\text{kmph}$$

#### Step 1: To find Equilibrium Super-Elevation

$$e = \frac{GV^2}{1.27R}$$

Where

$$V = 35 \text{ KMPH}$$

$$G = 1.676 \text{ for B.G Yard}$$

$$R = \frac{1720}{5}$$

Then We can get

$$e = \frac{1.676 * 35 * 35}{1.27} * \frac{5}{1720}$$

$$e = 4.71 \text{ cm}$$

#### Step2: To find the negative Can't

$$= \text{equilibrium cant} - \text{can't deficiency}$$

$$= (4.71 - 7.60) \text{ cm}$$

$$= 2.89 \text{ cm}$$

#### Note

Can't deficiency = 7.60 (for B.G Yards)

**Step3: To find negative can't**

Negative can't = maximum permissible Super-elevation on the main line  
= 2.89 cm

**Step 4: To find theoretical Super-elevation**

Theoretical Super-elevation Provided on the main line  
= 2.89+7.60 cm  
=10.49 cm

**Step 5: To find the Speed on the main line**

$$e = \frac{1.676 * V^2}{1.27} * \frac{3}{1720}$$

$$10.49 = \frac{1.676 * V^2}{1.27} * \frac{3}{1720}$$

$$V^2 = 4550 \text{ KMPH}$$

$$V = 67.40 \text{ KMPH}$$

6. If A 8° curved track diverges from a main track of 5° in an opposite direction in the layout of B.G Yard. Calculate the Super-elevation and Speed of a branch line. If the maximum Speed permitted on the main line is 45 KMPH

**Given Data**

$$V = 45 \text{ KMPH}$$

**Step 1: To find Equilibrium Super-Elevation**

$$e = \frac{GV^2}{1.27R}$$

Where

$$V = 45 \text{ KMPH}$$

$$G = 1.676 \text{ for B.G Yard}$$

$$R = \frac{1720}{5}$$

Then We can get

$$e = \frac{1.676 * 45 * 45}{1.27} * \frac{5}{1720}$$

$$e = 7.78 \text{ cm}$$

**Step2:TofindthenegativeCan't**

$$\begin{aligned}
 &= \text{equilibrium cant} - \text{cant deficiency} \\
 &= (7.78 - 7.60) \text{ cm} \\
 &= 0.18 \text{ cm}
 \end{aligned}$$

**Note**

**Can't deficiency= 7.60 (for B.G Yards)**

**Step3:Tofindnegativecant**

$$\begin{aligned}
 \text{Negative cant} &= \text{maximum permissible Super-elevation on the main line} \\
 &= - 0.18 \text{ cm}
 \end{aligned}$$

**Step 4: To find theoretical Super-elevation**

$$\begin{aligned}
 \text{Theoretical Super-elevation Provided on the main line} \\
 &= -0.18 + 7.60 \text{ cm} \\
 &= 7.42 \text{ cm}
 \end{aligned}$$

**Step 5: To find the Speed on the main line**

$$\begin{aligned}
 e &= \frac{1.676 * V^2}{1.27} * \frac{8}{1720} \\
 7.12 &= \frac{1.676 * V^2}{1.27} * \frac{8}{1720} \\
 V^2 &= 1210 \text{ KMPH}
 \end{aligned}$$

$$V = 34.70 \text{ KMPH}$$

**7. Explain the various types of conventional and modern methods of Survey used in railway. Give all in detail**

**(1) Surveys for track alignments**

The entire survey work to be conducted may be divided into the following parts:

- 1) Traffic survey
- 2) Reconnaissance survey
- 3) Preliminary survey
- 4) Location survey
- 5) Modern methods survey

**Traffic survey**

The main aim of traffic survey is to submit the field data to the authority judge the suitability of the project.

- 1) Particulars of villages and towns within about 20km from the proposed track along with the population.
- 2) Location of existing industries and the potential growth of them.
- 3) Volume of traffic in terms of passengers and goods wagons.
- 4) Availability of export based natural resources like, iron, coal, etc.

### **Reconnaissance survey**

**Reconnaissance survey should furnish the following details:**

- 1) Topographical features of the area.
- 2) Existing water resources along with their discharge details .
- 3) Natural features like ridges, valley, forest, etc.
- 4) Geographical and soil classification.

### **Preliminary survey:**

**Steps involved in this survey:**

- 1) Construction pillar is erected to mark the starting point.
- 2) A fly leveling is done to connect the starting point and a nearby GTS bench mark.
- 3) A compass survey is conducted along the alignment to prepare a route survey map covering about 100m on either side of the alignment.
- 4) A cross sectional leveling is done at regular intervals say 100m.

**From the field data collected as described in the above steps the following drawings prepares:**

- 1) Longitudinal section
- 2) Typical cross section
- 3) Profile of crossings with rivers, streams, canals, and rails roads crossings.
- 4) Maximum and minimum width of track.

**With the maximum required drawings, a comparative statement bringing out the following details are prepared:**

- 1) Length of the track
- 2) Gradient details both ruling and maximum
- 3) Sub grade and formation cost
- 4) General details

### **Location survey**

**The transfer is done by adopting the following steps:**

- 1) 15cm pegs at 30m intervals are driven
- 2) Every tenth peg is marked by 60cm pegs

- 3) Pegs are also driven to demarcate the center line of the track
- 4) At every km length masonry pillars are constructed which serve as bench marks.

### **Modern surveying instruments and methods:**

Some of these survey aids and techniques are the following:

- 1) Remote sensing data
- 2) Aerial photographs
- 3) Electro - magnetic distance measurement
- 4) Digital terrain modeling
- 5) Geographic information system

### **Remote sensing data**

Remote sensing data or satellite imagery provides a bird's eye view of large areas. Indian space research organization(ISRO) provides such maps which are up dated once a month.

Ground conditioned can be well defined with a combination of satellite images and topographical maps. Using these the best corridor is chosen for further analysis. Satellite data maps are of immense use wherein no adequate data could be got from topography.

### **Aerial photographs**

Aerial photogrammetric is that type of photography wherein the photographs are taken by cameras mounted on an aircraft flying over the area. Stereo photographs are taken is another system which is another system which is a recent development. In this system photographs are taken in pairs at the ends of a base line of known length and direction.

Aerial photographs of the entire country are taken once in every 3 to 5 years which are available with survey of India. These photographs are further used to develop details of the chosen corridor. The photographs are very useful to find tunnel locations stations sites, and identify correctly the river crossings, etc.

### **Electro magnetic distance measurements (EDM)**

Electro magnetic distance measurements is a general term used collectively in the measurements of distance applying electronic methods. Depending on the type of carrier wave used, EDM instruments may be classified as (1)microwave instruments (2)visible light instruments and (3)infrared instruments.

These instruments are very light and compact and can mounted with theodolite. Thus these instruments enable to measure angles and distances simultaneously.

### **Digital terrain modeling(DTM)**

Digital terrain modeling is a computer aided design. Using such models the most economical alignment may be obtained. After the alignment decision, ground stations are fixed in the form of mutually visible points.

All the other details, for the preliminary survey can be worked out with the help of contours maps, photogrammetric plotted sheets and other computer aids.

### Geographical information system (GIS)

GIS is new technology which covers a number of fields such as remote sensing, cartography, surveying and photography.

### 8. Enumerate the various types of rail sections used in railway. Give all in details

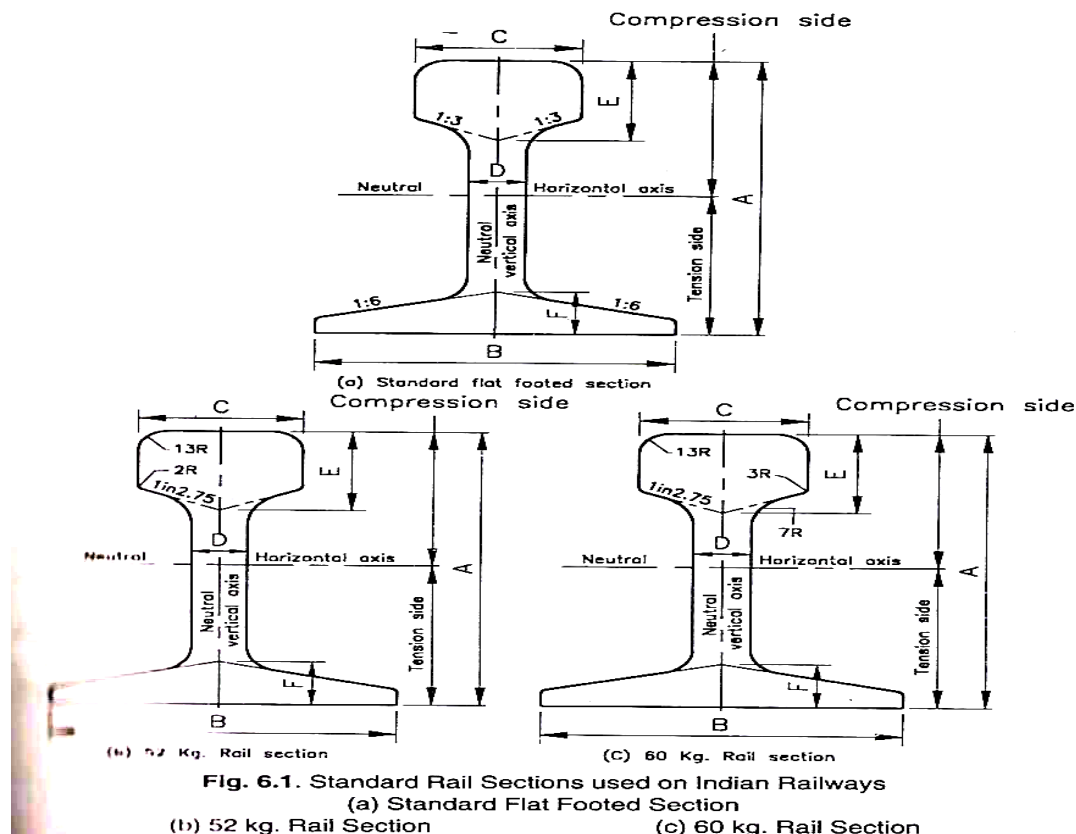
Rails are the prime members of the permanent way which are laid in two parallel lines to provides a continuous, level surface for the movement of train. In order to withstand the stresses they are made of high carbon steel.

#### Functions of rails :

- 1) Basically it is to provide a continuous and smooth surface with an acceptable gradient for the movement of trains.
- 2) Rails to bear the stresses developed due to heavy vertical loads, stresses due to lateral thrust, breaking stresses and thermal stresses.

#### Types of rails:

In general a rail section should be such that every part of the material is stressed to the maximum allowable stresses. Such a section only will ensure an economical section.



Double headed(DH) rail sections were the first rails used. It was felt that once one head wooden out the other one could e used. However it was found that due to the impact of the wheels lower surface in contact with the chairs got dented. This lead to the development of bull headed rail which had one head larger than the other. This was found to have a serious drawback that chairs were required for fixing the rails to the sleepers.

Thus a flat-footed (FF) rail with an inverted T-type was developed. This type could be fixed directly to the sleepers with the help of spikes. This type of rail is adopted all over the world. Compared to BH-type, the flat footed rails have the following advantages:

- 1) provides better rigidity and stiffness to resist vertical and lateral forces.
- 2) points and crossings are simpler.

#### **Requirements of an ideal rail:**

- 1) The rail section should be economical.
- 2) The rail should provide adequate lateral stiffness and vertical stiffness.

#### **Rails section and length:**

##### **Section;**

It is designated by weight per unit length.

- 1) Maximum axial load
- 2) Maximum permissible speed
- 3) Depth of ballast cushion
- 4) Type and spacing of sleepers
- 5) Gauge of the track

#### **Other relevant factors**

The standard rail sections used in Indian railways are 90R,75R,60R and 50R. These rails sections are based on BSS and are designated in FPS units whose dimensions and weight are now converted into metric units. The letter R stands for revised British specifications.

Two heavier rails sections 60 kg and 52 kg are recently introduced and are designated in metric units. Thus 60kg/m rail denotes that it has a weight of 60kg per meter length.

##### **Length:**

In general longer the rail, lesser the number of joints and fittings, lesser the cost of construction and maintenance. However the length of a rail is restricted due to the following factors:

- 1) Longer rails are difficult to transport
- 2) Manufacture is difficult
- 3) Difficulties in handling wide expansion joints
- 4) Large internal stresses

**9. Enumerate the various types of Sleepers and its advantages and disadvantages with all the details**

Sleepers are the piece of shaped material placed to support the rails in transverse direction. Sleepers play a vital role in the permanent way to transmit the wheel load from the rails on to the ballast.

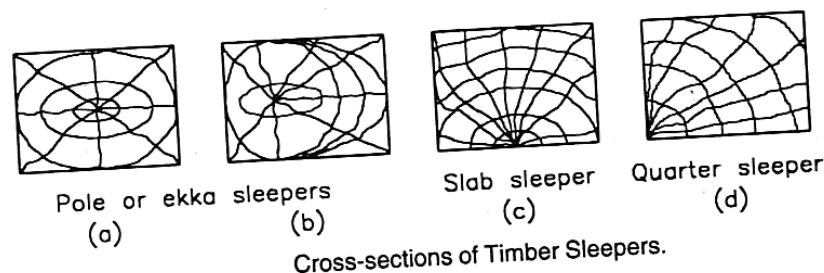
**Types of sleepers:**

**Sleepers which are in used in Indian railway are**

- 1) Timber sleepers
- 2) Steel sleepers
- 3) Cast iron sleepers
- 4) Concrete sleepers

**Timber sleepers:**

Timber sleepers have been in use ever since the inventions of railways. They are universally accepted material for sleepers as they fulfill almost all the requirements an ideal sleeper.



**Advantages:**

- 1) Useful for heavy loads and high speeds
- 2) Normally long life as long as 12 years
- 3) Normal sizes for all gauges can be made available
- 4) Easy to fix rails on the timber sleeper using spikes

**Disadvantages**

- 1) short life due to wear decay and attack by vermin
- 2) hard to maintain gauge
- 3) scrap value is very less

**steel sleepers:**

because of the great shortage of wooded sleepers, Indian railways have started using steel sleepers. It is mainly used in bridge girders.





- 1) less and simple form of fastenings
- 2) comparatively long life
- 3) maintenance and adjustment of gauge are easy

- 1) High initial cost
- 2) Susceptible to corrosion
- 3) Not suitable for track circuited areas
- 4) During service formation of cracks on rail seats

It may be of pot type or plate type.

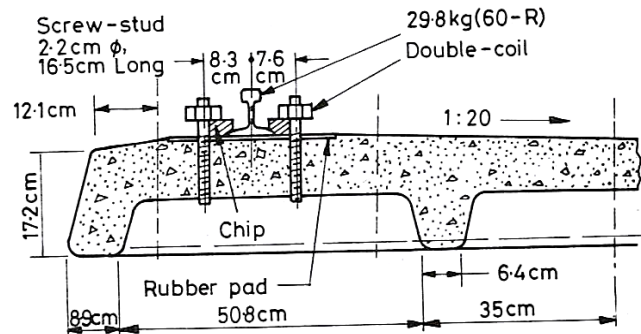
- 1) Corrosion resistant
- 2) High scrap value

- 1) Requires a large number of fittings.
- 2) As there is a possibility of tie bar to bend gauge maintenance is difficult

- 1) Block type RCC sleepers connected by a steel tie bar
- 2) Pre tensioned or post tensioned pre stressed concrete sleepers
- 3) Pre-stressed concrete block and steel tie bar

**Advantages:**

- 1) They can be used in track circuited areas
- 2) Comparatively long life

**Disadvantages:**

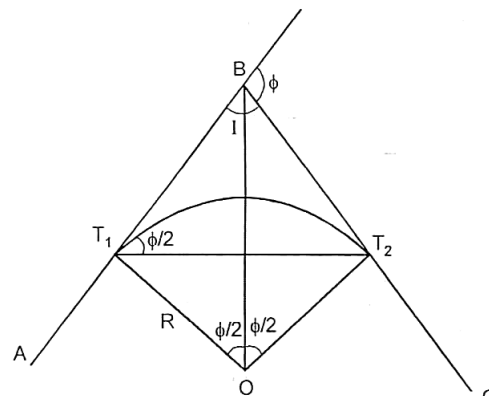
- 1) Difficult to handle and lay
- 2) Heavily damaged during derailment
- 3) No scrap value

**10. Explain the various types of horizontal curves. Give all in detail with neat Sketch**

- 1) Simple curve
- 2) Compound curve
- 3) Reverse curve
- 4) Transition curve

**Simple curve:**

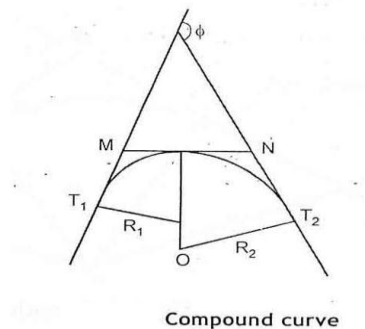
It is a curve consists of a single arc with a constant radius connecting the two straights or tangents



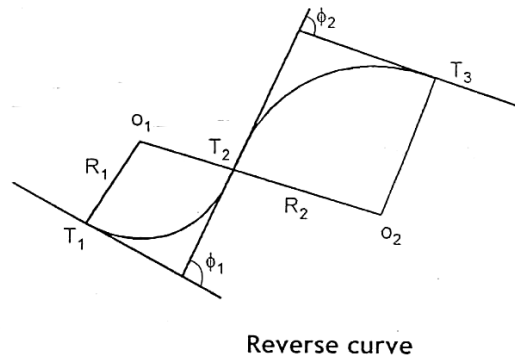
Simple circular curve

**Compound curve:**

When a curve consists of more than one radius connecting two intersecting straight lines it is called a compound curve.

**Reverse curve:**

When two curves of different or equal radii are bending in opposite directions then it is called a reverse curve. Reverse curves have one common tangent.

**Transition curve:**

A curve having a gradual varying is called a transition curve. For example a curve with infinite radius in the beginning and varying gradually to a finite radius.

