GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
INSTITUTE OF TECHNOLOGY
DEPARTMENT OF CIVIL ENGINEERING
B.TECH 3rd YEAR, Vth SEMESTER
SUBJECT: TRANSPORTATION ENGINEERING-II
COURSE CODE: 31CE05T
MAXIMUM MARKS: 60

Instruction:

(i) All Questions of Section-A are compulsory and carry 2 marks each.
(ii) Attempt any two Questions from each unit of Section-B, carry 4 marks each.
(iii) Draw sketches if necessary.
(iv) Assume suitable data if missing and mention it clearly.

SECTION-A

1 What is tube railway?

ANS. The railways which are constructed underground at a depth of 18 m is called Tube railway.

2 What is reconnaissance survey?

ANS. It is a rough inspection of various physical characteristics of the area to investigate the suitability of different alignments marked on the available map.

3 What is the weight of rail used in India for B.G.?

ANS. 45 Kg.

4 What do you mean by “adzing of sleepers”?

ANS. Cutting of wooden sleepers in 1:20 slope is called adzing of sleepers.

5 The rate of rise or fall provided to the formation of railway track is known as _____.

ANS. (a) Gradient

6 Minimum formation width in embankment as recommended by Indian Railway Board in single track is _____ m.

ANS. (b) 6.1

7 The bent portion of rail used in front of nose of crossing which guides the train wheel in their proper route is called _____ rail.

ANS. (b) Wing

8 The signal which controls the movement of the train before entering the station premises is called _____ signal.

ANS. (a) Home

9 The weight of the ship without cargo, fuel and stores is known as _____.

ANS. (b) Dispalcement light

10 _____ drain method is commonly used for drainage of the tunnel carrying double railway track or two lane road.

ANS. (b) Central

SECTION-B

UNIT-1

2 Explain what is meant by track alignment? What are the basic requirements of good alignment? Explain in details.

ANS.

TRACK ALIGNMENT

Track alignment is the position and direction given to the centre line of the railway track on the ground.

The vertical alignment includes changes in gradients and vertical curves. The horizontal alignment includes the straight path, its width, any deviations in width and curves.

Proper alignment of a new railway track is very essential as imporper alignment would result in capital loss due to higher initial cost of construction or recurring loss in maintenance and train operation. Once the track is aligned and constructed it is very difficult to change the alignment.

REQUIREMENTS OF A GOOD ALIGNMENT

A good alignment should fulfil the following requirements :

(i) The length of track should be as short as possible.
(ii) The construction cost should be minimum.
(iii) The maintenance cost should be minimum.
(iv) The transportation cost should be minimum.
(v) It should have easy gradient.
(vi) It should pass through aesthetic areas in view for comfortable and pleasant railway journey.
(vii) It should connect important places.
(viii) It should pass through important cities and industrial areas.

3 Why is it desirable to have a uniform gauge in a country? How is this problem being solved in India?

ANS. It desirable to have a uniform gauge in a country because of the following reasons:

1. A change from one gauge into another involves loading and unloading and resulting in additional cost in transportation. In the event of labour resorting to strike movement of essential goods is completely dislocated.
2. During the process of loading/unloading during change from one gauge to another delicate goods are likely to get damaged.
3. To meet the requirement of different guages large costly yards have to be provided which makes the operation uneconomical.
4. During loading and unloading from one gauge to another chances of theft are increased.
5. Transportation of the goods as a whole becomes comparatively costly giving rise to increase in cost of consumer and other goods.
6. Since wagon of one guage cannot be used in other gauge which results in a number of wagons lying idle at one gauge while there may be shortage of wagon at the other guage. This makes transportation uneconomical.
7. In case of war and other emergencies transport of army and other essential commodities gets considerably delayed if same gause is not in existence.
8. Yard and other passenger facilities such as platform, santitary arrangements, sidings, ticket office etc., have to be duplicated making the overall system of transportation of public and goods uneconomical.

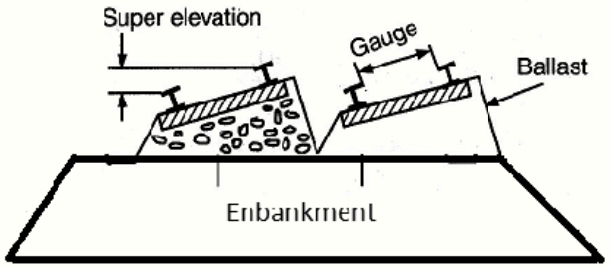
This problem being solved in India by adopting Broad gauge (1.676m) as Standard gauge throughout country.

4 a. Name the various instrument used in preliminary survey.
b. Draw a cross section of double line Broad Gauge track in Embankment on:
   i. Curved track.
   ii. Straight track.

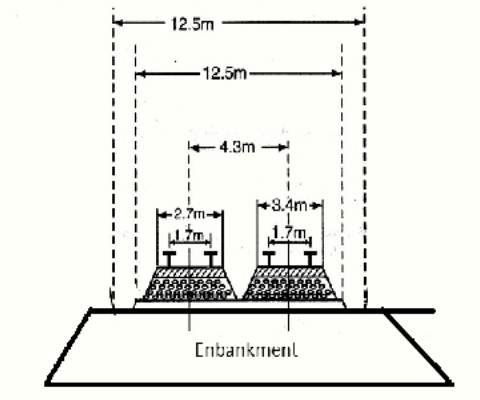
ANS. The various instrument used in preliminary survey are:

a. Theodolite
b. Tacheometer
c. Dumpy level for levelling
d. Plane table with accessories.
e. Prismatic compass for bearings.

Curved track.



Straight track.



UNIT-2

5 Compare wooden, steel, CI and concrete sleeper on the basis of different characteristics of sleepers.

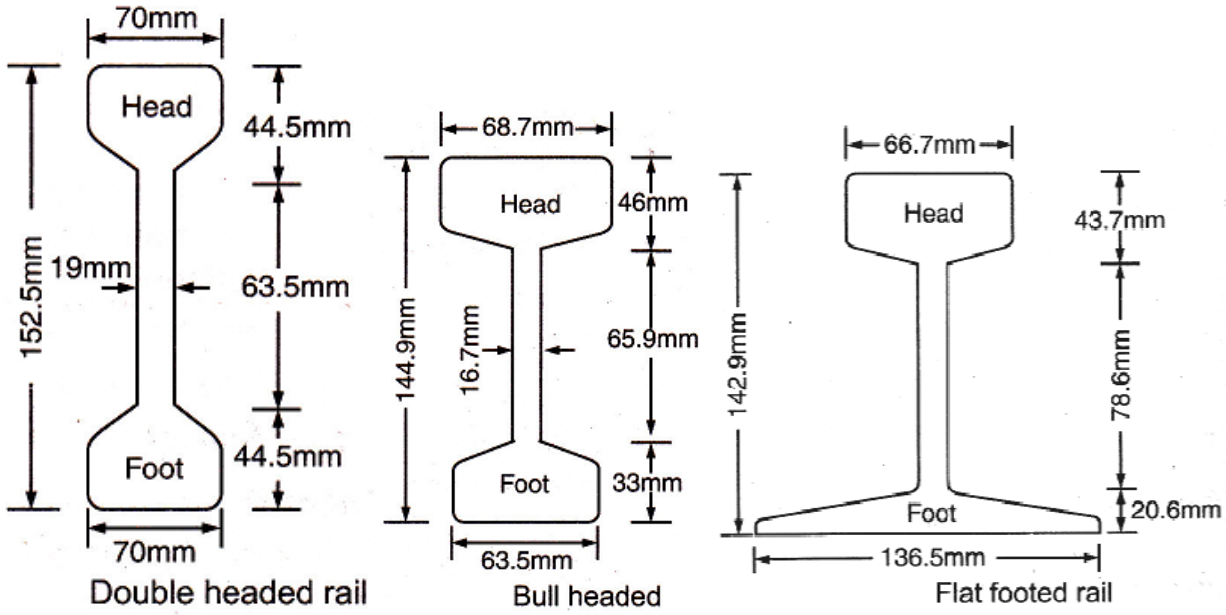
ANS.

S. N.	Items of comparision	Wood	Steel	Cast Iron	Concrete
1	Weight per sleeper (kg)	54.5	77.57	113.4	Heavier than others
2	Life (yrs)	12-15	40-50	40-50	50-60
3	Cost per sleeper	Least	Higher	Moderate	Depends on design
4	Fittings	Less	Less	More	Less
5	Handling	Not liable to break	Not liable to break	liable to break	Not liable to break
6	Gauge maintenance	Difficult	Simple	Simple	Simple
7	Gauge adjustment	Difficult	Easy	Easy	Easy
8	Elasticity	Poor	Better	Better	Better
9	Laying and Relaying	Easy	Easy	Difficult	Mechanically easy
10	Suitability	Suitable for all purpose	Suitable only for stone ballast	Suitable only for stone ballast	Suitable only for all locations
11	Rigidity	Poor	Better	Better	Best
12	Renewal	Easy	Difficult	Difficult	Difficult
13	Creep of rail	Heavy	Less	Less	Nil
14	Track circuiting	Best	Restricted	Restricted	Moderate
15	Cost of maintenance	Higher	Moderate	Moderate	Moderate
16	Overall Economy	Initially cheaper but higher in the long run	Initially cheaper but higher in the long run	Costlier initially but cheaper later on	Costlier initially but cheaper later on
17	Scrap value	Very little	Less	CI higher	Nil

6 Describe with neat sketches various types of rails. Compare merits and demerits of Bull headed

and Flat footed rail.

ANS.



The rails used in the construction of railway track are of following types :

1. Double headed rails (D.H. Rails)
2. Bull headed rails (B.H. Rails)
3. Flat footed rails (F.F. Rails)

Double Headed Rails:

The rail sections whose foot and head are of same dimensions. are called **Double headed** or *Dumb-bell rails*. In the beginning, these rails were widely used in the railways track. The idea behind using these rails was that when the head had worn out due to rubbing action of wheels, the rails could be inverted and reused. But by experience it was found that their foot could not be used as running surface because it also got corrugated under the impact of wheel loads. This type of rail is not in use in Indian impact of wheel loads. This type of rail is not in use in Indian Railways now-a-days.

Bull headed rails:

The rail sections whose head dimensions are more than that of their foot are called *bull headed rails*. In this type of rail the head is made little thicker and stronger than the lower part by adding more metal to it. These rails also require chairs for holding them in position. Bull headed rails are especially used for making points and crossing

Merits

(i) B.H. rails keep better alignment and provide more smoother and stronger track.

(ii) These rails provide longer life of wooden sleepers and greater stability to the track.

(iii) These rails are easily removed from sleepers and hence renewal of track is easy.

Demerits

(i) B.H. rails require additional cost of iron chairs.

(ii) These rails require heavy maintenance cost.

(iii) B.H. rails are of less strength and stiffness.

Flat footed rails:

The rail sections having their foot rolled to flat are called *flat footed* or *vignole's rails*. This type or rail was invented by Charles Vignole in 1836. It was initially thought that the flat footed rails could be fixed directly to wooden sleepers and would eliminate chairs and keys required for the B.H. rails. But later on, it was observed that heavy train loads caused the foot of the rail to sink into the sleepers and making the spikes loose. To remove this defect, steel bearings plates were used in between flat footed rails and the wooden sleeper. These rails are most commonly used in India.

Merits

(i) F.F. rails have more strength and stiffness.
(ii) No chairs are required for holding them in position.
(iii) These rails require less number of fastenings.
(iv) The maintenance cost of track formed with F.F. rails is less.

Demerits

(i) The fittings get loossened more frequently.
(ii) These rails are not easily removed and hence renewal of track becomes difficult.
(iii) It is difficult to manufacture points and crossings by using these rails.

7 a. What are the functions of ballast?
b. What are the requirements of good ballast?

ANS.

FUNCTIONS OF BALLAST

Ballast in railway track performs the following functions :

(i) To hold the sleepers in position and preventing the lateral and longitudinal movement.
(ii) To distribute the axle load uniformly from sleepers to a large area of formation.
(iii) To provide elasticity to the track. It acts as an elastic mat between subgrade and sleepers.
(iv) To provide easy means of maintaining the correct levels of the two rails in a track.
(v) To drain rain water from the track.
(vi) To prevent the growth of weeds inside the track.

Requirements of good ballast

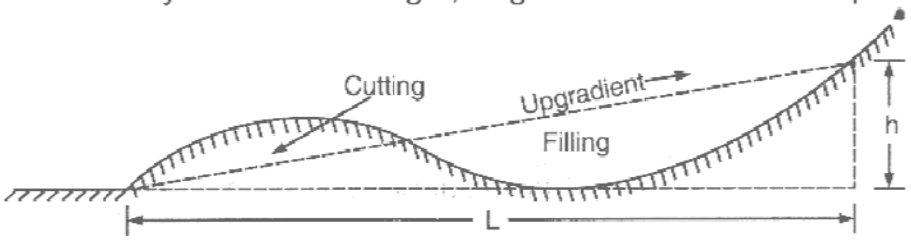
(i) It should have sufficient strength to resist crushing under heavy loads of moving trains.
(ii) It should be durable enough to resist abrasion and weathering action.
(iii) It should have rough and angular surface so as to provide good lateral and longitudinal stability to the sleepers.
(iv) It should have good workability so that it can be easily spread on formation.
(v) It should be cheaply available in sufficient quantity near and along the track.
(vi) It should not make the track dusty or muddy due to its crushing to power under wheel loads.
(vii) It should allow for easy and quick drainage of the track.
(viii) It should not have any chemical action on metal sleepers and rails.

8 Define gradient. What are the purposes of providing gradient in railway?

ANS.

GRADIENT

Gradient is the rate of rise or fall of the track. It is expressed as the ratio of vertical distance to horizontal distance or as percentage of rise or fall. If any track rises 1 m in 100 m horizontal length, its gradient is expressed as 1 in 100 or 1 percent. If another track falls by 1 m in 50 m length, its gradients is 1 in 50 or 2 percent.



$$\text{Gradient} = \frac{h}{L} \times 100 \text{ percent}$$

Gradient

Purpose of Providing Gradient

Gradients are provided to the formation of rail track to serve the following purpose:

(i) To reduce the cost of earthwork.
(ii) To provide uniform rate of rise or fall as far as practicable.
(iii) To reach the stations situated at different elevations.
(iv) To drain off rain water.

9 Derive a relationship of super-elevation with gauge, speed and radius of the curve.

ANS. **Relation of Superelevation with Gauge, Speed and Radius of the Curve**

When a train moves on a curve, it is subjected to following forces:

(i) The weight (W) of the train acting vertically downward.

(ii) The centrifugal force (F) acting horizontally outward through the C.G. of the train.

(iii) The reaction R_1 acting upward normal to the track and is equal to the resultant R of F and W, as shown in Fig.

Let W = Weight of train in kg

R = Radius of curve in m

v = Speed of vehicle in m/sec

V = Speed of vehicle in km/hr

G = Gauge of the track in metre

α = Angle of inclination

g = Acceleration due to gravity in m/sec^2

S = Length of the inclined surface in metres

e = Superelevation provided in metre.

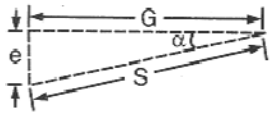
Centrifugal force acting on train (F) = $\frac{Wv^2}{gR}$

Resolving all the forces acting on moving train along the inclined plane

$$F \cos \alpha = W \sin \alpha$$

or $$\frac{Wv^2}{gR} \times \frac{G}{S} = W \times \frac{e}{S} \qquad \left[\text{where } \cos \alpha = \frac{G}{S} \text{ and } \sin \alpha = \frac{e}{S}\right]$$

$\therefore$ $$e = \frac{Gv^2}{gR} \text{ metre}$$



or $$e = \frac{G \times (0.278V)^2}{9.81R} \qquad [\text{where } v = 0.278\ V]$$

or $$e = \frac{GV^2}{127R} \text{ m}$$

For B.G., $e = \frac{1.676\ V^2}{127\ R}$ m For M.G., $e = \frac{1.0\ V^2}{127\ R}$ m

For N.G., $e = \frac{0.762\ V^2}{127\ R}$ m

10 What are the objects of providing transition curve? Give essential requirements of an ideal

transition curve.

ANS. **Transition Curves**

Transition curve is a curve having its radius varying gradually from infinity to a selected minimum in order to attain full superelevation. It is introduced between a straight and a circular curve or between two branches of a compound curve.

Object of Providing a Transition Curve

(i) To provide gradual change in the radius of curvature from infinite at the straight to that of circular curve of selected radius.
(ii) To provide gradual rise for the desired superelevation.
(iii) To provide smooth running of vehicles and comfort to the passengers.
(iv) To reduce the chance of derailment.
(v) To minimise wear of rails on curved portion of the track.

Requirements of a Transition Curve

(i) It should be perfectly tangential to the straight and circular curve.
(ii) The rate of increase of curvature should be the same as the superelevation.
(iii) The length of transition curve should be such that the full superelevation is achieved at the junction of transition and circular curve.
(iv) Its radius of curvature should vary from infinity at the straight to a finite value at the junction with circular curve.

11 What is marshalling yard? What are the different types of marshalling yards? Explain briefly.

ANS. **Marshalling Yards :** Marshalling yards are yards where trains are received, sorted out, new trains formed and despatched onwards. These are provided at important junction station which act as distributing centre for various destination. Marshalling yards are very costly in construction and maintenance.

The main functions of a marshalling yard are the following.

(i) Reception
(ii) Sorting
(iii) Departure

The following are the drawbacks of marshalling yard :

(i) Traffic congestion at approaches to the yard due of continuous shunting work in the yard.
(ii) Delay in transit of wagons.
(iii) Damage of wagons while shunting.

Types of Marshalling Yards

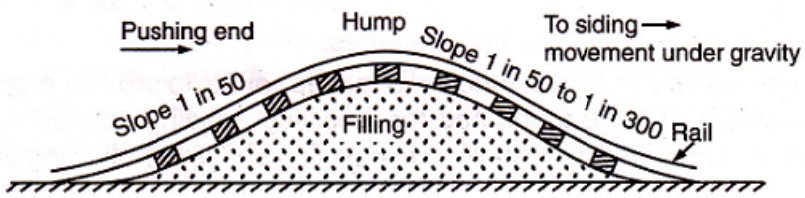
Marshalling yards are of following types :

(a) Flat yards
(b) Gravitational yards
(c) Hump yards

(a) Flat Yards : In flat yards, the tracks are laid on level ground and the entire space of yards is almost level. All the sorting work is done by means of engines running to and fro. Such yards are provided at the places where space is limited.

(b) Gravitational Yards : In this type of yards, the tracks are laid at such a gradient that wagons move under the action of gravity. Manual wagon brakes are used to control the movement of wagons.

(c) Hump Yards : In hump yards, humps or artificial hills are provided and wagons are pushed to the hump by a shunting engine. The wagons are then allowed to roll down to opposite slope of hump under the action of gravity. This type of yard is more popular, because shunting operation is done more quickly than gravity or flat yards,



Hump yard

4. Locomotive Yards : The yards constructed to house locomotives are where facilities for watering, coaling, repairing etc. of locomotives are available are known as *locomotive yards.* These are constructed at junction stations and on the same side as the marshalling yards. The following are the main requirement of a locomotive yard :

(i) It should be located near passenger yard and goods yard.
(ii) It should have sick siding for engines.
(iii) It should have facilities like ash pits, inspection pits, turn table, engine shed, hydraulic jack etc.
(iv) It should have space and equipments for loading fuel in engines.
(v) It should have overhead tank for supply of water.
(vi) It should have space for future expansion.

12 What is meant by crossing? What are the requirements of an ideal crossing? Explain square, acute angle and obtuse angle crossing with diagrams.

ANS. Crossing is a device provided at the intersection of two running rails to permit the wheel flange, moving along one to pass across the other.

Requirements of an ideal crossing:

i. Crossing assembly should be rigid enough to withstand severe vibrations.
ii. Wing rails and nose of crossing should be able to resist heavy wear due to movement of wheel, hence should be manufactured of special steel (alloy steel).
iii. The nose of crossing should have adequate thickness to take all stresses acting on the crossing.

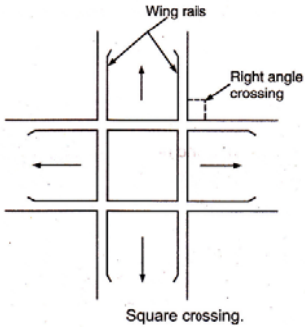
TYPES OF CROSSINGS

Crossings can be classified as follows :

1. On the basis of shape of crossing
   (a) Square crossing
   (b) Acute angle or V-crossing or Frog
   (c) Obtuse angle or Diamond crossing
2. On the basis of assembly of crossing
   (a) Ramped crossing
   (b) Spring or movable crossing.

Square Crossing

Square crossing is formed when two straight tracks of same or different gauge, cross each other at right angles. This type of crossing should be avoided on main lines because of heavy wear of rails.



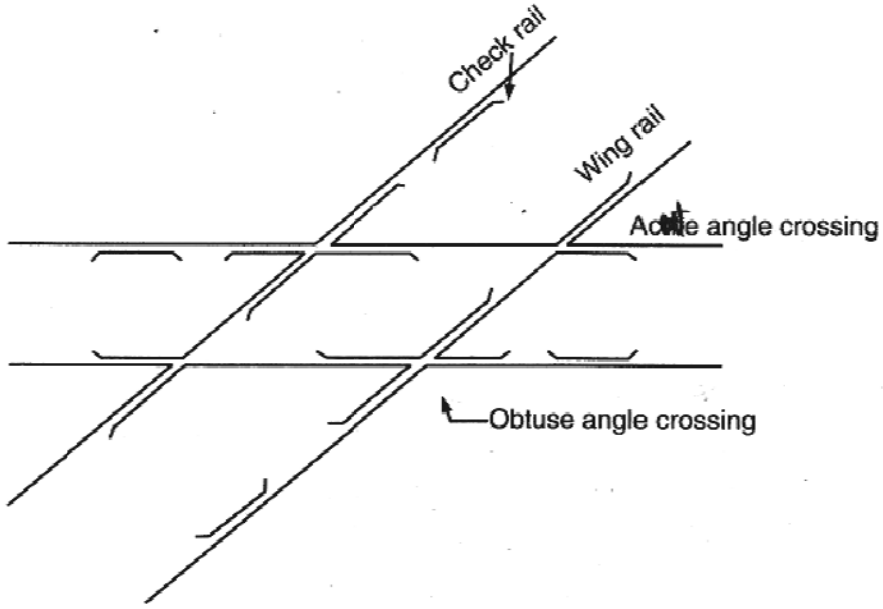
Square crossing.

Acute Angle Crossing

Acute angle crossing is formed when left hand rail of one track crosses right-hand rail of another track at an acute angle or vice versa. This type of crossing consists of a pair of wing rails, a pair of check rails, a point rail and a splice rail. This crossing is widely used.

Obtuse Angle Crossing

Obtuse angle crossing is formed when left hand rail of one track crosses right hand rails of another track at an obtuse angle or vice versa. This type of crossing consists mainly of two acute angle and two obtuse angle crossings. This is also called Diamond crossing.



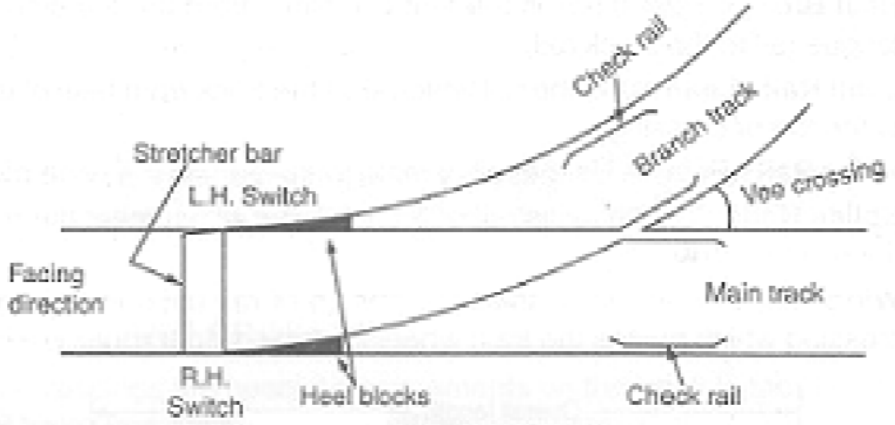
Obtuse angle crossing.

13 What is meant by turnout? Enumerate and explain the component parts of a turn out with their functions.

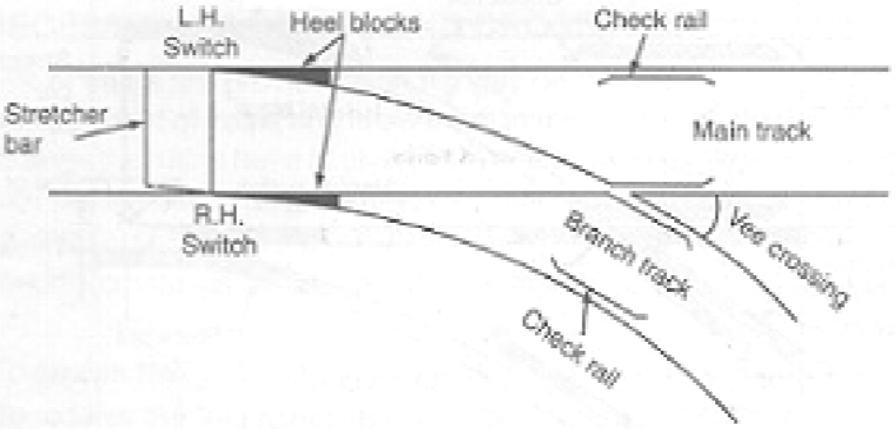
ANS.

TURNOUT

Turnout is an arrangement of points and crossings with lead rails by which trains may be diverted from one track to another moving in the facing direction



Left hand turnout



Right had turnout

A turnout is left handed or right handed as the train taking the turnout in the facing direction is deverted to the left or right of the main line.

Component Parts of a Turnout and their Functions

Following are the component part of a turnout (shown in Fig.

(i) A pair of tongue rails
(ii) A pair of stock rails
(iii) Two check rails
(iv) Four lead rails
(v) A vee crossing
(vi) Slide chairs
(vii) Stretcher bar
(viii) A pair of heel blocks

(ix) Switch tie plate or gauge tie chair

(x) Parts for operating points - Rods, cranks, levers etc.

(xi) Locking system which includes locking box, lock bar plunger bar etc.

(i) **A Pair of Tongue Rails :** The tongue rails along with the stock rails in a turnout form a pair of points or switches. The tongue rails facilitate the diversion of a train from the main track to a branch track.

(ii) **A Pair of Stock Rails :** They are the main rails to which the tongue rails fit closely. The stock rails help in smooth working of tongue rails.

(iii) **Two Check Rails :** Check rails are provided adjacent to the lead rails, one in main track and another branch track. These rails check the tendency of wheels to clamp over the crossing.

(iv) **Four Lead Rails** : Outer straight lead rails, outer curve lead rail, inner straight lead rail and inner curve lead rail are the four lead rails provided in a turnout. The function of these rails is to lead the track from heel of switches to the toe of crossing.

(v) **A Vee Crossing :** A Vee crossing is formed by two wing rails, a point rail and a splice rail. It provides gaps between the rails so that wheel flanges pass through them without any obstruction.

(vi) **Slide Chairs :** Chairs are provided to support the tongue rails throughout their length and to allow lateral movement for changing of points.

(vii) **Stretcher Bar :** Stretcher bar connects toes of both the tongue rails so that each tongue rail moves through the same distance while changing the points.

(viii) **A Pair of Heel Block :** These keep the heel ends of both the tongue rails at fixed distance from their respective stock rails.

(ix) **Switch Tie Plate :** The function of switch tie plate is to hold the track rigidly to the definite gauge at the toe of switches. These are provided below the slide chairs.

14 a. What is tunnel? Give the necessity of tunnels?

b. What are the advantages and disadvantages of tunnels?

ANS.

TUNNELS

Tunnels are underground passages constructed without removing the overlying rock or soil.

It is also defined as "an engineering structure, artificial gallery, passage or roadway beneath the ground, under the bed of a stream or through a hill or mountain".

These are constructed for the transportation of passengers, freight, water, gas, sewage etc.

NECESSITY OF TUNNELS

(a) To avoid longer surface route of railway track or road for reaching the other side of a hill.

(b) To avoid more depth of open cut for reaching the other side of a hill. As depth of open cut larger than 20 m is difficult to construct and maintain.

(c) To connect two terminal stations separated by a mountain.

(d) To carry road or railway traffic under the river bed when the provision of a bridge across the river is inconvenient and costlier.

(e) To avoid acquisition of valuable land and property for a road or railway project.

(f) To provide rapid transportation system in big cities and to avoid holding of traffic, for long periods due to traffic congestion.

(g) To protect railway track or road at high altitudes from blockage due to landslides or snow fall.

(h) To economically carry public aminities like water, oil, gas etc. across a stream or mountain.

(i) To avoid damage to transportation system of strategic importance and for safety of traffic during aerial war.

Advantages

(i) They avoid dangerous open-cut adjacent to the structure.

(ii) They carry public utilities like water, gas, railway lines or roads across a stream or a mountain.

(iii) Due to lighter grades possible in tunnels cost of hauling is decreased.

(iv) Tunnels are very useful during aerial warfare and bombing of citites.

(v) Tunnels protect pavements from snow, rain and other natural influences and hence less maintenance and operating cost.

(vi) They facilitate conduction of water to generate power.

Disadvantages

(i) Tunnels require more time to construct as compared to open cut.

(ii) Construction of tunnels is costlier than open out.

(iii) They require specialised equipments and methods for their construction.

(iv) Construction of tunnels requires skilled labour.

15 What do you understand by harbor planning? What considerations are taken in selecting the position of a harbor?

ANS.

Before construction of any Civil Engineering structure the requirement of the users has to be examined in detail followed by selection of suitable site which will satisfy the users demand. Harbour planning is accordingly governed by :

(*a*) Number of ships expected to visiting the harbour along with the characteristics of the ships expected to visit the planned harbour.

(*b*) Requirement of the harbour in respect of its accessibility size, shape, depth and salient features such as entrance, approach, turning basin, berthing basin, quay and wharves, Jetties docks, spillways, breakwaters ancillaries such as godowns, sheds, buoys, lights, fire protection etc.

Once the provisional selection of site has been arrived at the site has to be examined with respect to the following :

(*i*) Survey of the proposed area.

(*ii*) Soil investigation including borings, and soundings.

(*iii*) Nature of the harbour study of existence of sea insects.

(*iv*) Natural meteorological phenomena such as frequency of storms, range of tides, intensity of winds etc.

The above features associated with planning of harbour are briefly described below :

1. Characteristics of ships affecting the design and planning of the harbour :

(*i*) The dimensions of the channel will affect the type of vessel which can be accommodated in the harbour.

(*ii*) The number of vessels decide the type of channel to be designed will be single lane or double lane.

(*iii*) Speed of ship, alignment of channel will govern the development of the proposed harbour.

16 What is drainage of tunnels? What is its necessity? Explain various methods of drainage of tunnels, give neat sketches.

ANS.

DRAINAGE OF TUNNELS

Drainage system is provided in tunnels to collect and remove water entering the tunnel during and after construction. This is essential for the followings :

(i) For the progress of work during construction.

(ii) To reduce wear and tear of communication route.

(iii) To provide safety of the moving vehicles.

Classification of Drainage System

Drainage systems are classified as :

(a) Drainage system provided at the time of construction or temporary drainage system.

(b) Drainage system provided in completed tunnels or permanent drainage system.

• **(a) Temporary Drainage System :** This is provided to remove groundwater from the tunnel at the time of construction. In this system water is removed either by

(i) Open-ditch drainage system or

(ii) Pumping system

(i) Open-Ditch Drainage System : In this system, water is collected and removed in open ditches, laid with proper slopes at some distance away from the place of work. This is suitable for impermeable soil and rock bases.

(ii) Pumping System : In this system sumps are constructed at regular intervals. Water is collected in the sumps and is pumped out.

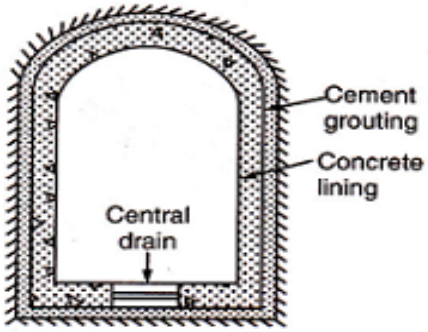
(b) Permanent Drainage System : Permanent drainage system is provided in one of the following methods.

(i) By providing a central drain

(ii) By providing side drains

(iii) By providing corrugated iron shed and side drains.

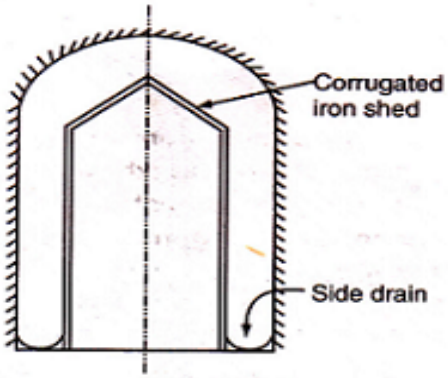
(i) By Providing a Central Drain : A central drain is provided between two railway tracks or under the pavement. It should have enough capacity to handle the expected water in the tunnel. It should be provided with facilities for inspection and clearing. Inspection manholes are also provided at 30 m to 50 m interval.



Central drain system

(ii) By Providing Side Drains : This system is suitable in single lane road or railway tunnel and where the quantity of water to be drained is small. In this system, drains are provided on either side of the track or road.

(iii) By Providing Corrugated Iron Shed and Side Drains : This is provided in tunnels in which water leaks from the roof and side walls of tunnels. By providing corrugated iron shed, shaped to the contour of the roof, water is prevented from dropping on the pavement or railway track. The corrugated shed guides the water to the side drains and is drained out.



Corrugated iron shed and side drains