UNIT IV – RAILWAY PLANNING (PART-A)

1. **List the various gauges used in Indian Railways?** (May/ June 2012)

   a) Broad Gauge (B.G.) – 1.67 mtrs.

   b) Meter Gauge (M.G.) – 1.00 mtrs.

   c) Narrow Gauge (N.G.) – 0.762 mtrs.

   d) Light Gauge or Freeder Track Gauge –0.610 mtrs.

2. **Give the various functions of rails?** (May/ June 2011)

1. Rails provide a hard, smooth and unchanging surface for passage of heavy moving loads with a minimum friction between the steel rails and steel wheels.

2. Rails bear the stresses developed due to heavy vertical loads, lateral and barking forces and thermal stresses.

3. The rail material is such that it gives minimum wear to avoid replacement charges and failures of rails due to wear.

3. **Define obligatory point.** (May/ June 2012)

Obligatory points are controlling points which govern the alignment of railway tracks. Some important obligatory points are; (i) Important towns and cities (ii) Shortest width and permanent path of rivers (iii) Hill passess.

4. **What are the disadvantages of "Coning of wheels**"? (Nov/ Dec 2012)

   The disadvantages are;

   - ✓ Pressure of horizontal components near the inner edge of rails has a tendency to accelerate wearing of rails.
   - ✓ It tends to turn rails outwardly and consequently, the gauge is widened.
   - ✓ Cause damages to outer edge of rails, if no base plates are provided.

5. **What is meant by cant deficiency?** (Nov /Dec 2012)

   The equilibrium cant is provided on the basis of the average speed of different trains on the track. This equilibrium cant or super elevation will fall short of that required for speed higher than average speed. This storage of cant is called cant deficiency.

6. **What are the various types of the Gradients that are adopted in laying a railway track?** (May /June 2013)

(1) Ruling gradients

(2) Momentum gradients

(3) Pusher gradients

(4) Gradients in station yards.

7. **On a B.G track of 4° curve, equilibrium cant is provided for a speed of 60 km/hr. Calculate**

(i) Value of equilibrium cant

(ii) **Maximum speed allowing maximum deficiency** (May /June 2013)

Given data:

Degree of curve = 4°

Nominal Gauge (B.G) = 1750 mm

Speed of train = 60 km/hr

Solution

Radius of curvature R = 1750/D = 1750/4 = 437.5 m

Equilibrium cant $e = \frac{GV^2}{127R}$ = 1750 x 60^2/127x 437.5= 113.39 mm

8. **List the uses of Remote sensing in route alignments.** (Nov / Dec 2013)

Gives a birds' eye view of a large areas. Ground condition can be defined with a combination of satellite images and topographic maps.

9. **Mention the functions of formation** (Nov / Dec 2013)

Formation is the base over which the ballast is spread. Sometimes the natural ground may not meet the requirements for placing ballast. In such cases a raises bank is constructed over the natural ground which is called the embankment. Sometimes, the formation below the natural ground is made which is called cutting.

10. What is creep? How is it prevented? (Nov/ Dec 2014)

Creep is the longitudinal movement of rails in a track.It occurs due to several reasons The effect of creep tends to dig the track. It is prevented by providing sufficient ballast which could hold the rails.

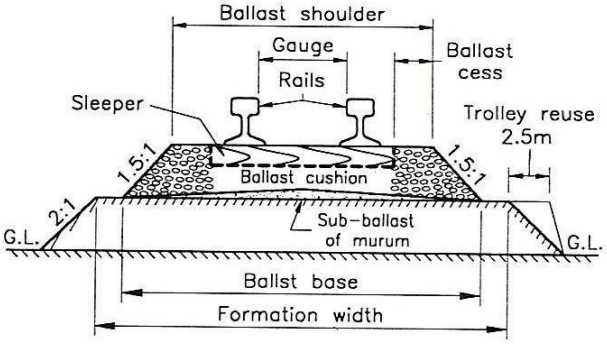
11. What do you mean by sleeper density? (Nov/ Dec 2014)

Sleeper density is defined as the number per rail length. It is specified as

M+ x where M is the length of the rail in metres

X is the number that varies

12. Sketch the cross section of a permanent way (May/ June 2015)



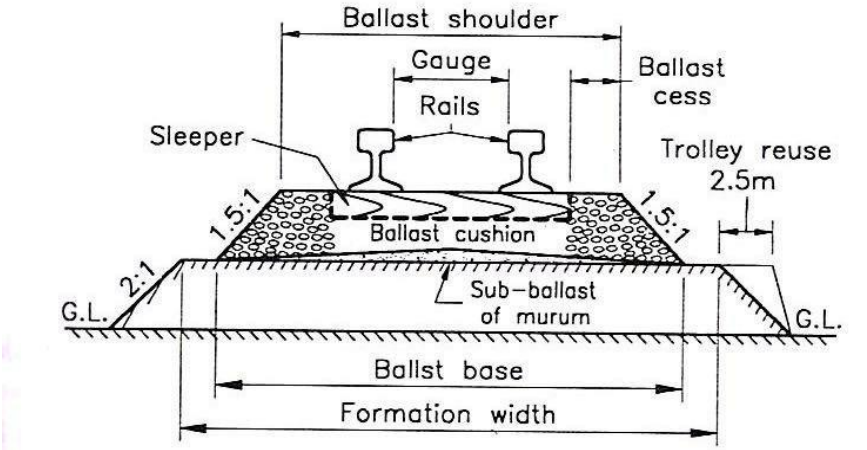
Typical Cross-section of a Permanent Way on Embankment.

PART B

1. Explain the permanent way components with neat sketch. (May / June2013)

The combination of rails, fitted on sleepers & resting on ballast & subgrade is called as railway track or permanent track something temporary tracks.

In permanent way, the rails are joined in series by fish plate & bolts and then they are fixed to sleeper by different types of fastening.



Typical Cross-section of a Permanent Way on Embankment.

Permanent way

Rails:

Rails are unsymmetrical I sections,made up of steel.They are laid along two parallel lines over sleepers.Rails are joined longitudinally by fish plate or by welding.These are placed end to end to provide a continuous & level surface for trains to move.

Types of rails.

1. Double headed rails.
2. Bull headed rails
3. Flat footed rails.

Functions:

1. Act as gider and transmit load to large area of formation through sleepers and ballast..

2. It should be an economic section consistent with strength stiffness and durability

3. The head of rail should have adequate depth to allow for allow for vertical wear.

4. Web should be sufficiently thick to withstand stresses.

Sleepers.

Sleepers are members generally laid transverse to the rails on which the rails are supported and fixed, to transfer the loads from rails to the ballast and subgrade below.

Functions of sleepers:

Sleepers perform the following functions,

1. To hold the rails to correct gauge.

2. To hold the rails in proper level or transverse tilt i.e., level in turnouts, cross-overs,

3. To act an elastic medium between the ballast and rails to absorb the blows and vibrations of moving loads.

4. To distribute the loads from the rails to index area of ballast underlying it or to the girders in case of bridges.

5. They also provide means to rectify track geometry during service life.

Ballast: layer of material which is place below and packed around sleepers for distribution of load from sleepers to the formation.

Functions:

(i) Provides level and hard bed for sleepers

(ii) To hold sleepers while passage of trains

(iii) Forms a load distribution medium between sleepers and formation

(iv) Provides elasticity and resilience to the track for proper riding comfort.

(v) Acts a draining of water.

(vi) Resists lateral, longitudinal and vertical displacements of the track

Types:

(i) Broken stone (ii) Gravel (iii) coal or ash cinders

(ii) (iv) Sand (v) Moorum (vi) Selected earths

2. **If a 8° curve track diverges from main curve of 5° in an opposite direction in the layout of a B G yard. Calculate the super elevation and speed on branch line, if the maximum speed permitted on the main line is 45 kmph. (Nov / Dec 2010) (8 mark)**

Solution:

Radius of main curve,

$$R_m = \frac{1719}{8} = 214.9 \text{ m}$$

Radius of branch curve,

$$R_b = \frac{1719}{5} = 348.8 \text{ m}$$

Super elevation of main line,

$$e_m = 1.315 \frac{V^2}{R}$$

$$e_m = \frac{1.315 \times 45^2}{214.9}$$

$$= 12.39 \text{ cm}$$

Assume cant deficiency as 76 mm = 7.6 cm

Theoretical super elevation on main line = Cant deficiency + change in super elevation (c_h)

$$12.39 = 7.6 + e_{ch}$$

$$e_{ch} = 12.39 - 7.60 = 4.79 \text{ cm}$$

$$e_{ch} = e_b - 7.6$$

$$-4.79 = e_b - 7.6$$

i.e., $e_b = 2.81$ cm

Super elevation of branch = 2.81 cm

Speed of branch line $= \sqrt{\frac{e_b \times R}{1.315}}$

= 27.10 kmph

Speed of branch line = 27.10 kmph

3. **What are the requirements of an ideal rail joint? Explain the various rail joints used in railways with neat sketches. (Nov / Dec 2013)**

Requirements of Ideal Rail Joints:

Two rails are connected by a joint which forms the weakest part of the track.

Different fastenings are used to make this joint as much efficient as possible. The characteristics of a good ideal rail joint are as follows:

- The rail joint should hold the two ends of rails as nearly as possible and should be at same level in a straight line.
- It should have the same strength and stiffness with rails.
- It should provide space for expansion and contraction of rails due to changes in temperature.
- It should be arranged in such a way that any rail while repair.
- It should be durable, cheap in initial cost and maintenance.
- It should provide sufficient elasticity to absorb vibrations and shocks.
- It should provide resistance to the longitudinal forces developed due to acceleration, deceleration.
- The joint fittings should be simple and universal type so that iit can be used for all types of sleepers.

Types of Rail joints:

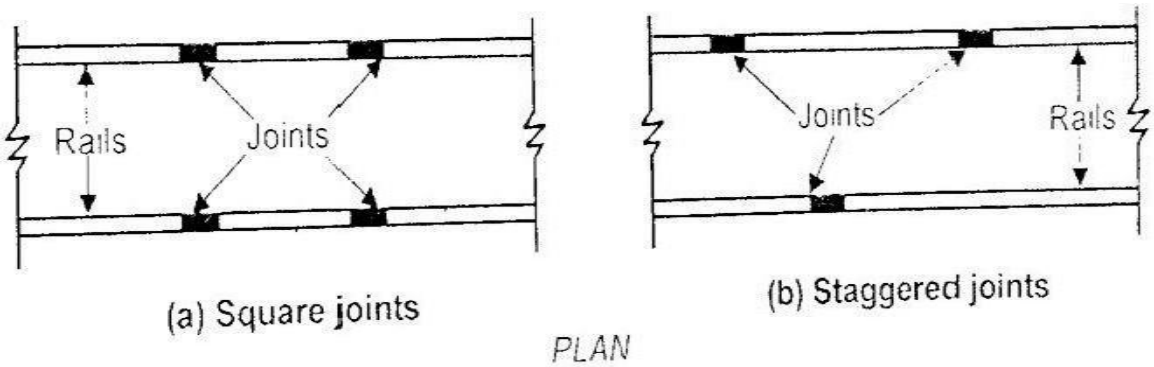
Depending upon the position of joints or sleepers, rails are classified as

(1) According to position of joints:

- Square joints
- Staggered joints

Square joint: When a joint in one rail is exactly opposite to the joint in the parallel rail, it is known as a square joint and it is very common in straight track.

Staggered joint: When a joint in one rail is exactly opposite to the centre of the parallel rail length, it is known as a staggered joint.



(2) According to position of sleepers:

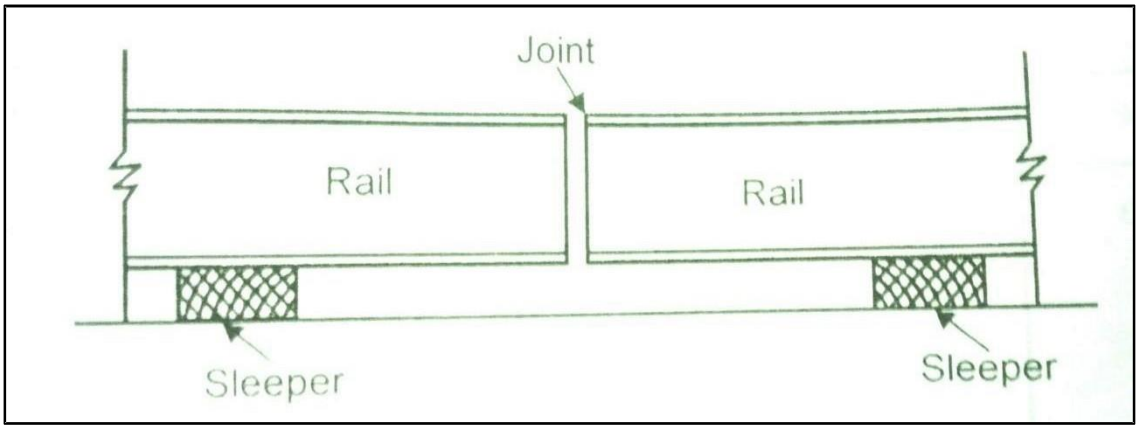
- Suspended joints
- Supported joints
- Bridge joints

Suspended joint:

The rail joint, when placed at the centre of two consecutive sleepers is known as suspended joint.

In this type of joint, load will be equally distributed on sleepers and also when joint is depressed, rail ends are pressed down evenly.

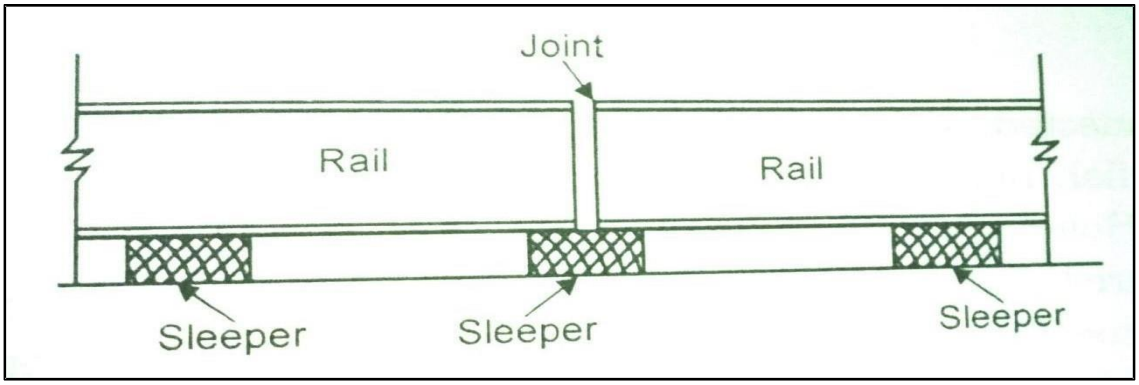
It is most commonly adopted since it provides greater elasticity.



Supported joint:

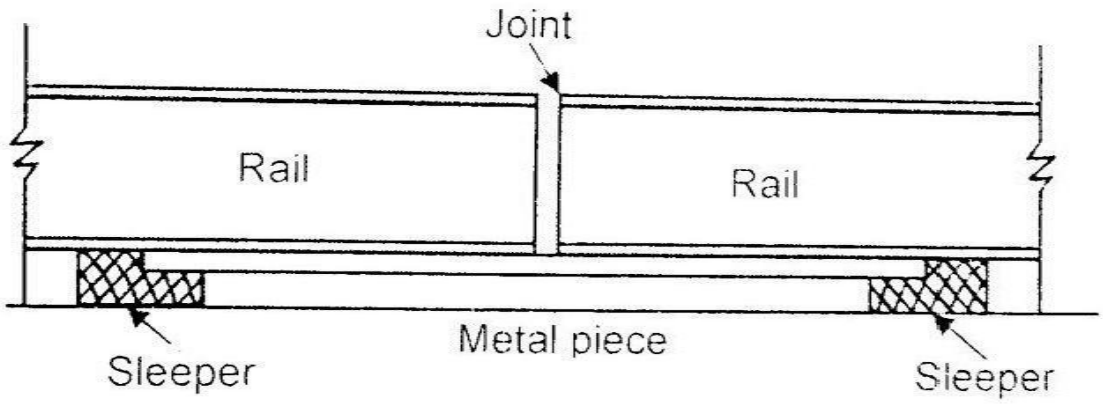
When the sleeper is placed exactly below the rail joint, it is known as supported joint.

These types of joints are not used at present.



Bridge joint:

When a suspended joint is bridged by a metal piece so as to connect the ends of the two rails and thereby preventing bending stress in the rail.



4. Briefly explain the modern methods of surveys for track alignment. (Apr / May 2011) (8 mark)

Introduction:

Railway planning needs precious and cost effective methods of surveying. Modern methods like GIS, GPS etc were incorporated for effective surveying.

Different features :

- Survey of India map
- Village map
- Ward / block map
- Updating of map

Application of modern survey equipments for railway alignment surveying:

i. Global positioning system (GPS)

It measures co-ordinates of any point anywhere on the globe. This survey is possible at any weather conditions and a minimum of 24 no. of satellites at a distance of 10,000 km from earth's surface will be involved in surveying.

ii. Electronic distance meter (EDM)

EDM works on electromagnetic waves travel between the given origin and

destination. Typical EDM can measure a distance upto 5 – 10 km.

iii. Total station (TS)

It works on same procedure of EDM but it also measures the angle along with the distance. It is more accurate than EDM and has a least count of one second. Also reduces human interventions and measurements.

iv. Geographical Information systems (GIS)

It is a system of software and hardware. It is used to prepare highway, railway alignment. Techniques of GIS such as buffering and network analysis are widely applied in highway and railway planning.

v. Remote sensing data products

a. Aerial photos
b. Satellite imageries
c. High resolution satellite imageries

Merits of modern methods:

- Rapid process of surveying
- Optimum resource planning
- Acceleration construction programming
- More accuracy
- Less time consuming
- Updating and correction of old map will be much easier.

Demerits of modern methods:

- Applies only for skilled workers
- Exact boundaries cannot be determined on satellite imageries
- Procurement of equipment/systems such as GPS, EDM, GIS, Stereo potters are ost intensive.

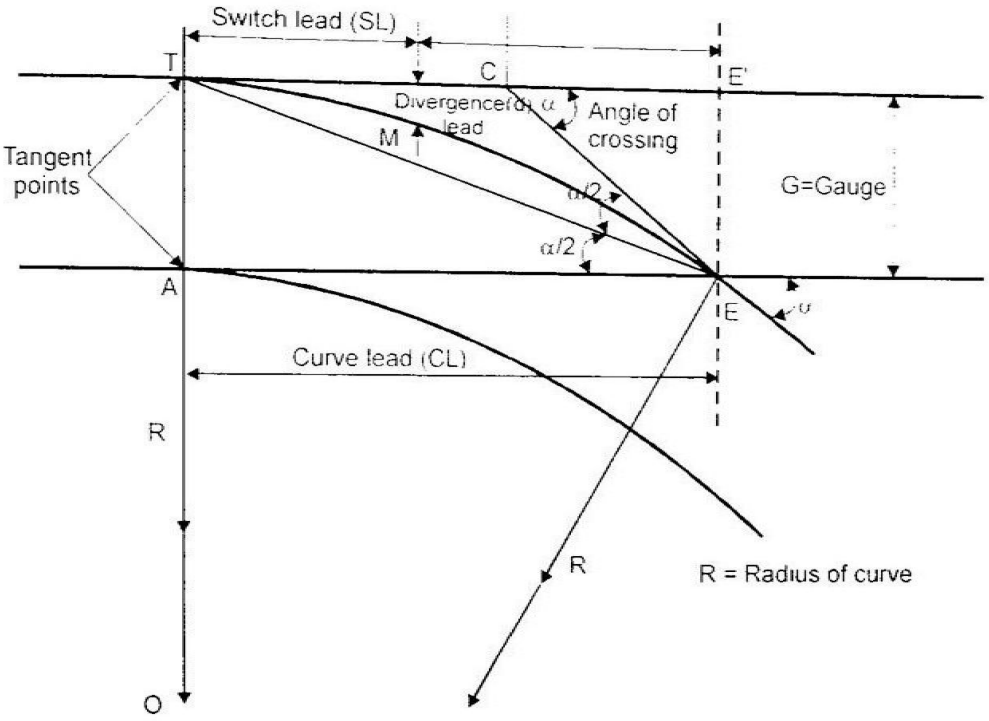
5. Determine all the elements of a turnout, when the following data is given:

Heel divergence = 13.65 cm

Angle of switch = 1 34' 27"

Gauge = 1.676 m

Number of crossing = 8.5 (Nov / Dec 2012)



Solution:

Number of crossing = 8.5

Gauge of track (G) = AT = EE' = 1.676 m

Angle of crossing (α) = = = $\cot^{-1}$ (8.5)

(i) Curve head, CL

CL = 2 GN

= 2 x 1.676 x 8.5

= **28.49 m**

Heel divergence (d) = 13.65 m

= 0.1365 m

(iii) Radius of curve (R)

R = 1.54 + 24N2

= 1.54 + 248.52

= **1735.54 m**

(iv) Switch Lead (SL)

SL = $\sqrt{2}\, x\, 1735.54$ - 0.137^2

= **58.91**

(v) Lead Crossing (L)

L = G cot α/2 - $\sqrt{2Rd}$ - d^2

= **1.676 x cot α/2 – 58.91**

6. Illustrate with neat sketches a right hand or a left hand turn out, points and crossings and explain their working principles. (Apr / May 2011)

Turnout:

A turnout is a complete set of points and crossings along with lead rails which enables a rolling stock to be diverted from one track to another.

Important components:

- A pair of points or switches
- A pair of stock rail
- Check rail
- Lead rail
- Stretcher bar
- Crossings or 'V' piece
- Wing rail

Points or Switches:

Types:

Stub switch: No separate tongue rail is provided

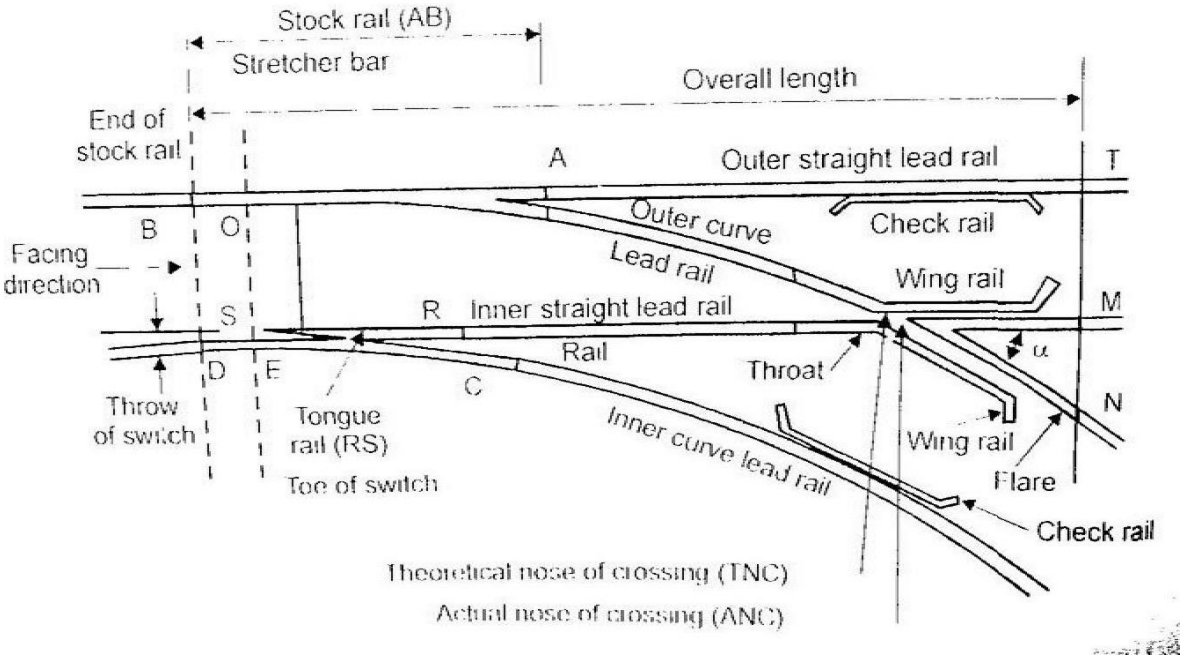
Split switch: Loose heal type

Fixed heal type

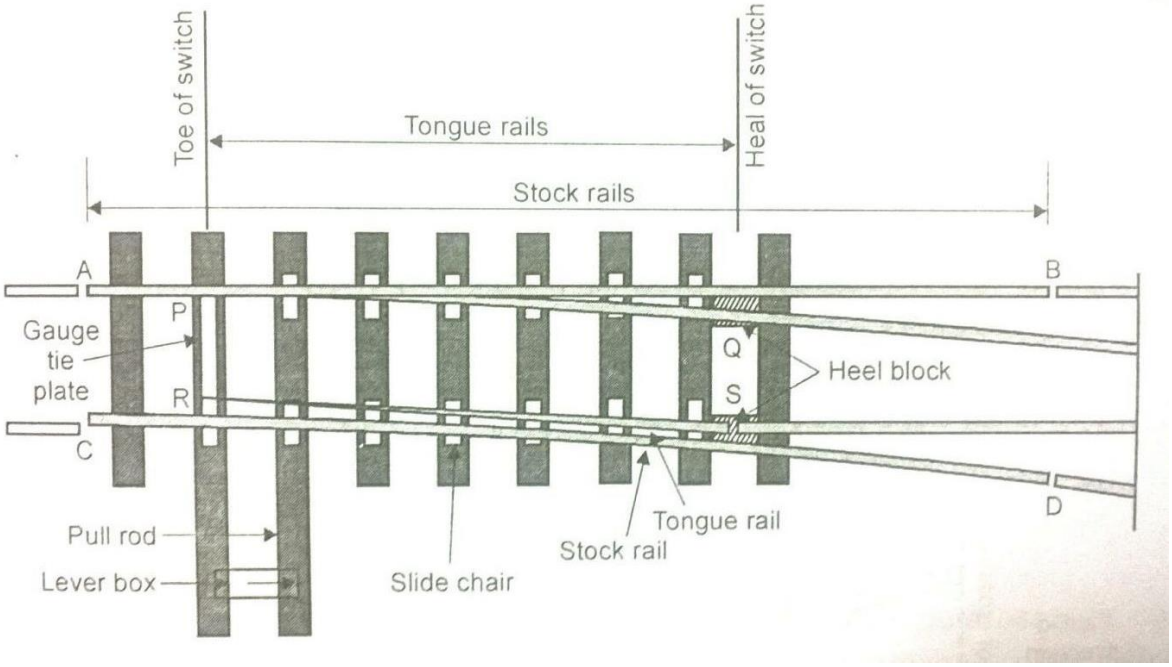
Constituents:

- A pair of stock rails AB and CD
- A pair of tongue rails PQ and RS

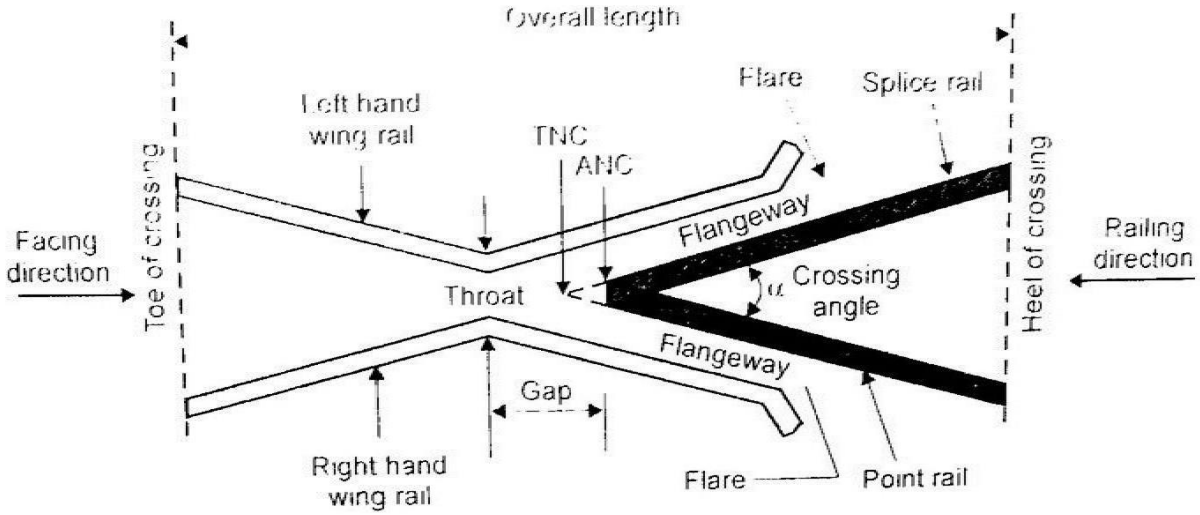
- A pair of heel blocks
- gauge tie plate to ensure correct gauge



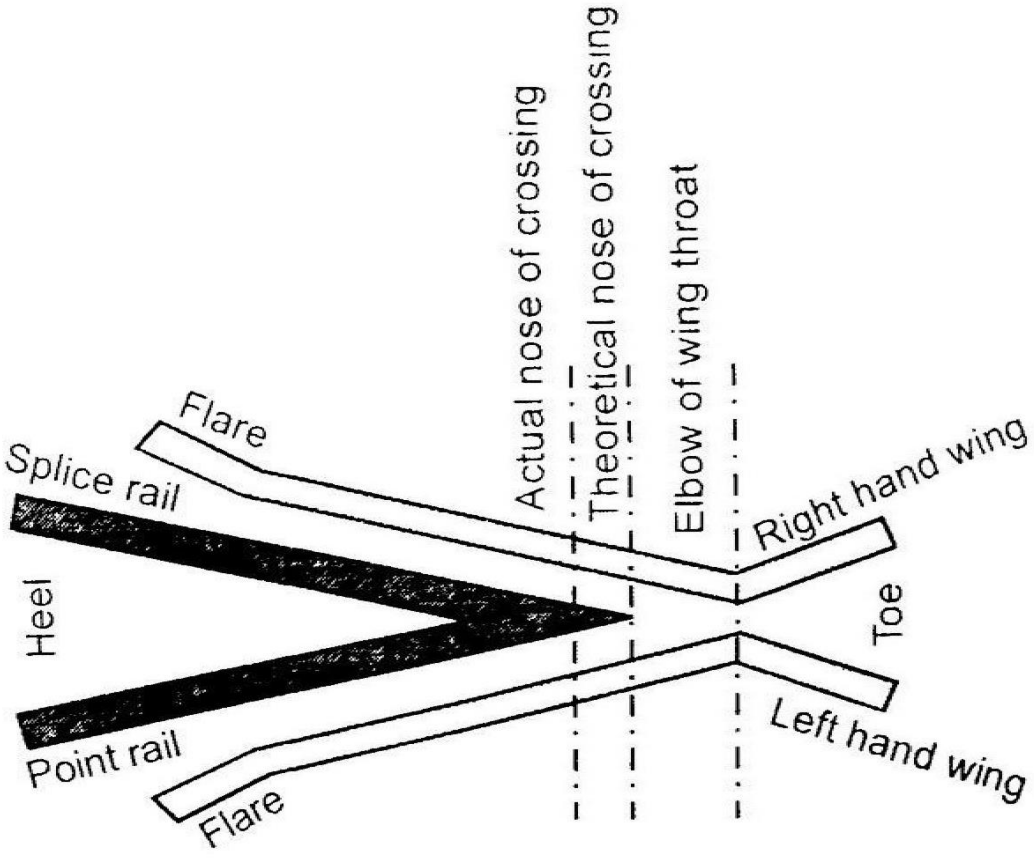
Components of a right hand turnout



Details of a switch



Details of a crossing



Point rail and splice rail

Crossings:

Definition and purpose: A Crossing is a device, inserted at a location where two rails

cross each other. It enables the wheel flanges of rails to pass from one track to another track. Flanged wheels jump over the gap provided from the throat to the nose of the crossing.

Constituents: A crossing consists of

- Two rails called point and splice rail which are machined to form nose. The point rail ends at the nose.
- A left hand and right hand wing rails form a throat and diverging again on either side of nose.
- pair of check rails to guide and to provide a path for wheel flanges.

Working principle of points and crossings:

a. **Split switch:** It consists of tongue rail and a stock rail with fastenings. A pair of them constitutes a set of points. The points by their operation can divert traffic moving in facing direction from one track to another track.
b. **Crossing device:** A crossing is a device introduced at the intersection of two running rails to permit the wheel flanges, moving along one to pass across the other. The crossing should be rigid enough to withstand against severe vibrations.
c. **Check rail:** A pair of check rails are provided to guide the wheel flanges and to route a path for them by which the sideway movement is prevented.

7. Explain super elevation giving its relationship with gauge, speed and radius of the curve. (Nov / Dec 2014) (8 mark)

Superelevation:

Superelevation or cant is the difference in height between the outer and inner rail on a curve. This is provided in the field by a gradual lifting of the outer rail while maintaining the inner rail in its original level.

Functions:

i. To minimize the wear and tear of the rails and rolling stock
ii. To have better load distribution on both the rails
iii. To modify the effect of lateral forces

iv. To provide a comfortable journey to the passengers

Equilibrium superelevation:

While vehicle on curves experience an outward centrifugal force due to the radial acceleration. The centrifugal force is given as

$$F = m (V^2 / R) = (W / g) (V^2 / R)$$

Where F = centrifugal force (tonnes)

W = weight of the vehicle (tonnes)

V = speed (m/s)

= acceleration due to gravity (m/sec^2)

R = radius of the curve (m)

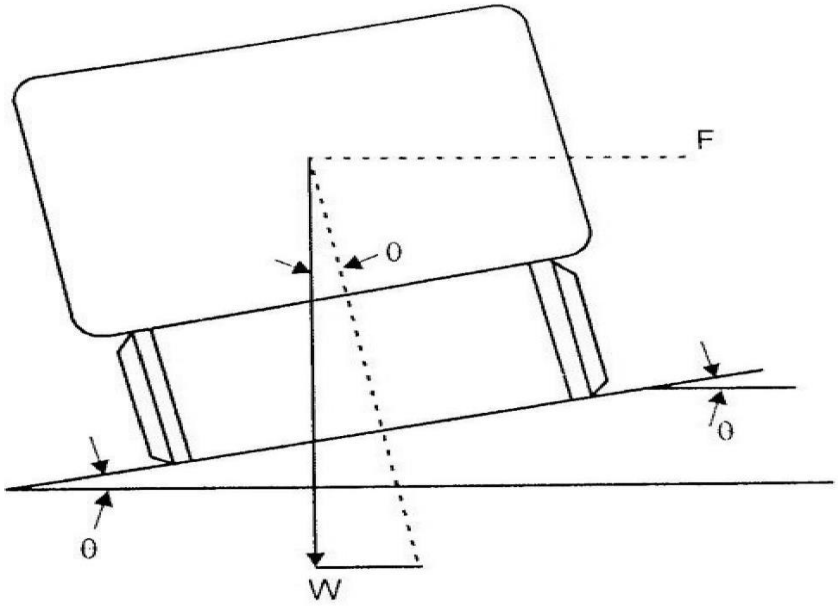
In order to counteract the effect of centrifugal force, the outer rail of the curve is raised with respect to the inner rail by an amount equal to the superelevation.

Let θ be the angle that the inclined plane (line joining the top inner and outer rails) make with the horizontal. Then

$$\text{Tan } \theta = \frac{\text{Superelevation}}{\text{Gauge}} = \frac{e}{G}$$

Also

$$\text{Tan } \theta = \frac{\text{Centrifugal force}}{\text{Weight}} = \frac{F}{W}$$



Equilibrium Superelevation

Equating the values of Tan ◆

$$\frac{e}{G} = \frac{F}{W}$$

Or $e = F \times \frac{G}{W} = \frac{W}{g} \times \frac{V^2}{R} \times \frac{G}{W}$

i.e., $e = \frac{GV}{gR}$

where, e = superelevation

G = gauge (min)

= gauge length + width of rail heads

This is equal to

1750 for BG tracks

1058 for MG tracks

8. What do you understand by "cant deficiency'? (Apr / May 2015) (8 mark)

Cant deficiency:

When a train moves around a curve at a speed more than the equilibrium speed, then deficiency in cant occurs. Thus the cant deficiency is the difference between the theoretical cant required for high speed and the actual cant provided.

Cant excess:

When a train moves around a curve at speed less than the equilibrium speed then

cess in cant occurs. Thus cant excess is the difference between the actual cant provided and the theoretical cant required.

Cant gradient:

Cantgradient and deficiency gradient express the increase or decrease in the cant or the deficiency of the cant in a given length of transition. For example, a gradient of 1 in 1000 represents that a cant deficiency of cant of 1 mm is attained or lost in every 1000

mm of transition length.

The maximum values of cant deficiency prescribed for Indian railways are given below:

Gauge	Group	Normalcant deficiency (mm)	Remark
BG	A and B	75	For BG group
BG	C, D and E	75	A & B routes: 100 mm cant deficiency permitted only for nominate stock and routes with the approval of CL
MG	-	50	
NG	-	40	

9.What is meant by gradient and enumerate the various types of gradient with all the details.(Nov / Dec 2008)(May / June 2012)

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. omentum 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 has 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

9.Enumerate the concept of an grade compensation and also explain the basic formulas used in grade compensation.(Nov / Dec 2012)(April / May 2011)(Nov / Dec 2007)

Due to the rigidity of the Wheel base, it is sometimes found on the Curve that the rails are tilled outwards so that the actual gauge in 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.

UNIT V – RAILWAY AND CONSTRUCTION MAINTENANCE

PART A

1. What are the types of signals based on the various categories(May/June 2015) or What are the characteristic classification of signals? (May/June 2013)

i. Operating characteristics a) Audible signals b) Visual indication signals

ii. Functional characteristics a) Stop signals b) Warner signals c) Disc signals d) Coloured signals

iii. Locational characteristics a) Outer signals (reception) b) Home c) Starter s ignals d) Advanced Starter signals

iv. Special characteristics a) Routing signals b) Repeating signals c) Co-acting signals d) Calling- on signals e) Indicators

2. State the principles of interlocking. (May /June 2011).

(a) When a train is properly set and locked to a particular line, it shall be responsible to unlock or reverse points.

(b) It shall be impossible to admit trains from opposite or converging directions in the same line, at the same time.

(c) When a signal is set for a particular line, it shall be impossible for loose wagons from any yard to obstruct the line.

3. What is meant by track circuiting? (May /June 2011).

Track circuiting is an electric circuit formed by combining running rails, signals and cabin. Its prime function is to specify the presence of any train or vehicle on the track. Various types of circuits used in Indian Railways are:

(i) D.C track circuit

(ii) A.C track circuit

(iii) Electric track circuit

4. What is cross-over? (May /June 2012).

When two adjacent parallel or diverging tracks, which may be straight or curved, are connected by two sets of turnouts, with or without a straight length between them,

the connecting line is known as cross-over.

.5. List the components of switch (Nov/Dec 2012)

A set of switches or points comprises of the following components:

(i) A pair of stock rails
(ii) A pair of tongue rail or switch rail.
(iii) A pair of heel blocks
(iv) Slide chairs
(v) Stretcher bars
(vi) A gauge tie plate.

6.Define interlocking (May /June 2013).

Interlocking is defined as the mechanical relationships established between various levers operating the signals and the points through mechanical or electrical agencies such that contrary effects are not at all possible in the working of the signal mechanism.

7.Distinguish between gravity yard and hump yard. (Nov/Dec 2013)

Sl no	Gravity yard	Hump yard
1	Wagons move under gravity in the marshalling yard provided with suitable gradient	The wagons are pushed upon the hump by the engine and then allowed to gravitate
2	Shunting operations are carried out slowly assisted by engine power.	Shunting operations are carried out quickly
3	Uneconomical since power is required to move the wagons	Economical since no power is required to move the wagons

8. What are the various sources of moisture in a railway track? (May /June2014)

The various sources of moisture affecting a railway track are: a) Surface water due to rain, dew or snow. b) Hydroscopic water or Held water. c) Seepage water d) Moisture by capillary action in sub grade.

9. What is a buffer stop? (May /June2015)

The dead end of a siding or the end of any track of terminal station is not kept bare but a form of stop or barrier is provided at the end of the track, to prevent the

vehicles, from running off the track. This stop or barrier provided at the end, across the track of a siding or at terminal station is known as “Buffer stop”.

10. Write the difference between ‘loop and siding’. (Nov/Dec 2012)

Loop: Loop lines are the ones provided near the station building to stop slow-moving or passenger trains to stop and give way for express trains to move on the mainline without any difficulty.

Siding: Sidings are provided at the marshalling yard. There are three types of sidings

(i) **Reception sidings –** intended to receive incoming trains.
(ii) **Sording sidings –** for shunting operations
(iii) **Departure sidings –** similar to reception siding and is used for departure

PART B

1. How are stations classified? Explain the features of each station. (May/June 2014)

Stations and yards are the field control units of the railway communication system. They also provide waiting places and repairing places for the locomotives and wagons.

Classification of Railway stations:

Two categories: 1. Operational considerations

2. Functional considerations

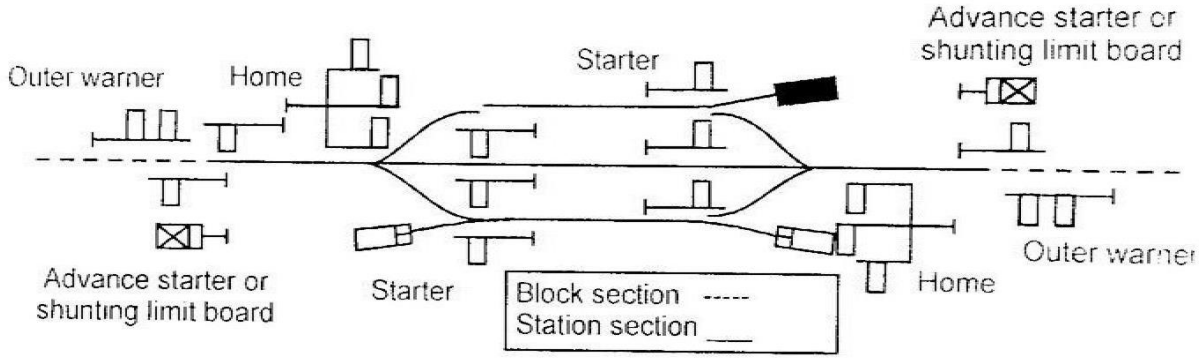
Operational considerations:

As per Indian railways, (i) block stations or (ii) non-block stations

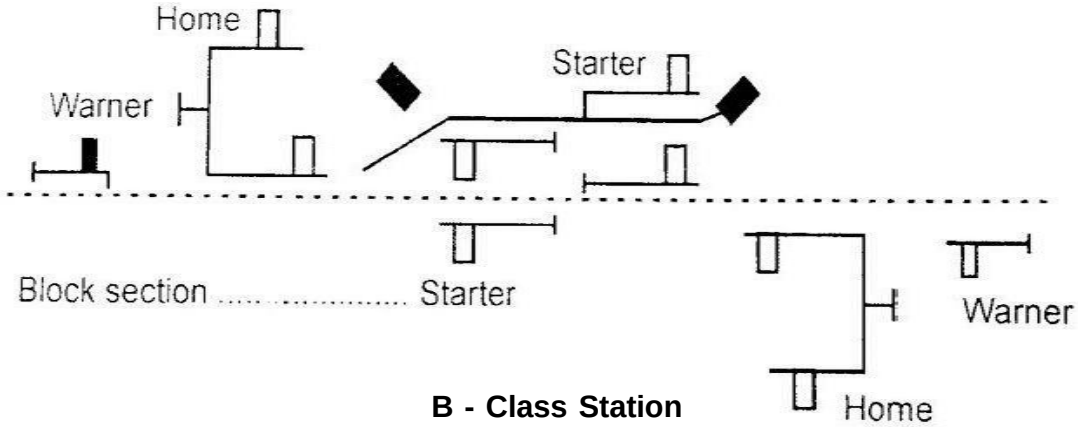
(i) **Block station:** No traffic is dealt, but trains have to get permission to proceed further. Further classified as A, B, C classes.

A – incoming train is received after clearing at least a distance of 400 m beyond home signal

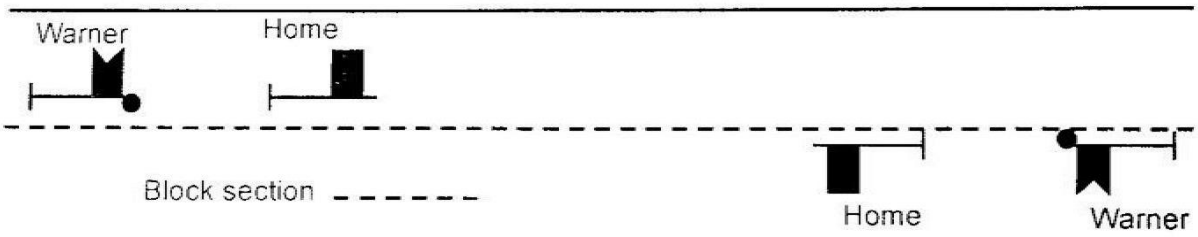
B –permission to the incoming train is given before the receiving line is made clear within the station section



A – Class station



B - Class Station



C –stations where train do not stop

b) C – Class station

(ii) Non-block station: classified as D-class or flag stations. Only traffic is dealt and no arrangements to control the movement of train. Located between two block stations.

Functional classification:

(i) Halt stations

(ii) Flag stations

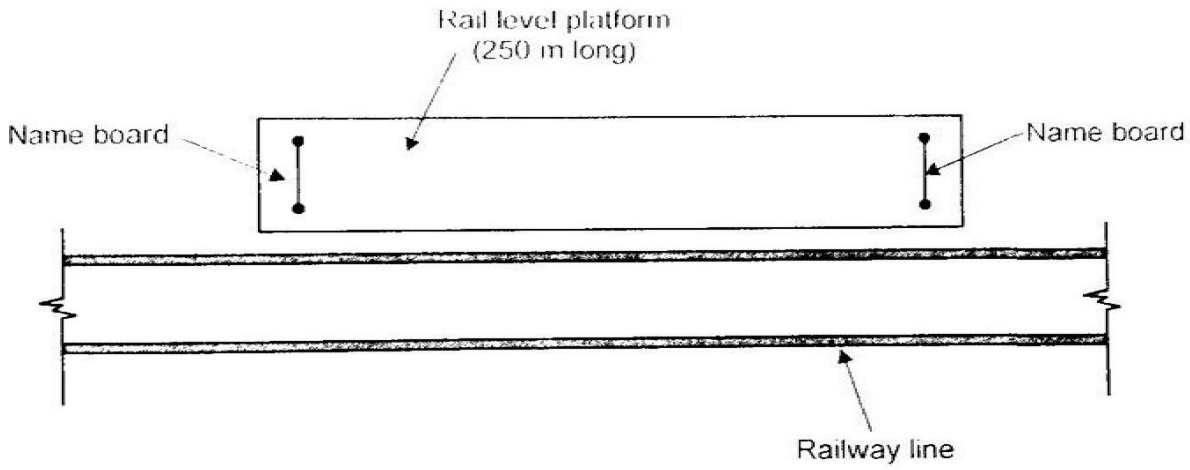
(iii) Wayside junctions

(iv) Junction stations

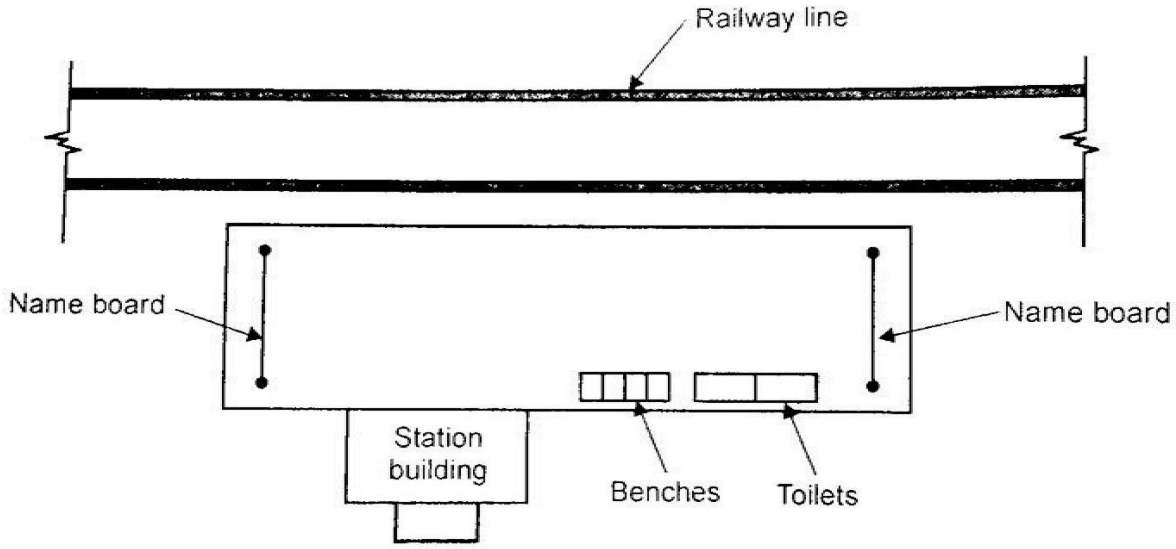
(v) Terminal stations

Halt stations: simplest station where trains can stop on a railway line. Provided with small waiting shed, name boards are provided at both end.

Halt station

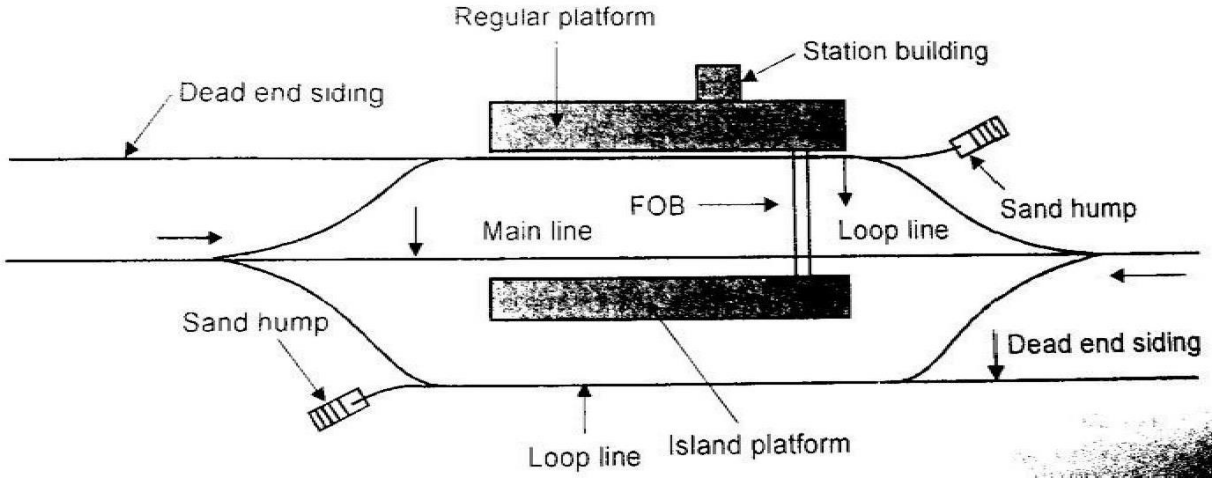


Flag stations: provided with station building and staff. Provided with booking office, benches, drinking water facility. Sometimes siding is also provided for stabling of wagons booked for that station.



Flag station

Wayside station: called as crossing station. Provision is made to cross an up and a down train or for over-taking the slow-moving trains by the fast-moving trains.



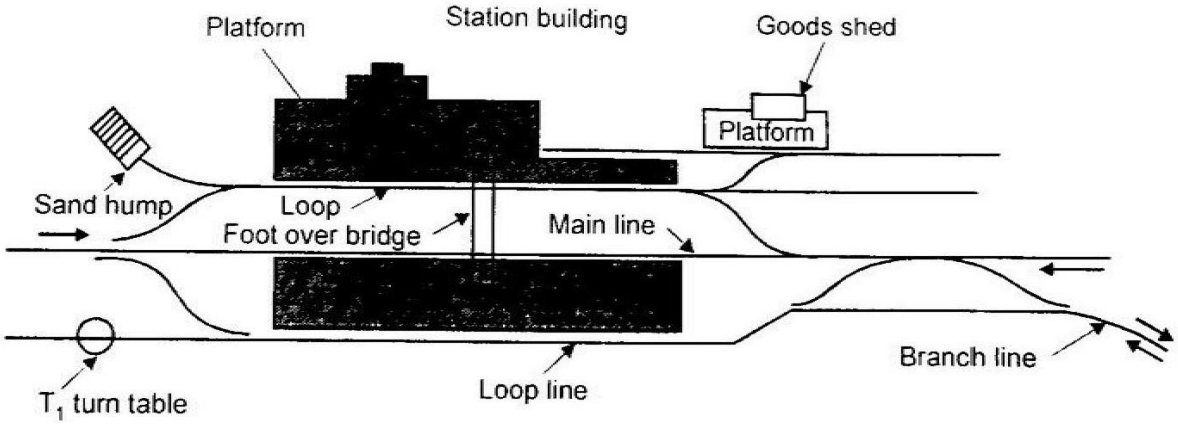
A wayside or crossing station on a single-line section

Junction stations: is a meeting point of three or more line coming from different conditions.

a. Feasibility to interchange of traffic inbetween main and branch lines

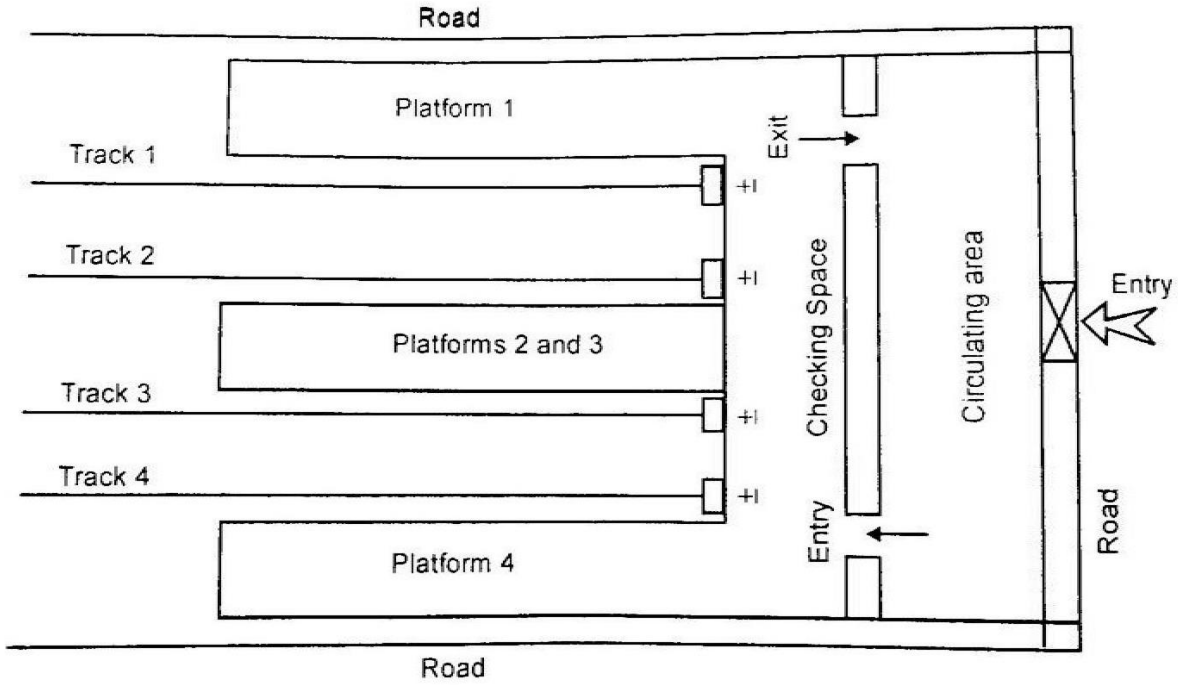
b. Possibility to clean and repair vehicles which terminate at the junctions

Occur between a single branch line and a single or double main lines or between double branch line and main tracks.



Junction station with single main line and single branch line

Terminal station: station at which a railway line or one of its branches ends or terminates without further proceeding. Provided with facilities to reverse the locomotive, examination pits, additional sidings, ticket office, restaurant etc.



Terminal station

2. What is marshalling yard? Explain with a neat sketch, the working of a hump type of marshalling yard. (Apr / May 2011)

Yard:

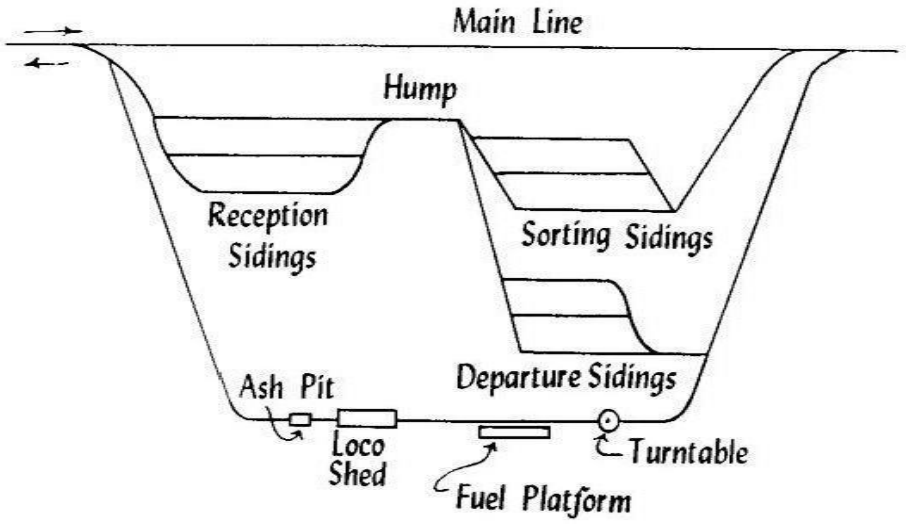
A yard is defined as a system of tracks laid within definite limits for various purposes such as storing of vehicles, making up trains, despatch of vehicles, etc. It attends to unscheduled movement of trains subjected to rules and regulations.

Types:

- Passenger yards
- oods yards
- Marshalling yards
- Locomotive yards

Marshalling yards:

The main purpose of marshalling yard is to isolate goods wagons received from various centres in order of station at which they are to be sent. It works as distribution centres and also the empty wagons are kept in marshalling yards.



Marshalling yard

Design aspects of marshalling yards:

- Shunting operations should not disturb the regular movement of trains.
- More number of wagons should be despatched rather than storing more wagons.

- It should be feasible for future expansion so as to accommodate more goods traffic.
- To the maximum extend the marshalling yards should be made parallel to the running lines.
- All main stations should have the marshalling yard facility.
- Wagons are to be made to move in one direction only.
- Adequate repair facility for sick wagons.
- Enough lighting arrangements should be made to function at all times.
- The cost of construction and maintenance should be low.

Layouts of marshalling yards:

An ideal layout of marshalling yard consists of three types of sidings:

a) Reception sidings
b) Sorting sidings
c) Departure sidings

a) Reception sidings:

These sidings are used to receive incoming trains. These sidings are laid in the form of parallel grid with equal length. Such arrangement enables the goods trains to stand on these sidings till they are shunted out.

b) Sorting sidings:

These sidings are intended for shunting operations. Each sidings is allotted to specific destination wagons. The sorting sidings are generally laid in the form of a fan or balloon. The number of sidings depends on the number of destinations.

c) Departure sidings:

These are similar to reception sidings. If the mainline is not busy their sidings may be omitted. The number of sidings both for reception and departure depend on the intensity of traffic on the main line, time required to marshall and number of goods trains to be marshalled at the same time.

Types of marshalling yards:

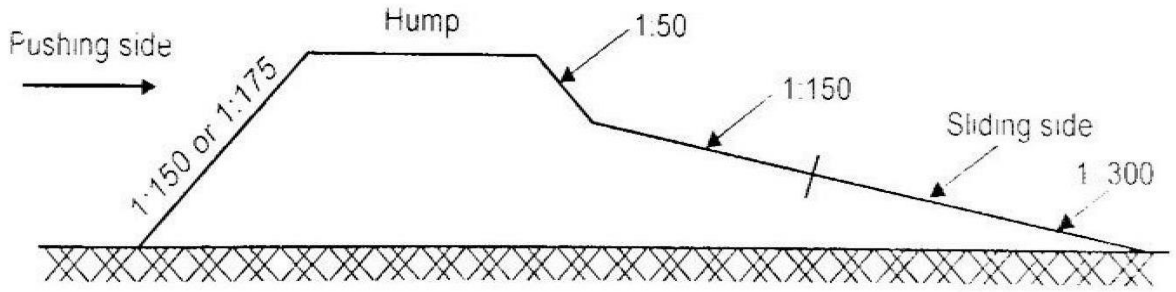
- Flat yards

- Gravitation yards
- Hump yards

Hump yards:

Hump or summits or man-made hills are provided and the wagons are pushed upto this point by the engine. Then the wagons are allowed to gravitate down the slope. The modern trend is to adopt this type of marshalling yards as shunting operations are carried out more quickly than gravity or flat yards.

They are found to be more economical because no power is required to move the wagons. A rising gradient of 1 in 150 or 1 in 175 is provided at the pushing end for a length of about 183 metres. Then the hump is kept level and it is followed by falling gradients of 1 in 150 and 1 in 300 an then level. (Ref Fig)



Hump yard

Functions: The stopping of individual wagons or group of wagons in hump yards is carried out as follows:

(i) Men run along the wagons and apply the wagon brakes at the desired point of stoppage.

(ii) Retarders may be employed to stop the moving wagons. These are blocks or bars which are fixed on either side of the rails. The retarders are operated automatically to press against the sides of wheels of moving wagons to stop it.

(iii) Skids may be placed on the rails to prevent further movement of wagon by friction developed on skid.

The action of hump yards is little uncertain because the rate of movement of wagons depends on the following factors:

- Climatic conditions
- Different types of axle-boxes
- Weight of the wagons

3. Describe the following:

(i) Necessity of track maintenance (6)

(ii) Essentials of good track maintenance (5)

(iii) Advantages of proper track maintenance (5)(May/June 2014)

(i) Necessity of track maintenance:

There are mainly two reasons for maintain track in proper order:

New track:

- The newly laid track will settle down slowly, so special gangs are to be employed to bring the embankment to the proper formation level.
- Generally 4 men are employed per kilometre length of this track for this purpose.

Constant use:

- The railway tracks are being constantly used by trains, therefore it requires some treatment to remain in the working condition.
- It is achieved by maintenance gangs all along the railway track, which keeps the track in good condition.
- For this type of maintenance the track is divided into suitable sections, each having a length of about 6 km for main line and 8 km for branch line section and one gang is attached to this section. The number of men required depends on the volume of traffic, nature of soil and strength of permanent way.

(ii) Essentials of good track maintenance:

The following are the characteristics of a well maintenance track

i. Curvature of gauge subjected to limitations.
ii. Rails at same level with appropriate super elevation at curves.
iii. Alignment free from kinks and other irregularities
iv. Gradients as per standards, prescribed.

v. Track with the property of resilience to regain its original position after deformation.

vi.vi. Track with lateral strength to withstand side thrust and centrifugal and lateral forces and to maintain the alignment intact.

vii.vii. Upkeep and maintenance of radius of curvature, super elevation, points and crossings.

viii. Perfect drainage system.

ix. Precaution against creep.

x. Various components of the railway track such as formation, ballast, sleepers and rails fullfill the essential requirements of maintenance.

(iii) Advantages of Proper track maintenance:

It consists of one gangmate or ganger, one keyman and nine to ten workers for B.G and about four to five workers. Each gang works in a length of about 90 meters a day. The duties of gangmate, keyman and P.W.I are:

i. The ganger is the head of the gang and he is personally responsible for the upkeep of track in his section.

ii. The ganger must keep his section in good running condition at all times.

iii. He is responsible for maintaining the track in his section in correct alignment and level.

iv. The ganger has to arrange for tools and other equipments required by his gang.

v. The points and crossings should be periodically checked and examined by the ganger.

vi. In case of emergency, the ganger should stop or slow down a running train by the use of temporary signals.

vii. In case of accident, the ganger should look after the broken fittings of the rolling stock and track components.

4.(i) List the conventional and modern methods of maintenance of railway track. What are the different types of equipment used?

4.(ii) What are the advantages of welded rails? Describe any one method of welding the rails. (May/June 2012)

(i) Track maintenance:

The maintenance of track irrespective of old or new is to be done periodically. Since the track may be damaged due to weathering effect like rain, sun and sand, track maintenance is necessary.

Conventional methods of track maintenance:

The conventional method of maintaining of tracks by manual labour has been traditionally accepted. The calendar system of maintenance has been followed by Indian railways. As per this system a time table has been charted out which outlines the track maintenance work to be performed by gangs in the course of the year. The following operations are carried out:

- Through packing
- Systematic overhauling
- Packing up slacks

i. Through packing:

Due to the movement of trains over the track frequently the ballast under the sleepers become loose. The ballast under the sleepers should be regularly packed so as to keep the track in good running condition.

ii. Systematic overhauling:

In order to ensure the best possible standard of track conditions, tracks should be overhauled (renewing) periodically.

iii. Picking up Slacks:

Slacks are those points in the track where the running of trains is faulty or substandard. Depending on the season working sessions are decided. In rainy season only slacks are picked up and no through packing is done. In every working session, a certain number of days in each week are allotted for picking up of slacks.

Modern methods are track maintenance:

- Track Machines (TMs)

- Measured shovel packing (MSP)
- Directed Track maintenance (DTM)

i. Track Machines:

Different types of track machines are used in Indian railways are discussed below:

Plassermatic tamping machines have the functions of tamping, levelling and aligning.

Plasser Ballast cleaning machine is used to excavate, clean and put the screen ballast back in the track and remove unwanted material.

Switch relaying machines are used which can remove and install parts or complete assemblies of points and crossings.

Track Relaying Trains are capable of relaying the entire track automatically with very less use of labour.

ii. Measured Shovel packing:

It comprises of taking accurate measurements of track defects such as unevenness and voids in ballast.

iii. Directed Track Maintenance:

It is a method of maintaining track based on the directions that are given for maintenance every day rather than routine maintenance.

Different types of equipments used in maintenance:

TOOLS REQUIRED DURING MAINTENANCE		
S.No	**Name of the tool**	**Use**
1	Beater cum pickaxe	To pack ballast under sleeper
2	Rail guage	To verify the distance between inner faces of rails i.e. gauge
3	Cant board	To verify cant
4	Spanner	To tighten or loose fish-bolts
5	Powrah	To handle the ballast
6	Jim crow	To bend the rails
7	Auger	To drill holes for the spikes
8	Chisel	To cut rails, bolts, etc.
9	Lifting jacks	To lift the track
10	Rail tongs	To lift the rails.
11	Ballast screens	To screen the ballast
12	Sleeper tangs	To lift sleepers

(ii) Advantages of welded rails:

a) It increases the life of rails due to decrease in wear of ends.
b) It results in decrease in maintenance cost to the extent of about 25%.
c) It results in comfort of passengers due to smooth working of the track.
d) The creep is considerably reduced.
e) For track circuited and electrified tracks, the welding of rails shows better results.
f) They are helpful for large bridges as rails of length equal to each span give better performance and reduce the effect of impact.
g) t decreases construction cost due to less number of rail joints.
h) The fast and heavy traffic may be permitted on track with long welded rails.
i) The rail coaches and wagons with reduced weights can be used on the welded track.
j) The pulling effort is reduced due to elimination of the loss of strain energy and impact energy at rail joints, hence it reduces fuel consumption.
k) The use of long welded rails affords more lateral, longitudinal and vertical stability to the track.

Methods of welding:

- **Electric arc welding**
- **Oxy-acetylene welding**
- **Chemical welding**
- **Flash-butt welding**

Oxy-acetylene welding:

In this process, intense heat is produced by means of oxy-acetylene flame. Site welding can be done, since it can be easily carried from one place to another. The cost of welding is high and this can be adopted for cutting of steel.

It is also known as gas pressure welding process and it is used widely due to various techno-economic considerations. In this process, the rail ends are heated by gas mixture. The temperature does not reach the fusion temperature of the rail ends either at the beginning or at the end of the welding process. The welding temperature

renders easy plastic flow where upon the application of pressure causes the welding surface to come into close contact and be joined with smooth upsetting.

It is mainly performed mechanically as a result of which, the weld strength is uniform and its reliability is high. In India, it was successfully used for rail welding on the Konkan Railway for its entire 760 km. The gas pressure welding plants can be either as a portable plant or as a movable plant.

6. Name the various methods of tunneling in hard and soft rocks. Describe one in each case. (R 2013)

Tunneling may be basically divided into two main groups.

(a) Tunneling in hard rocks

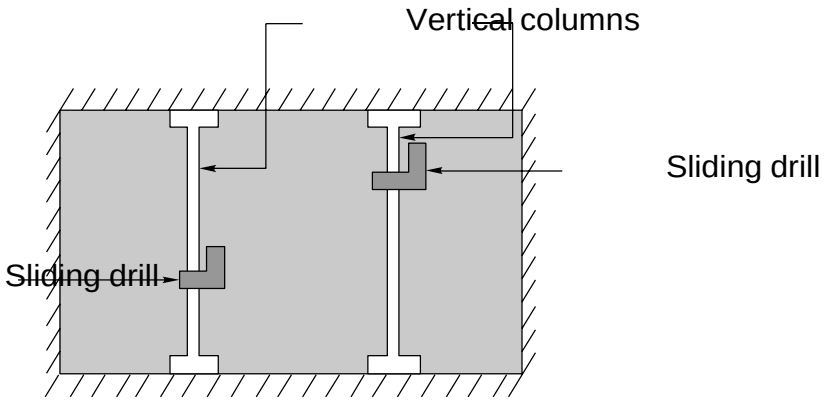
(b) Tunneling in soft rocks

Tunneling in Hard Rocks

- ✓ **Full face method**
- ✓ **Heading and bench method**
- ✓ **Drift method**
- ✓ **Pilot tunnel method**

Full face method

The full face method is normally selected for small tunnels whose dimensions do not exceed 3 m. In this method, the full face or the entire facade of the tunnel is tackled at the same time. Vertical columns are erected at the face of the tunnel and a large number of drills mounted or fixed on these columns at a suitable height as shown in Fig. A series of holes measuring 10 mm to 40 mm in diameter with about 1200 mm centre-to-centre distance are then drilled into the rock, preferably in two rows. These holes are charged with explosives and ignited. Next the muck is removed before repeating the process of drilling holes.



Full face method

Advantages

(a) Since an entire section of the tunnel is tackled at one time, the method is completed expeditiously.

(b) Mucking tracks, which are tracks used for collecting muck, can be laid on the tunnel floor and extended as the work progresses.

(c) With the development of the 'jumbo' or drill carriage, this method can be used for larger tunnels too.

Disadvantages

(a) The method requires heavy mechanical equipment.

(b) It is not very suitable for unstable rocks.

(c) It can normally be adopted for small tunnels only.

Tunneling in Soft Ground or Soft Rock

Tunneling in soft ground or soft rock is a specialized job. It does not involve the use of explosives and the requisite excavation work is done using hard tools such as pickaxes and shovels. In recent times, compressed air has also been used for this purpose. During excavation, the rail requires support at the sidewalls and the roofs depending upon the type of soil. The support could be provided in the form of timber or steel plates or other similar material. The various operations involved in soft rock tunneling are as follows:

(a) Excavation or mining

(b) Removal of excavated material

(c) Scaffolding and shuttering

(d) Lining of tunnel surface

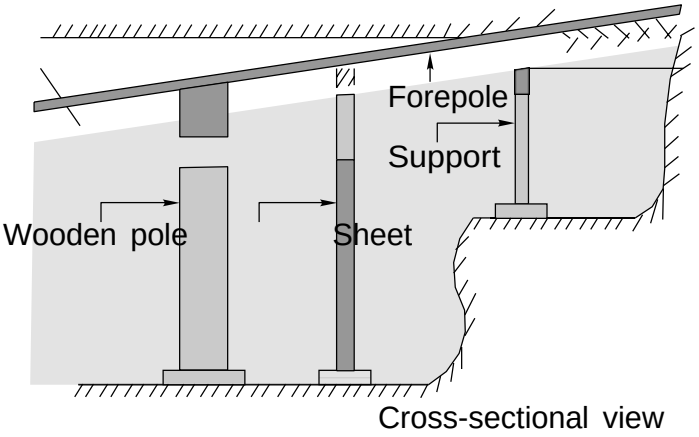
The nature of the ground is the most important factor in deciding the method to be used for tunneling.

The important methods of tunnelling in soft rock are:

- ✓ **Forepoling method**
- ✓ **Linear plate method**
- ✓ **Needle beam method**
- ✓ **American method**
- ✓ **English method**
- ✓ **Austrian method**
- ✓ **Belgian method**

FOREPOLING METHOD

Forepoling is an old method of tunnelling through soft ground. In this method, a frame is prepared in the shape of the letter A, placed near the face of the tunnel, and covered with suitable planks. Poles are then inserted at the top of the frame up to a viable depth. The excavation is carried out below these poles, which are supported by vertical posts. The excavation is carried out on the sides and the excavated portion is suitably supported by timber. The entire section of the tunnel is covered thus. The process is repeated as the work progresses.



Forepoling method

Forepoling is a slow and tedious process and requires skilled manpower and strict supervision. The method has to be meticulously repeated in sequence and there is no short cut for the same.

7. Explain about Track Drainage, and how Surface and Sub surface Water Can be removed From Railway track. Give all in Details. (AUC NOV/DEC 2011)

Definition

Drainage of a track, Station Yards and platforms are the three places Where Drainage arrangements are needed. Track Drainage Comprises of Interception, Collection and disposal of from the track. This is done by adopting proper Surface and Subsurface Drainage System.

Types of track Drainage

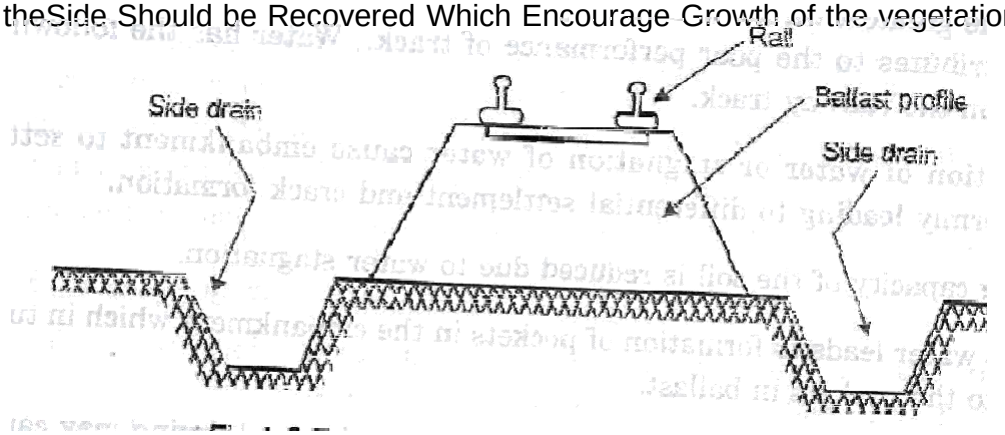
Surface Drainage

Surface Water due to rain or Snow or Flow From Adjacent areas have to be Disposed of Through Surface Drainage. Surface Drainage has to be attended to in three locations. Drainage in mid- Section Between railway Stations.

1.Drainage in mid-section
2.Drainage in Station Yards3.Drainage at Station Platforms

1.Drainage in mid-section

A typical arrangement of cross Section of a mid-section. Side Drains may be unlined or lined. At a level Crossing all water should flow to the side Drains. In cutting catch water Drains Have Been Provided Wherever Necessary. All Extra Ballast on theSide Should be Recovered Which Encourage Growth of the vegetation.



2. Drainage in Station Yards

Open Surface Drains-Shaped Drains, Longitudinal Drains and Open Drainage are Provided to Free Station Yard From Water.

A typical surface drainage system with open Drains for a Station Yard .Every Station Yard is Provided with a network of Cross and Longitudinal Drains.

In Station Yard the vulnerable points are water columns and carriage watering points with washing Hydrants.

3. Drainage at Station Platforms

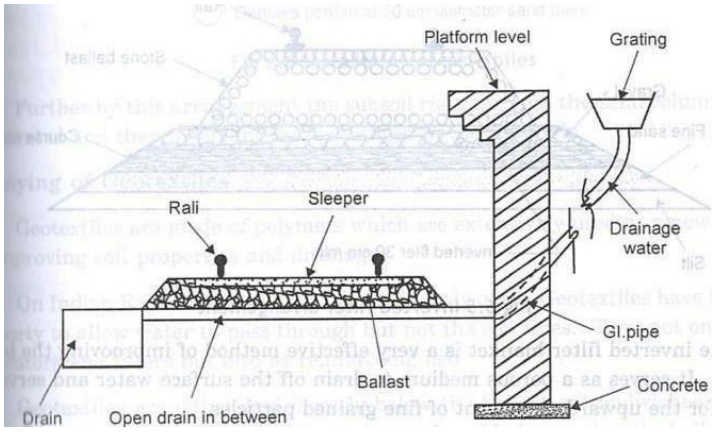
For Drainage of Station Platforms the following Points Should be Taken into account 1.Slopes away From the track

2. Discharge on non-Track Side

3. Discharge not towards Ruin-through lines

In general all end of platforms should be sloped away From the Track. all other Discharges Form tea Stalls, Toilets, Water taps. If there is need be covered longitudinal Drains Should Be Provided

In case of island platforms, all Drains Should discharge on the less important side of the track



2.Sub-Surface Drainage

Sub-surface water is due to the capillary water. Other sources are seepage from adjacent areas percolation of rain water. The sub grade and the formation are immediately affected by the Sub-Surface irrigation.

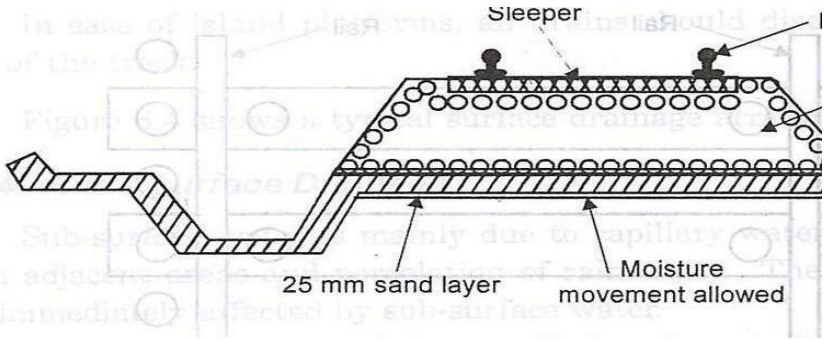
1. **Provision of an inverted fillers**
2. **Sand piling**
3. **Laying of Geotextiles**
4. **Other Methods**

1. Provision of an inverted fillers

An inverted fillers blanked of adequate thickness is provided between the ballast

and the week formation. The Blanket is of non-Cohesive material with enough bearing capacity to sustain the load.

The inverted fillers Blanket is a very effective method of improving the bearing capacity. It serves as a porous medium to drain to drain off the Surface Water and Serves as a barriers for the upward movement of fine Grained particles



2. Sand piling

Sand filling is an effective technique . A series of 30cm diameter vertical holes are drilled inside and outside the rail to a depth of 2-3m. the holes are filling with clean sand and the surface is resurfaced. The area covered by the Sand piles Should be About 20% of the formation area. Sand piles provide a mechanical support and the Drainage of the Sub grade improves.

Further by the arrangement of the Subsoil rises through the sand column And get evaporated.