Model Set Questions with Answers

MODEL - 1

(CET - 603)

Full Marks : 70 **Time : 3 Hours**

Answer any **five** questions.

The figures in the right-hand margin indicate marks.

1. (a) What do you mean by Afflux ? [2
   (b) Discuss the various factors which should be considered while selecting site for bridge. [5
   (c) Draw a neat sketch of permanent way. Explain the function of each component. [7
2. (a) What is coning of wheel ? [2
   (b) List the requirements of an ideal rail joint. [5
   (c) Name the different methods of welding rails. Describe any one method. [7
3. (a) What are the two types of switches used in Railway point and crossing ? [2
   (b) What are the main causes of failure of a railway embankment ? [5
   (c) Prepare a neat sketch of a typical cross section of an embankment with the ballast section for a single-line or double-line broad gauge. [7
4. (a) Define permanent way. [2
   (b) What do you understand by deep screening of ballast ? Describe the procedure. [5
   (c) What is the need for the proper maintenance of a track ? Discuss the various methods that ensure that a track is well maintained. [7
5. (a) What do you mean by crossing ? [2
   (b) What are the various points required to be checked during the inspection of points and crossings ? [5
   (c) Calculate the lead and radius of a 1 in 8.5 BG turnout for 90 R rails using Coles method. [7
6. (a) What is boxing ? [2
   (b) Draw a neat sketch of simple right hand and left hand turnout show various components used in it. [5
   (c) What is the ballast ? Why is it used in the railway track ? Briefly describe the various types of ballasts used. [7
7. (a) What do you mean by linear waterway ? [2
   (b) Explain briefly the necessity of providing bearing in bridges. [5
   (c) Classify and describe briefly each classification of steel and concrete bridges. [7

MODEL - 1 (ANSWER)

1. (a) What do you mean by Afflux ?

Ans. Afflux : To carry the maximum flood discharge the velocity under a bridge increases. The increased velocity gives rise to a sudden heading up of water on the upstream side of stream is known as afflux.

(b) Discuss the various factors which should be considered while selecting site for bridge.

Ans. Selection of Bridge Site : The choice of the right site is a crucial decision in the planning and designing of a bridge. It may not be possible always to have a wide choice of sites for a bridge. This is particularly so in case of bridges in urban areas and flyovers. For river bridges in rural areas, usually a wider choice may be available.

The characteristics of an ideal site for a bridge across a river are :

(i) A straight reach of the river.
(ii) Steady river flow without serious whirls and cross currents.
(iii) A narrow channel with firm banks.
(iv) Suitable high banks above high flood level on each side.
(v) Rock or other hard inerodible strata close to the river bed level.
(vi) Economical approaches which should not be very high or long or liable to flank attacks of the river during floods, the approaches should be free from abstacles such as hills, frequent drainage crossings, sacred places, graveyards, or built up areas or troublesome land acquisition.
(vii) Proximity to a direct alignment of the road tobe connected.
(viii) Absense of sharp curves in the approaches.
(viii) Absense of expensive river training works.
(ix) Avoidance of excessive underwater construction.

(c) Draw a neat sketch of permanent way. Explain the function of each component.

Ans. The Permanent Way : The combination of rails, fitted on sleepers and resting on ballast and sub-grade is called the railway track or permanent way. Sometimes temporary tracks are also laid for conveyance of earth and materials during construction works. The name permanent way is given to distinguish the final layout of track from these temporary tracks. Figure below shows a typical cross section of a permanent way on an embankment.

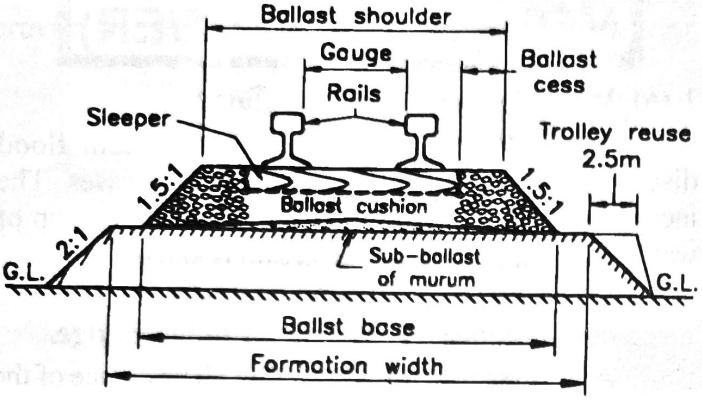


Fig. Typical Cross-section of a Permanent Way on Embankment.

In a permanent way, the rails are joined in series by fish plates and bolts and then they are fixed to sleepers by different types of fastenings. The sleepers properly spaced, resting on ballast, are suitably packed and boxed with ballast. The layer of ballast rests on the prepared subgrade called the formation.

The rails act as girders to transmit the wheel load to the sleepers. The sleepers hold the rails in proper position with respect to the proper tilt, gauge and level, and transmit the load from rails to the ballast.

The ballast distributes the load over the formation and holds the sleepers in position.

On curved tracks, super-elevation is maintained by ballast and the formation is levelled. Minimum ballast cushion is maintained at the inner rail, while the outer rail gets kept more ballast cushion. Additional quantity of ballast is provided on the outer cess of each track for which the base width of the ballast is kept more than for a straight track.

2. (a) What is coning of wheel ?

Ans. Coning of Wheel : The tread of the wheels of a railway vehicle is not made flat, but sloped like a cone in order to enable the vehicle to move smoothly on curves as well as on straight tracks. The wheels are generally centrally aligned on a straight and level surface with uniform gauge, and the circumference of the treads of the inner and outer wheels are equal.

(b) List the requirements of an ideal rail joint.

Ans. Requirements of an Ideal Rail Joint : The ideal rail joint is one that provides the same strength and stiffness as the parent rail. The characteristics of an ideal rail joint are briefly summarized here.

Holding the rail ends. An idea rail joint should hold both the rail ends in their precise location the horizontal as well as the vertical planes to provides as much continuity in the track as possible. This helps in avoiding wheel jumpting or the deviation of the wheel from its normal path of movement.

Strength. An ideal rail joint should have the same strength and stiffness as the parent rails it joins.

Expansion gap. The joint should provide an adequate expansion gap for the free expansion and contraction of rails caused by changes in temperature.

Flexibility. An ideal rail joint should provide flexibility for the eacy replacement of rails, whenever required.

Provision for wear. An ideal rail joint should provide for the wear of the rail ends, which is likely to occur under normal operating conditions.

Elasticity. An ideal rail joint should provide adequate elasticity as well as resistance to longitudinal forces so as to ensure a trouble-free track.

Cost. The initial as well as maintenance costs of an ideal rail joint should be minimal.

(c) Name the different methods of welding rails. Describe any one method.

Ans. There are four welding methods used on railways.

(i) Gas pressure welding

(ii) Electric arc or metal arc welding.

(iii) Flash butt welding.

(iv) Thermit welding

The detail descriptions of o ne method :

Gas Pressure Welding : In this type of welding, the necessary heat is produced by the combination of oxygen and acetylene gases. The rail ends to be welded are brought together and heat is applied through a burner connected to oxygen and acetylene cylinders by means of regulators and tubes. A temperature of about 1200°C is achieved. At this temperature, the metal of the rail ends melts, resulting in the fusion and welding together of the ends.

The rails to be welded are clamped at the wall by applying a pressure of 40 t pressure, heated to a temperature of about 1200°C to 1400°C, and butted with an upset pressure of about 20 t. Then the joint is again heated to a temperature of 850°C and allowed to cool naturally. It has been seen that this method of welding is cheaper as compared to flash butt welding. The quality of this welding joint is also claimed to be quite good. There are both stationary and mobile units available for gas gas pressure welding.

The process, though simple, has not yet been adopted on a large scale by Indian Railways. The main reason behind this is its limited output and the difficult and irregular availability of gas.

3. (a) What are the two types of switches used in Railway point and crossing ?

Ans. The two types of switches used in railway crossing and points are Tongue rail and Stock rail.

(b) What are the main causes of failure of a railway embankment ?

Ans. Failure of Railway Embankment : A railway embankment may fail due to the following causes.

- Failure of the natural ground.
- Failure of the fill material in the embankment.
- Failure of the formation top.

Failure of the Natural ground :

The natural ground on which the embankment is made can fail either due to shear failure or due to excessive settlement. Failure of this kind is generally associated with the unheaval of the ground beyond the toes of the embankment. Shear failure of natural ground generally takes place when construction is in progress or immediately after construction. Once the ground stabilizes, it hardly fails under existing embankments.

Failure of the Fill Material of Embankments :

Sometimes shear failure and excessive settlement of an embankment takes place due to the failure of the fill material of the embankment. This can easily be avoided by judicious selection of the fill material, better construction procedures, and adopting a suitably designed section for a new embankment.

Failure of the Formation Top :

Failure of the formation top is very common in clayey soils during or just after monsoons. Some locations may trouble throughout the year. The main causes for such failures, are :

- Low bearing capacity of the soil.
- Action of water and moving loads.
- Effect of weather.

(c) Prepare a neat sketch of a typical cross section of an embankment with the ballast section for a single-line or double-line broad gauge.

Ans.

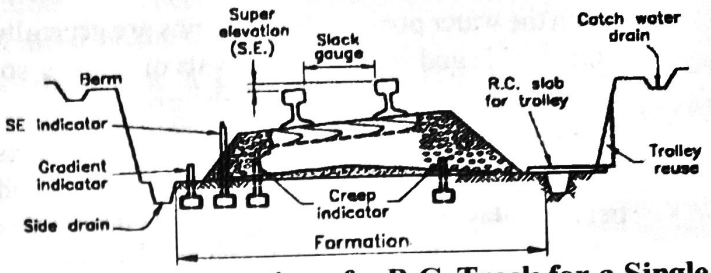


Fig. The Cross-section of a B.G. Track for a Single line (on Curved Track)

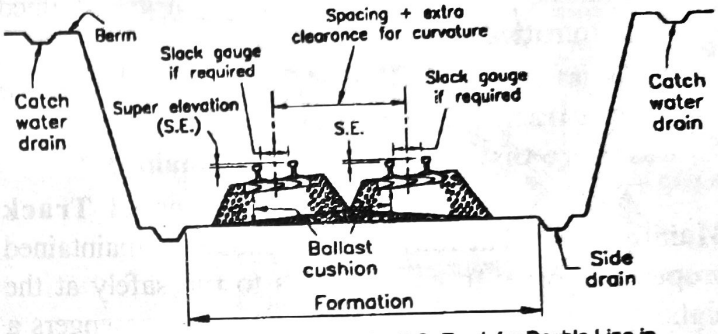


Fig. 3.6 The Cross-section of a B.G. Track for Double Line in Cutting (on Curved Track)

4. (a) Define permanent way.

Ans. Permanent Way is the track which is of permanent nature and handles the normal commercial traffic for which it meant.

(b) What do you understand by deep screening of ballast ? Describe the procedure.

Ans. Deep Screening of Ballast : The problem of ballast pockets canbe tackled by assessing the depth of the penetration of the ballast in the bank. For this purpose, about five vertical trial bores are drilled to get a complete picture of the drainage condition of the subsurface structure. Water pockets can then be removed by any of the methods, depending upon the situation.

(i) If the problem has just started, it can be remedied by deep screening and the provision of a previous layer of 30-60 cm. If necessary, the water pockets can be drained using a perforated pipe drain inserted with the help of a jack.

(ii) Cement grouting can also be done to seal thewater pockets in case of problem is in a very small stretch. This method is, however, very expensive.

(iii) If the problem is extensive, a geological survey

should be done to access the type of soil strata available. In case there is impervious soil under the water pocket, it can be drained out using a perforated pipe to deep screening of the ballast is done, the water pockets are drained out using a perforated pipe, and then an inverted filter of about 30 cm thickness is provided.

(iv) Counterfiet drains are sometimes provided to drain the water pockets. S uch drains are generally 60 cm wide and spaced at intervals of 10 m or so, depending upon the extent of the problem.

(v) Water may also be help up in the ballast pockets by an impervious layer of soil over a good pervious layer of soil of fissured strate. In this case the remedy lies in drilling a tap hole in the thin impervious strata, allowing the water to go into the pervious sub-soil, where it gets drained automatically.

(c) What is the need for the proper maintenance of a track ? Discuss the various methods that ensure that a track is well maintained.

Ans. Necessity and Advantaes of Track Maintenance : The railway track should be maintained properly in order to enable trains to run safely at the highest permissible speeds and to provide passengers a reasonable level of comfort during the ride. Track maintenance becomes a necessity due to these reasons.

(i) Due to the constant movement of heavy and high-speed trains, the packing under the sleepers becomes loose and track geometry gets disturbed. The gauge, alignment, and longitudinal as well as cross levels of the track thus get affected adversely and the safety of the track is jeopardized.

(ii) Due to the vibrations and impact of high-speed trains, the fittings of the track come undone and there is heavy wear and tear of the track and its components.

(iii) The track and its components get worn out as a result of the weathering effect of rain, sun, and sand.

A well-maintained track offers a safe and comfortable journey to passengers. If the track is not maintained properly, it will cause discomfort to the passengers and in extreme cases may even give rise to hazardous conditions that can lead to derailments and a consequential loss of life and property. Track maintenance ensure that such situations do not arise.

(i) If the track is suitably mainained, the life of the track as well as that of the rolling stock increases since there is lesser wear and tear of their components.

(ii) Regular track maintenance helps in reducing operating costs and fuel consumption.

(iii) Small maintenance jobs done at the appropriate time such as tightening a bolt or key, hammering the dog spike, etc., helps in avoiding loss of the concerned fitting and thus saving on the associated expenditure.

(iv) When track maintenance is neglected for a long time, it may render the track beyond repair, calling for heavy track renewals that entail huge expenses.

5. (a) What do you mean by crossing ?

Ans. Crossing : Crossings are contrivances or arrangements by which different routes either parallel or diverging are connected and affort the means for train to move from the route to another. These connections are not only useful for trains to move from one route to another but also help for marshalling and shunting work in station yards.

(b) What are the various points required to be checked during the inspection of points and crossings ?

Ans. Inspection and Maintenance of Points and Crossings : Points and crossings should be inspected in detail, as the quality of a train ride greatly depends on their maintenance. The following important points should be checked.

Condition of tongue rails and stock rails. There should be no wear on the top as well as the gauge face side of the tongue rail.

Condition of fittings of tongue and stock rails. The fitting should be tight and the spherical washers must be placed at their correct locations.

Gauge and cross level at switch assembly. The gauge and cross levels should be checked for correctness at the following locations : (i) the stock joint, (ii) 150 mm (6″) behind the toe of the switch, (iii) the mid-switch for the straight track and for the turnout side, and (iv) the heel of the switch for the straight track and for the turnout side.

Clearance between stock and tongue rails at the heel of thw switch. The correct divergence to be provided at heel of the switch :

1 in 16 or 1 in 12	1 in 8.5
BG – 133 mm (5.25″)	120 mm (4.25″)
MG – 117 mm (4.65″)	120 mm (4.75″)

Throw of the switch. The throw of the switch should be as follows :

Recommended	Minimum
BG – 115 mm (4.25″)	95 mm (3.25″)
MG – 100 mm (4″)	89 mm (3.5″)

Condition of crossing and tongue rail. The condition of the crossings and of the fittings should be checked. The maximum vertical wear permitted on a point or wing rail is 10 mm and these should be reconditioned when the wear is 6 mm.

Gauge and cross level of crossing assembly. The gauge and cross level should be checked at the following locations and should always be correct : (i) 1m ahead of the nose on straight tacks and on turnouts, (ii) 150 mm (6″) behind the ANC on straight tracks and on turnouts, and (iii) 1m behind the ANC on straight tracks and on turnouts.

Check rails. The condition of check rails should be ascertained. Check rail clearance should be as follows:

Maximum	Minimum
BG 48 mm	44 mm
MG 44 mm	41 mm

Lead curvature : The curvature should be checked either by the offset method or by the ersine method. The curvature should be correct and uniform.

Cross levels on straiht tracks and turnouts. The cross levels on straight tracks and turnouts should be checked to see that they are correct at all places.

Sleepers. The condition of the sleepers and their fittings should be checked and unserviceable sleepers should be replaced. The squaring and spacing of sleepers should be proper and they should be well packed.

Ballast and drainage. Enough quantity of ballast should be available so as to provide an adequate cushion. The drainage should be proper.

(c) Calculate the lead and radius of a 1 in 8.5 BG turnout for 90 R rails using Coles method.

Ans. G = 1.676 m d = 120 mm

$\alpha = 6° 41'35''$ N = 8.5

(i) Curve lead (CL) = 1 + N2

= 1.676 × 8.5 + 1.6761 + 8.52

= 28.6 m.

(ii) Radius of turnout curve (R) = 1.5 G + 2 GN2

= 1.5 × 1.676 + 2 × 1.676 × 8.5

= 245 m.

(iii) Switch lead (SL) = 2 Rd – d2

= 2 × 2.45 × 0.12 – 0.122 = 7.67 m.

(iv) Lead = CL – SL = 20.6 – 7.7 = 20.9 m.

6. (a) What is boxing ?

Ans. Boxing : For process of filling the ballast around the sleepers is called boxing of the ballast. This ballast boxes the sleeper.

(b) Draw a neat sketch of simple right hand and left hand turnout show various components used in it.

Ans.

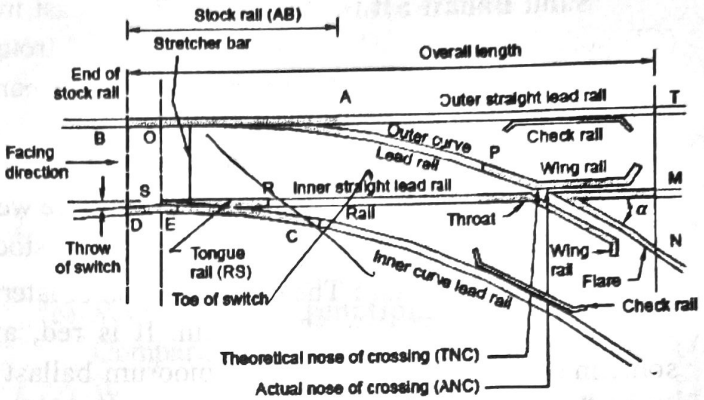


Fig. Constituents of a turnout

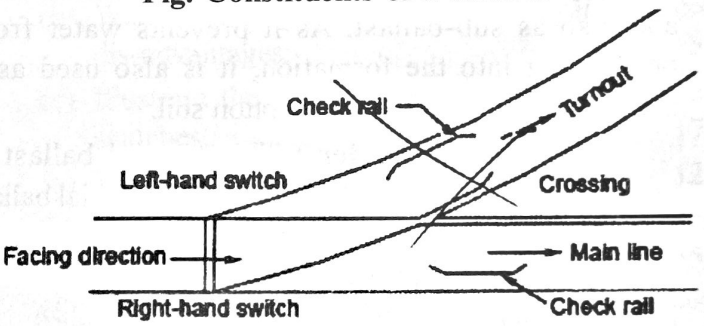


Fig. Left-hand turnout

(c) What is the ballast ? Why is it used in the railway track ? Briefly describe the various types of ballasts used.

Ans. The ballast is a layer of broken stones, gravel, moorum, or any other granular material placed and packed below and around sleepers for distributing load from the sleepers to the ballast. It helps in providing elasticity to the track.

The uses of function of ballast inthe Railway Track:

- Provides a level and hard bed for the sleepers to rest on.
- Holds the sleepers in position during the passage of trains.

- Transfer and distributes load from the sleepers to a large area of the formation.
- Provides elasticity and resilience to the track for proper riding comfort.
- Provides the necessary resistance to the track for longitudinal and lateral stability.
- Provides effective drainage to the track.
- Provides an effective means to maintaining the level and alignment of the track.

Types of Ballast :

- The different types of ballast used on Indian Railways are described in the following :

Sand Ballast : It is used primarily for cast iron (CI) pots. It is also used with wooden and steel trough sleepers in areas where traffic density if very low. Coarse sand is preferred in comparison to fine sand. It has good drainage properties, but has the drawback of blowing off because of being light. It also causes excessive wear of the rail top and the moving parts of the rolling stock.

Moorum Ballast : The decomposition of laterite results in the formation of moorum. It is red, and sometimes yellow, in colour. The moorum ballast is normally used as the initial ballast in new constructions and also as sub-ballast. As it prevents water from percolating into the formation, it is also used as a blanketing material for black cotton soil.

Coal ash or cinder : This type of ballast is normally used in yards and sidings or as the initial ballast in new constructions since it is very cheap and easily available. It is harmful for steel sleepers and fittings because of its corrosive action.

Broken stone Ballast : This type of ballast is used the most on Indian Railways. A good stone ballast is generally procured from hard stones such as granite, quartizite, and hard trop. The quality of stone should be such that neither is it porous nor does it flake off due to the vagaries to weather. Good quality hard stone is normally used for high-speed tracks. This type of ballast works out to be economical in the long-run.

7. (a) What do you mean by linear waterway ?

Ans. Linear Waterway : The linear waterway of a bridge shall be the length available in the bridge between extreme edge of a water surface at the highest flood level, measured at right angles to the abutment faces.

(b) Explain briefly the necessity of providing bearing in bridges.

Ans. The main functions of the bearings can be divided under the following categories :

(i) Longitudinal movement due to Temperature Variations : Temperature variations, result in expansion or contraction of the members, if one end of a simply supported members is free to move longitudinally, other end being held in position, changes in temperature of concrete lengthens, or shortens, the member itself. In other words, stresses in the members, due to temperatue variation can be avoided if adequate arrangement are provided at ne of its ends to move freely in a longitudinal direction. In RCC and prestresed concrete bridges, where rich mixes are adopted shrinkage starts from the movement concrete is poured and may continue for two or three months or more. In the bridge super-structure due to its expansion or contraction end of the super-structure must rest on bearing which will allow freely such longitudinal movement to take place.

(ii) Transference of Horizontal forces due to Braking : Due to application of brakes to vehicles, the super-structure of bridge is acted by breaking forces. This force can be fully transmitted to the sub-structure only if one of the bearing is fixed and does not permit horizontal movement.

(iii) Rotation of supports due to Deflection of Girders : The deflection of a simply supported girder under loads, result in an angular movement over the supports. The bearing at both ends must accordingly rotate to assume a position tangents to the deflected bottom shape of the girder. If this angular movement is not provided for the result is a bad distribution of the bearing pressure in the bridge seating, the forward area being loaded much more heavily than the rear.

(iv) Vertical movement due to sinking of the support.

(c) Classify and describe briefly each classification of steel and concrete bridges.

Ans. Rainforced Cement Concrete Bridge :

There are numerous type of bridges built in reinforced cement concrete. The following are in general use.

(1) Slab Bridges : This is the simplest type of RCC bridge and easiest to construct. This type is mot suitable as submersible bridge. It is suitable for span upto 8m.

(2) Girder Bridges : This type of bridge is

ıs as main girders. For two lane or wider ıdway is supported on a number of tee ıgitudinal girders with or without ams.

low Girder Bridges : These bridges are spans between 25 to 30 m. They are losed box section. The design of hollow to that of T-beam super-structure, except bars are spread over a larger area on the

anced Cantilever Bridge : It can be used ng from 35m to 60 m. In yielding river ındations are expensive and small spans cal, it can be used with advantages.

tinuous Bridges : They are used for d where unyielding foundations are gh stresses are introduced even if slight piers or abutments occur usually end span out 16% to 20% smaller than the ans.

h Bridges : These are more graceful earance and suited for deep gorges within ese bridges can be economically used out 200 m. The arches may be of barriel

Steel Bridges : Steel bridges, are builkt ses carrying a highway a railway track, water pipes, gas or oil pipes etc. For in India steel is used for very small span ans.

g upon the efloor location, bridges can :

dges : In this type of floor is place done a plate girder and on the top chord in a

Bridges : In this type the floor is level of lower chord and the top chord ly.

ugh Bridges : In this type the floor is near the bottom, but the top chords of braced.

Deck Bridges : May rail-cum-road tructed with two decks.

The figures in the right-hand margin indicate marks.

1. (a) What do you mean by super elevation or cant ? [2
   (b) Describe briefly negative super elevation with neat sketch. [5
   (c) Calculate the maximum permissible speed on a curve of high speed B.G. track having the following particulars : [7
   (i) Degree of the curve = 1
   (ii) Amount of super elevation = 8.0 cm.
   (iii) Length of transition curve = 130 meters.
   (iv) Maximum speed of the section likely to be sactioned = 153 k.m.p.h.
2. (a) What is ballast crib ? [2
   (b) Write down the types of ballast briefly. [5
   (c) What are the functions of ballast ? Write Comparison of different types of ballast. [7
3. (a) What is rail failure ? [2
   (b) What is bearing plates ? Write its advantages and dis-advantages. [5
   (c) Illustrate the various types of rail failures with sketches. [7
4. (a) Write the different types of crossing. [2
   (b) Draw a neat line diagram of right hand and left hand turnout and show its component parts. [5
   (c) What is turnout ? Describe the design of turnouts and fittings with turnouts. [7
5. (a) Mention different types of movable bridge. [2
   (b) What is wing walls ? Write at least three function of wing wall. [5
   (c) Write the classification of bridge and describe its components. [7
6. (a) What is Sand piling ? [2
   (b) What are the effects of creep of rails ? [5
   (c) What are the main causes of failure of a railway embankment, draw a neat figure and failure of formation ? [7
7. (a) What do you mean by grade compensation ? [2
   (b) Explain Transition curve with a diagram. Write the requirements of an ideal transition curve. [5

(c) Enumerate the parameters which affect the geometrical design. Write the necessity of geometric design. [7

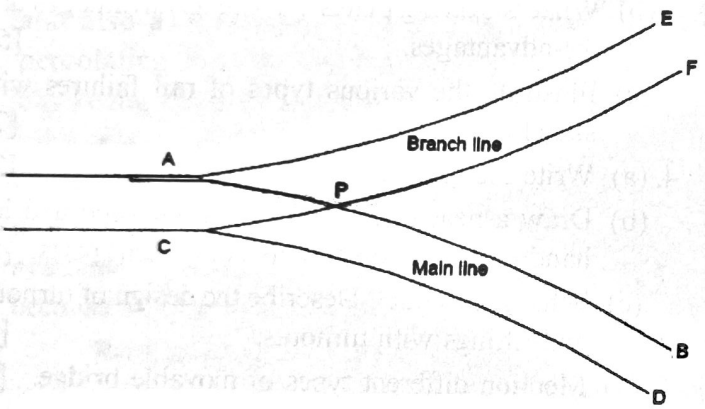
MODEL - 2 (ANSWER)

1. (a) What do you mean by super elevation or cant ?

Ans. On counteract the effect of centrifugal force, the level of outer rail is rised above the inner rail by a certain amount. This raising of outer tail over the inner rail is called superelevation or cart.

(b) Describe briefly negative super elevation with neat sketch.

Ans. Negative Superelevation : When the main line lies on a curve and has a turnout of country flexure leading to a branch line, the superelevation necessary for the average speed of trains running over the main line curve cannot be provided. AB, which is the outer rail of the main line curve, must be higher than CD. For the branch line, however, CF should be higher than AE or point C should be higher than point A. These two countradicatory conditions cannot be met within one layout. In such cases, the branch line curve has a negative superelevation and, therefore, speeds on both tracks must be restricted, particularly on the branch line.



(c) Calculate the maximum permissible speed on a curve of high speed B.G. track having the following particulars :

(i) Degree of the curve = 1

(ii) Amount of super elevation = 8.0 cm.

(iii) Length of transition curve = 130 meters.

(iv) Maximum speed of the section likely to be sactioned = 153 k.m.p.h.

Ans. Data given,

Degree of the curve = 1

Hence, Radius of the curve (R)

$$= \frac{1720}{1} = 1720 \text{ metres.}$$

(i) Safe speed on the curve (for high speed) :

$$L = 4.58\sqrt{R}$$

$$= 4.58\sqrt{1720}$$

$$= 4.58 \times 416.5 = 190 \text{ k.m.p.h.}$$

(ii) Speed from S.E. consideration :

Actual superelevation = 8.0 cms.

Maximum cant deficiency for high speed track = 10.0 cms.

Theoretical superelevation = 8.0 + 1.0 = 18.0 cms.

Equilibrium speed for this S.E.

$$18 = \frac{GV^2}{127\,R} \qquad \left(\text{as } e = \frac{GV^2}{127\,R}\right)$$

$$18 = \frac{1.676 \times V^2}{127 \times 1720}$$

$\therefore$ V = 153 k.m.p.h.

(iii) Speed from length of transition curve.

(a) $L = \frac{e \times V_{max}}{198}$

where, e = 8.0 cm or 80 mm.

L = 130 meters.

$$130 = \frac{80 \times V_m}{198}$$

$\therefore$ V_{max} = 320 k.m.p.h.

(b) $L = \frac{D \times V_{max}}{198}$

D = 100 mm, L = 130 meter.

or $130 = \frac{100 \times V_{max}}{198}$

V_{max} = 257 k.m.p.h.

The maximum permissible speed on the curve is :

(i) Safe speed on curve = 190 k.m.p.h.

(ii) Speed from S.E. consideration = 153 k.m.p.h.

(iii) Speed from length of transition curve = 257 k.m.p.h.

(iv) Maximum speed that can be sanctioned = 153 k.m.p.h.

Therefore, maximum permissible speed = 153 k.m.p.h. say 150 k.m.p.h.

2. (a) What is ballast crib ?

Ans. Ballast Crib : The loose ballast between the two adjacenet sleepers is known as ballast crib.

(b) Write down the types of ballast briefly.

Ans. Types of Ballast : The different types of ballast used on Indian Railways are :

Sand Ballast : It is used primarily for cast iron (CI) pots. It is also used with wooden and steel trough sleepers in areas where traffic density if very low. Coarse sand is preferred in comparison to fine sand. It has good drainage properties, but has the drawback of blowing off because of being light. It also causes excessive wear of the rail top and the moving parts of the rolling stock.

Moorum Ballast : The decomposition of laterite results in the formation of moorum. It is red, and sometimes yellow, in colour. The moorum ballast is normally used as the initial ballast in new constructions and also as sub-ballast. As it prevents water from percolating into the formation, it is also used as a blanketing material for black cotton soil.

Coal ash or cinder : This type of ballast is normally used in yards and sidings or as the initial ballast in new constructions since it is very cheap and easily available. It is harmful for steel sleepers and fittings because of its corrosive action.

Broken stone Ballast : This type of ballast is used the most on Indian Railways. A good stone ballast is generally procured from hard stones such as granite, quartizite, and hard trop. The quality of stone should be such that neither is it porous nor does it flake off due to the vagaries to weather. Good quality hard stone is normally used for high-speed tracks. This type of ballast works out to be economical in the long-run.

Other Types of Ballast : There are other types of ballast also such as brickbat ballast, gravel ballast, kankar stone ballast, and even earth ballast. These types of ballast are used only in special circumstances.

(c) What are the functions of ballast ? Write Comparison of different types of ballast.

Ans. Functions of Ballast : The ballast serves the following functions in a railway track.

- Provides a level and hard bed for the sleepers to rest on.
- Holds the sleepers in position during the passage of trains.
- Transfers and distributes load from the sleepers to a large area of the formation.
- Provides elasticity and resilience to the track for proper riding comfort.
- Provides the necessary resistance to the track for longitudinal and lateral stability.
- Provides effective drainage to the track.
- Provides an effective means of maintaining the level and alignment of the track.

Comparison of Different Types of Ballast :

Type of Ballast	Advantages	Disadvantages	Suitability
Sand ballast	• Good drainage properties. • Cheap • No noise produced on the track. • Good packing material for CI sleepers.	• Causes excessive wear • Blows off easily • Poor retentivity of packing. • Track cannot be maintained to high standards.	• Suitable for CI pot sleeper tracks. • Not suitable for high-speed tracks.
Moorum ballast	• Cheap, if locally available. • Prevents water from percolating. • Provides good aesthetics.	• Very soft and turns into dust. • Maintenance of track the difficult. • Quality of track average.	• Used as a sub-ballast • Initial ballast for new construction.

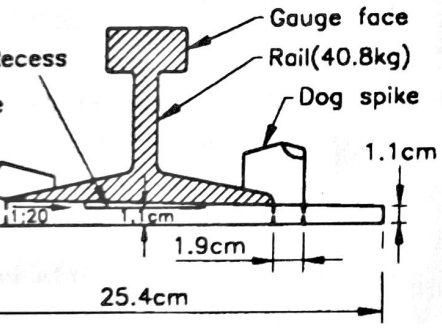
• Good drainage	• Soft and easily pulverized. • Maintenance is difficult.	
• Hard and durable when procured from hard rocks. • Good drainage properties. • Is stable and resilient to the track.	• Initial cost is high • Difficulties in procurement. • Angular shape may injure wooden sleepers.	• Suitable for packing with track machines. • Suitable for high speed tracks.

rail failure ?

l Failure : A rail is said to have failed if necessary to remove it immediately from count of the defects noticed on it. The failures originate from the fatigue cracks alternating stresses created in the rail unt of the passage of loads.

bearing plates ? Write its advantages advantages.

aring Plates : Bearing plates are es of Mild Steel (M.S.) or Cast Iron (C.I.) low F.F. rails to distribute the load on a timber sleepers particularly of soften below).



ages of using bearing plates are the

bute the load coming on rails to the ver a larger area and thus to prevent the rail in the soft wooden sleepers.

prevent the destruction of the sleeper bing action of the rail, thus increasing the sleeper and improving economy.

of sleeper is required when bearing plates are used because the bearing surfaces ar canted at 1 in 20. This results in uniforn distribution of load over sleepers.

(iv) They help in firm and perfect holding of spike to the sleepers which in turn prevent the shiftin of rails and no widening or cutting is required.

(v) Better maintenance of gauge, if bearing plates ar used, is possible.

Disadvantages of using bearing plates are the following.

(i) The plates rattle when loose.

(ii) When any hole for a spike is injuried and a new hole is required to be made in such cases, all the spikes in the bearing plate have to be pulled ou which spoil the good hold of the spikes.

(iii) When bearing plates are loose, they admi moisture and result in increase of mechanical wea of the sleepers.

(c) Illustrate the various types of rail failures with sketches.

Ans. Rail Failures : The sudden failure of a rail is generally due to defects in its manufacture, although the other causes may also exist. Two such other common causes, are : (i) Abrupt change of section of rail, (ii) Notches with corners in the foot of the rails. Such failures, though rare on Indian Railways, may occur in one or more of the following forms (figure below).

(i) Crushed Heads : Crushed heads are those which have either sagged or flattened. Besides the defect of manufacture, crushed heads are due to (a) slipping f wheels, (b) flat spots on wheels which are developed due to skidding of wheels, (c) weak support at the rail end. This weak and support may be due to loose fish bolts, (figure below).

(ii) Square or Angular Break : The rail may be completely broken either in a vertical plane or in an inclined plane. (figure below).

(iii) Split Heads : In this, cracks occur in the middle of the head or pieces are split from the side to the end of the head. If the surfaces of the crack, when opened, appear smooth and dark, the defective rail is known as "piped rail". This happens either due to cavity formed during manufacture or shringkage of metal when the metal not having been closely welded together.(fig)

(iv) Split Web : This is the through crack in the web, though not necessarily, runs through the bolt holes. (figure).

(v) Horizontal Fissures : These are developed in the rail head. They are more in the form of a fracture and develop gradually. (figure)

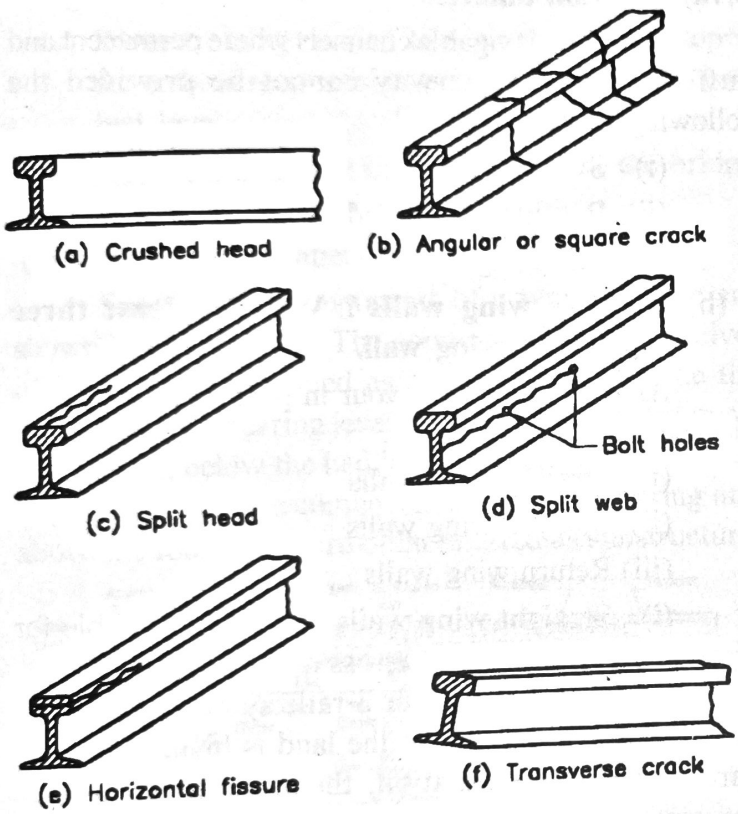


Fig. Different types of Rail Failures

(vi) Transverse Fissures : This is the most common cause of rail failures in America. It is a cross wire crack which starts from a point inside the head and spreads like contours shape gradually. The broken surface has a smooth oval or round bright spot. This defect is either a manufacturing defect or may occur due to overstraining of metal in service. (figure)

(vii) Flowing Metal in Heads : The metal in the rail head is forced to flow on the sides due to which, the rail head gets widened and depressed.

(viii) Horizontal Cracks : The occur at rail ends between head and web. Such tracks are believed to be due to worn fish plates or insufficient ballast packing under joint sleepers, resulting in pumping of joints and consequent fatigue failure of steel. This defect is very common in rails in America and is increasing day-by-day. This defect is either due to fatigue caused by shearing stresses or due to reversal of stresses (from high compressive to low tensile stresses) in the rail between supports.

In India, Sonirail Detector, an electronic device, for testing of rail and web defects and for failure detection, is used.

4. (a) Write the different types of crossing.

Ans. The different types of crossings are :

- Acute angle crossing.
- Obtuse or diamond crossing.
- Square crossing.
- Spring or movable crossing.
- Ramped crossing.

(b) Draw a neat line diagram of right hand and left hand turnout and show its component parts.

Ans. These are termed as left-hand or right-hand switches depending upon left or right when seen from the facing direction i.e., stand at the points and look towards the crossing, figure below.

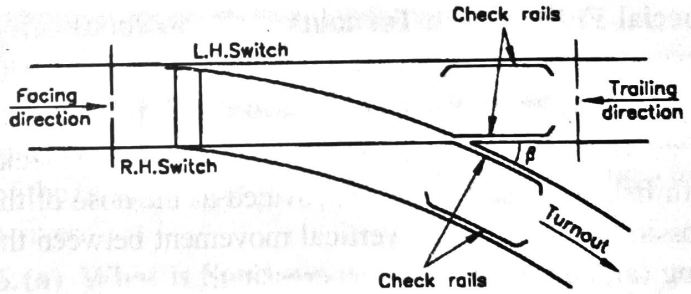


Fig. Line Diagram of Right-hand + Turnout.

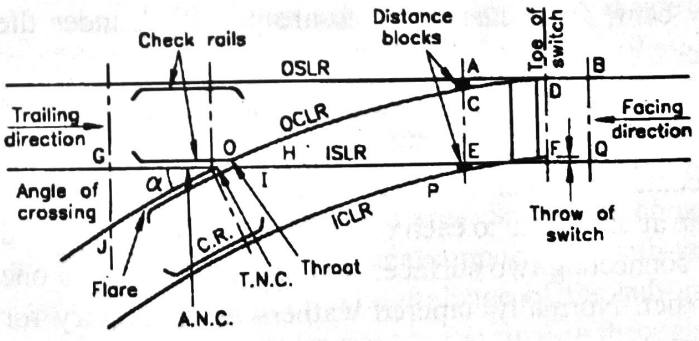


Fig. Line diagram of left-hand turnout

(c) What is turnout ? Describe the design of turnouts and fittings with turnouts.

Ans. Turnout : A complete set of points and crossing with the intervening lead rail is called a turnout. The simplest arrangement of points and crossing can be found on a turnout taking off from a straight track.

Describing the Design of Turnouts :

Curve Lead (CL) : This is the distance from the tangent point (T) to the theoretical nose of crossing (TNC) measured along the length of the main track.

Switch Lead (SL) : This is the distance form the tangent point (T) to the heel of the switch (TL) measured along the length of the main track.

Lead of Crossing (L) : This is the distance measured along the length of the main track as follows:

Lead of crossing (L) = curve lead (CL) – switch lead (SL).

Gauge (G) : This is the gauge of the track.

Heel Divergence (D) : This is the distance between the main line and the turnout side at the heel.

Angle of Crossing (α) : This is the angle between the main line and the tangent of the turnout line.

Radius of Turnout (R) : This is the radius of the turnout. It may be clarified that the radius of the turnout is equal to the radius of the centre line of the turnout (R1) plus half the gauge width.

$$R = R1 + 0.5\,G$$

As the radius of a curve is quite large, for practical purposes, R may be taken to be equal to R1.

Special Fittings with Turnouts :

Some of the special fittings required for use with turnouts are enumerated below.

Distance blocks : Special types of distance blocks with fishing fit surfaces are provided at the nose of the crossing to prevent any vertical movement between the wing rail and the nose of the crossing.

Flat bearing plates : As turnouts do not have any cant, flat bearing plates are provided under the sleepers.

Spherical wasters : These are special types of washers and consist of two pieces with a spherical point of contact between them. This permits the two surfaces to lie at any angle to each other. These washers are used for connecting two surfaces that are not parallel to one another. Normally, tapered wathers are necessary for connecting such surfaces. Spherical washers can adjust to the uneven bearings of the head or not of a bolt and behind the heel on the left-hand side of the track.

Slide chairs : These are provided under tongue rails to allow them to move laterally. These are different for ordinary switches and overriding switches.

Grade off chairs : These are special chairs provided behind the heel of the switches to give a suitable ramp to the tongue rail, which is raised by 6 mm at the level.

Gauge tie plates : These are provided over the sleepers directly under the toe of the switches, and under the nose of the crossing to ensure proper gauge at these locations.

Stretcher bars : There are provided to maintain the two tongue rails at an exact distance.

5. (a) Mention different types of movable bridge.

Ans. For navigable channels where permanent and sufficient clear waterway cannot be provided the following bridges are used.

(i) Swinging bridge

(ii) Bascule bridge and

(iii) Lift bridges

(b) What is wing walls ? Write at least three function of wing wall.

Ans. As per their layour in plan, wing walls are classified as follows :

(i) Straight wing walls

(ii) Splayed wing walls

(iii) Return wing walls

(i) Straight wing walls : They are suitable for small bridges constructed across drains with low banks. Generally, they are built for a railway bridge specially in cities, where the cost of the land is high. In case of hard and rocky foundation, the wing walls may be constructed in steps. When the soil loose, the foundations when provided. Must be built will vertical joint, as otherwise their will be a crack formed due to unequal settlement.

(ii) Splayed wing walls : They are constructed generally at 45° with abutment and are straight or curved in plan. This lop is 0.5m thick and their face batter is 1 in 12 and back batter is 1 in 6. They are best suited for the crossing of a river. They provide a smooth entry and exist to the flowing water. They are also adopted when the road has to narrow on crossing the bridge, or when two or more roads meet at the approach.

(iii) Return wing walls : These are walls built at

right angles to the abutment at its both ends. They are disgned to retain the earth filling of the approach road. Their top width is 1.5 m face is vertical, and the back is given either a batter of 1 in 4 or stepping if the abutment has a stepped back. They are suitable where the backs are high and rocky. They are best fitted where the cost of the land is high.

(c) Write the classification of bridge and describe its components.

Ans. Components of a Bridge : The main parts of a bridge structures are :

(i) Decking, consisting of deck slab, girders, trusses, etc.

(ii) Bearings for the the decking.

(iii) Abutments and piers.

(iv) Foundations for the abutments and the piers.

(v) River training works, like revetment for slopes for embankment at abutments, and aprons at river bed level.

(vi) Approaches to the bridge to connect the bridge proper to the roads on either side.

(vii) Handrails, parapets and guard stones.

Some of the components of a typical bridge are shown in figure below. The components above the elvel of bearings are grouped as super-structure, while the parts below the bearing level are classed as substructure. The portion below the bed level of river bridge is called the foundation. The components below the bearing and above the foundation are often referred as substructure.

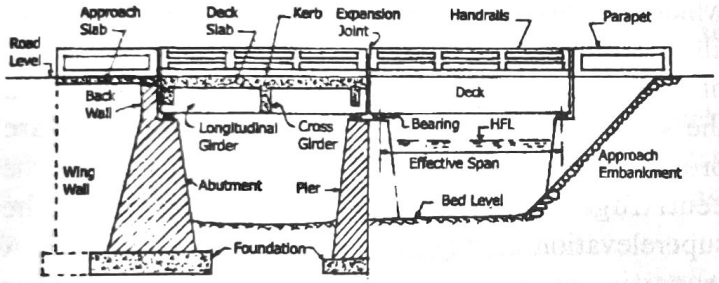


Fig. Components of a typical bridge

Classification : Bridges may be classified in may ways, as below :

(i) According to function as aqueduct (canal, over a river), viaduct (road or railway over a valley), pedestrian, highway, railway, road-cum-rail or a pipeline bridge.

(ii) According to the material of constructioin of super-structure as timber, masonry, iron, steel, reinforced concrete, prestressed concrete, composite or aluminium bridge.

(iii) According to the form of type of super-structure as slab, beam, truss, arch, cable stayed or suspension bridge.

(iv) According to the inter-span relations as simple, continuous or cantilever bridge.

(v) According to the position of the bridge floor relative to the super-structure as deck, through, half-through or suspended bridge.

(vi) According to the method of connections of the different parts of the super-structure, particularly for steel construction, as pin-connected, riveted or welded bridge.

(vii) According to the road level relative to the highest flood level of the river below, particularly for a highway bridge, as high-level or submersible bridge.

(viii) According to the method of clearance for navigation as high-level, movable-bascule, movable-swing, movable-lift or transporter bridge.

(ix) According to the length of bridge (total length between the inner faces of dirtwalls) as culvert (less than 6m), minor bridges (6 to 60 m), major bridges (above 60 m) or a long span bridge when the main span of the major bridge is above 120 m.

(x) According to degree of redundancy as determine or indeterminate bridge.

(xi) According to the anticipated type of service and duration of use as permanent, temporary, military (pontoon, Bailey) bridge.

These classification are not mutually exclusive. Any one type may overlap with others. For example, a multi-span highway bridge may consists of steel trusses of the through type and may be a high-level bridge over a river.

6. (a) What is Sand piling ?

Ans. Sand Pilling : In sand piling is a series of 30 cm diameter holes are drilled vertically inside and outside the rail to a depth of 2-3 m by means of augers or other devices. The holes are then filled up with clean sand and the track is resurfaced. The sand piles are so arranged that the cross-sectional area of the sand piles is about 20% of the formtion area. Sand piles compact the soil and provide mechanical support to the sub-grade just like wooden piles. The drainage of the sub-grade also improves, as water rises to the surface through the sand piles by capillary action and evaporates.

(b) What are the effects of creep of rails ?

Ans. Effects of Creep of Rails : The following are the common effects of creep.

Sleepers out of square : The sleepers move out of their position as a result of creep and become out of square. This in turn affects the gauge and alignment of the track, which finally results in unpleasant rides.

Disturbance in gaps get distrubed : Due to creep, the expansion gaps widen at some places and close at others. This results in the joints getting jammed. Undue stresses are created in the fish plates and bolts, which affects the smooth working of the switch expansion joints in the case of long welded rails.

Distortion of points and crossings : Due to excessive creep, it becomes difficult to maintain the correct gauge and alignment of the rails at points and crossings.

Difficulty in changing rails : If, due to operational reasons, it is required that the rail be changed, the same becomes difficult as the new rail is found to be either too short or too long because of creep.

Effect on interlocking : The interlocking mechanism of the points and crossings gets disturbed by creep.

Possible buckling of track : If the creep is excessive and there is negligence in the maintenance of the track, the possibility of buckling of the track cannot be ruled out.

Other effects : There are other miscellaneous effects of creep such as breaking of bolts and kinks in the alignment, which occur in various situations.

(c) What are the main causes of failure of a railway embankment, draw a neat figure and failure of formation ?

Ans. Failure of Railway Embankment : A railway embankment may fail due to the following causes.

(i) Failure of the natural ground.

(ii) Failure of the fill material in the embankment.

(iii) Failure of the formation top.

Failure of Formation : Failure of the formation top is very common in clayey soils during or just after monsoons. Some locations may trouble throughout the year. The main causes for such failures are the following.

Low bearing capacity of the soil : Sinking of the ballast and the track, and the heaving up of cresses and bulging of side slopes as a consequence. The ballast punches into the formation causing ballast pockets.

Action of water and moving loads : The top soil becomes soft and gets pumped up resulting in the sinking of the ballast. The ballast also gets clogged and looses its drainage property.

Effect of weather : Cracks develop on the formation during the summer months and the ballast sinks through the cracks, resulting in the settlement of the track. The situation gets further worsened during the monsoons when water seeps through these cracks, turning the upper layers of the formation to slush and resulting in the formation of deeper ballast pockets.

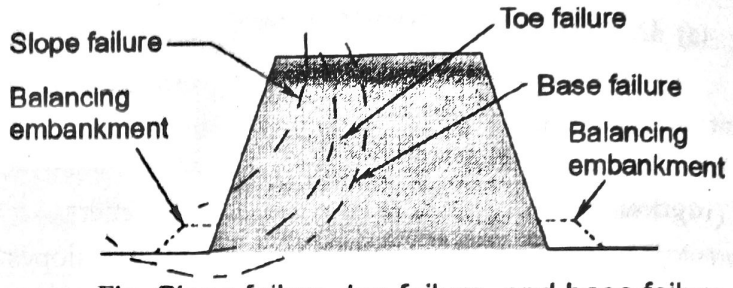


Fig. Slope failure, toe failure, and base failure

7. (a) What do you mean by grade compensation ?

Ans. Grade Compensation : The amount of gradient is reduced, whenever a curve and gradient have to be provided together. The reduction in grade is known as grade compensation on waves.

(b) Explain Transition curve with a diagram. Write the requirements of an ideal transition curve.

Ans. Transition Curve : As soon as a train commences motion on a circular curve from a straight line track, it is subjected to a sudden centrifugal force, which not only causes discomfort to the passengers but also distorts the track alignment and affects the stability of the rolling stock. In order to smoothen the shift from the straight line to the curve, transition curves are provided on either side of the circular curve so that the centrifugal force is built up gradually as the superelevation slowly runs out at a uniform rate. A transition curve is, therefore, the cure for an uncomfortable ride, in which the degree of the curvature and the gain of superelevation are uniform throughout its length, starting from zero at the tangent point of the specified value at the circular curve. The following are the objectives of a transition curve.

(i) To decreases the radius of the curvature gradually in a planned way from infinity at the straight line to the specified value of the radius of a circular curve in order to help the vehicle negotiate the curve smoothly.

a curve smoothly.

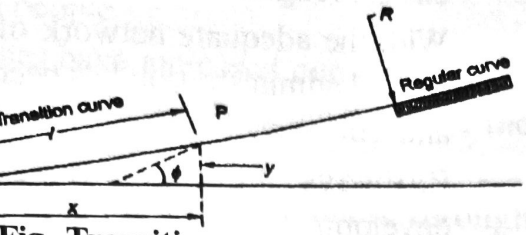


Fig. Transition curve

f an Ideal Transition Curve :

nsition curve should satisfy the g conditions :

be tangential to the straight line of , i.e., it should start from the straight he track with a zero curvature.

join the circular curve tangentially, ould finally have the same curvature f the circular curve.

ture should increase at the same rate perelevation.

gth of the transition curve should be e to attain the final superelevation, crease gradually at a specified rate.

ate the parameters which affect the ical design. Write the necessity of ic design.

e geometric design of a railway track se parameters which determine or affect of the track. These parameters are as

nts in the track, including grade sation, rising gradient, and falling .

re of the track, including horizontal rtical curves, transition curves, ss of the curve in terms of radius or of the curve, cant or superelevation on etc.

ent of the track, including straight as curved alignment. It is very important ks to have proper geometric design in to be considered while arriving at the geometric design of the track.

Necessity for Geometric Design :

The need for proper geometric design of a track are :

- To ensure the smooth and safe running of trains.
- To achieve maximum speeds.
- To carry heavy axle loads.
- To avoid accidents and derailments due to a defective permanent way.
- To ensure that the track requires least maintenance.
- For good aesthetics.

MODEL - 3

(CET - 603)

Full Marks : 70 **Time : 3 Hours**

Answer any **five** questions.

The figures in the right-hand margin indicate marks.

1. (a) Define gauge with neat sketch. [2
   (b) What do you understand by loading gauge ? How is it different from the construction gauge ? [5
   (c) Write the advantages of railway. [7
2. (a) Write the types of rail section used in our country. [2
   (b) Write down the requirements of an ideal rail section. [5
   (c) What is failure of rail ? Write the causes of rail failure. [7
3. (a) What is tilting of rail ? [2
   (b) Discuss the theories of creep. [5
   (c) What are the effects of creep ? Write about adjustment of creep. [7
4. (a) What do you mean by Throw of switch ? [2
   (b) What is rail wear ? What are the type of wears on rail. Write the methods to reduce wear. [5
   (c) Write short notes on : [7

(i) Hogged rail
(ii) Kinks in rail
(iii) Damaged rail

5. (a) Define cross drainage. [2
(b) Write the necessity of maintenance and advantages of maintenacne. [5
(c) Categorize and briefly describe the various duties of a permanent way inspector. [7
6. (a) Classify different types of bridges. [2
(b) Give brief description of various types of causeway in use. [5
(c) Write down the factors affecting selection of bridge site. Also list out various design data to be collected and the purpose of surface investigation for construction of bridge. [7
7. (a) Write the causes of failure of embankment. [2
(b) What are the requirements of a good track drainage system ? [5
(c) Explain the duties of a assistant engineer. [7

MODEL - 3 (ANSWER)

1. (a) Define gauge with neat sketch.

Ans. Gauge is defined as the minimum distance between two rails. The gauge is measured as the clear minimum distance between the running faces of the two rails.

(b) What do you understand by loading gauge ? How is it different from the construction gauge ?

Ans. Loading Gauge : The loading gauge represents the maximum width and height to which a rolling stock, namely, a locomotive, coach, or wagon, can be built or loaded. Sometimes, a loading gauge is also used for testing loaded and empty vehicles as per the maximum moving dimensions prescribed for the section. In Indian Railways, the maximum height and width of rolling stock prescribed as per the loading gauge.

Construction Gauge : The construction gauge is decided by adding the necessary clearance to the loading gauge so that vehicles can move safely at the prescribed speed without any infringement. The various fixed structures on railway lines such as bridges, tunnels, and platform sheds are built in accordance with the construction gauge so that the sides and top remain clear of the loading gauge.

(c) Write the advantages of railway.

Ans. Advantages of Railway : Railways have brought about many political, social and economic changes in the life of Indian people :

(i) Political Advantages :

- Railways have united the people of different castes, religions customs and traditions.
- With the adequate network of Railways, the central administration has become more easy and effective.
- Railways have contributed towards developmetn of a national mentality in the minds of people.
- The role of Railways during emergencies in mobilising troops and war equipment has been very significant.
- Railways have helped in the mass migrationof the population.

(ii) Social Advantages :

- The feeling of isolation has been removed from the inhabitants of the Indian villages.
- By travelling together into the compartment without any restriction of caste, the feeling of caste difference has disappeared considerably.
- The social outlook of the masses has been broadened through railway journeys.
- Railways has made it easier to reach places of religious importance.
- Railways provide a convenient and safe mode of transport for the country.

(iii) Economic Advantages :

- Mobility of people has increased, thereby the congested areas can be relieved of congestion and the sparsely populated areas can be developed.
- Mobility of labour has contributed to industrial development.
- During famines, Railways have played the vital role in transporting food and clothing to the affected areas.
- Growth of industries has been promoted due to transportation of raw materials through Railways.

- Speedy distribution of finished product is achieved through Railways.
- Railways provide employment to millions of people and thus help in solving the unemployment problems of the country.
- Trade developed due to Railways thereby has increased the earnigs and standard of living of Indian people.
- Land values have increased due to industrial development which ultimately result in the increase of national wealth.
- Due to the mobility of products through Railways, the price stabilisation of commodities could be possible.
- Commercial farming is very much helped by the railway network throughout the country.

(iv) Techno-Economic Advantages :

- Cost saving in transportation of long haul bulk traffic.
- Energy-Efficiency (Railways consumes one-seventh of fuel used by the road sector).
- Environment friendliness.
- Higher safety (fatal accidents one-tenth of road sector in India).
- Efficient Land use and ease in capacity expansion.

2.(a) Write the types of rail section used in our country.

Ans. The types of rail section used in our country are :

(i) Double headed rail

(ii) Bull headed rail

(iii) Flat-footed rail

(b) Write down the requirements of an ideal rail section.

Ans. Requirements of an Ideal Rail Section : The requirements for an ideal rail section are as follows:

- The rail should have the most economical section consistent with strength, stiffness, and durability.
- The centre of gravity of the rail section should preferably be very close to the mid-height of the rail so that the maximum tensile and compressive stresses are equal.
- A rail primarily consists of a head, a web, and a foot, and there shoule be an economical and balanced distribution of metal in its various components so that each them can fulfill its requiements properly.

The requirements, as well as the main considerations, for the design of these rail components are :

Head : The head of the rail should have adequate depth to allow for vertical wear. The rail head should also be sufficiently wide so that not only is a wider running surface availale, but also the rail has the desired lateral stiffness.

Web : The web should be sufficiently thick so as to withstand the stresses arising due to the loads bone by it, after allowing for normal corrosion.

Foot : The foot should be of sufficient thickness to be able to withstand vertical and horizontal forces after allowing for loss due to corrosion. The foot should be wide enough for stability against over-turning. The design of the foot should be such that it can be economically and efficiently rolled.

Fishing angles : Fishing angles must ensure proper transmission of loads from the rails to the fish plates.

The fishing angles should be such that th e tighteting of the plate does not produce any excessive stress on the web of the rail.

Height of the rail : The height of the rail should be adequate so that the rail has sufficient vertical stiffness and strength as a beam.

(c) What is failure of rail ? Write the causes of rail failure.

Ans. Failure of Rail : A rail is said to have failed if it is considered necessary to remove it immediately from the track on account of the defects noticed on it. The majority of rail failures originate from the fatigue cracks caused due to alternating stresses created in the rail section on account of the passage of loads, but sometimes due to reasons such as an inherent defect in the metal, the section becomes weak at a particular point and leads to prematuer failure of the rail.

Causes of Rail Failures :

The main causes for the failure of rails are as follows :

- Inherent defects in the rail Manufacturing defects in the rail, such as faulty chemical composition, harmful segregation, piping, seams, laps, and guide marks.
- Defects due to fault of the rolling stock and abnormal traffic effects Flat spots in types, engine burns, skidding of wheels, severe braking, etc.
- Excessive corrosion of rails Excessive corrosion in the rail generally takes place due to weather conditions, the presence of corrosive salts such as chlorides and constant exposure of the rails to moisture and humidity in locations near water columns, ash pits, tunnels, etc. Corrosion normally leads to the development of cracks in regions with a high concentration of stresses.
- Badly maintained joints poor maintenance of joints such as improper packing of joint sleepers and loose fittings.
- Defects in welding of joints. These defects arise either because of improper composition of the thermal weld metal or because of a defective welding technique.
- Improper maintenance of track ineffective or careless maintenance of the track or delayed renewal of the track.

3. (a) What is tilting of rail ?

Ans. Tilting of Rails : Rails are tilted inward at an angle of 1 in 20 to reduce wear and tear on rails as well as on the tread of the wheels. As the pressure of the wheel acts near the inner edge of the rail, there is heavy wear and tear of the rail. Lateral bending stresses are also created due to eccentric loading of rails. Uneven loading on the sleepers is also likely to cause tilting.

(b) Discuss the theories of creep.

Ans. Theories for the Development of Creep :

Various theories have been put forward to explain the phenomenon of creep and its causes, but none of them have proved to be satisfactory. The important theories are briefly discussed.

Wave Motion Theory : Acording to wave motion theory, wave motion is set up in the resilient track because of moving loads, causing a deflection in the rail under the load. The portion of the rail immediately under the wheel gets slightly depressed due to the wheel load. Therefore, the rails generally have a wavy formation. As the wheels of the train move forward, the depressions also move with them and the previously depressed portion springs back to the original level. This wave motion tends to move the rail forward with the train. The ironing effect of the moving wheels on the wave formed in the rail causes a longitudinal movement of the rail in the direction of traffic resulting in the creep of the rail.

Percussion Theory : Accordin to percussioin theory, creep is developed due to the impact of wheels at the rail end ahead of a joint. As the wheels of the moving train leave the trailing rail at the joint, the rail gets pushed, forward causing it to move longitudinally in the direction of traffic, and that is how creep develops. Though the impact of a single wheel may be nominal, the continuous movement of several of wheels passing over the joint pushes the facing or landing rail forward, thereby causing creep.

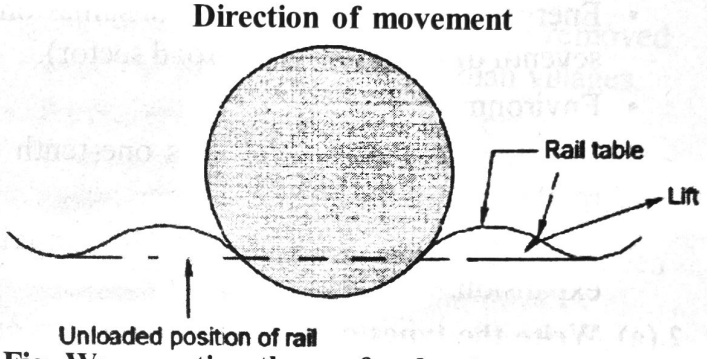


Fig. Wave motion theory for development of creep

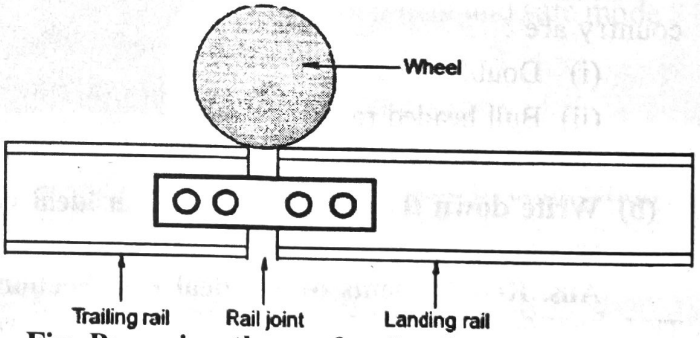


Fig. Pecussion theory for development of creep

Drag Theory : According to drag theory, the backward thrust of the driving wheels of a locomotive has the tendency to push the rail backwards, while the thrust of the other wheels of the locomotive pushes the rail in the direction in which the locomotive is moving. This results in the longitudinal movement of the rail in the direction of traffic, thereby causing creep.

(c) What are the effects of creep ? Write about adjustment of creep.

Ans. Effects of Creep : These are the common effects of creep.

- *Sleepers out of square* : The sleepers move out of their position as a result of creep and become out of square. This in turn affects the gauge and alignment of the track, which finally results in unpleasant rides.
- *Disturbance in gaps get disturbed* : Due to creep, the expansion gaps widen at some places and close at others. This results in the joints getting jammed. Undue stresses are created in the fish plates and bolts, which affects the smooth working of the switch expansion joints in the case of long welded rails.
- *Distortion of points and crossings* : Due to excessive creep, it becomes difficult to maintain the correct gauge and alignment of the rails at points and crossings.
- *Defficulty in changing rails* : If, due to operational reasons, it is required that the rail be changed, the same becomes difficult as the new rail is found to be either too short or too long because of creep.
- *Effect on interlocking* : The interlocking mechanism of the points and crossings gets disturbed by creep.
- *Possible buckling of track* : If the creep is excessive and there is negligence in the maintenacne of the track, the possibility of buckling of the track cannot be ruled out.

Adjustment of Creep :

When creep is in excess of 150 mm resulting in maintenance problems, the same should be adjusted by pulling the rails back. This work is carried out after the required engineering signals have been put up and the necessary caution orders given. The various steps involved in the adjustment of creep are :

- A careful survey of the expansion gaps and of the present position of rail joints is carried out.
- The total creep that has been proposed to be adjusted and the correct expansion gap that is to be kept are decided in advance.
- The fish plates at one end are loosened and those at the other end are removed. Sleeper fittings, i.e., spikes or keys, are also loosened or removed.
- The rails are then pulled back one by one with the help of a rope attached to a hook. The pulling back should be regulated in such a way that the rail joints remain central and suspended on the joint sleepers.
- The pulling back of rails is a slow process since only one rail is dealt with at a time and can be done only for short isolated lengths of a track. Normally, about 40-50 men are required per kilometer for adjsuting creep.
- When creep is required to be adjusted for longer lengths, five rail lengths are tackled at a time. The procedure is almost the same as the preceding steps except that instead of pulling the rails with a rope, a blow is given to then using a cut rail piece of a length of about 5 m.

4. (a) What do you mean by Throw of switch ?

Ans. Throw of Switch : This is the distance through which the tongue rail moves laterally at the toe of the switch to allow movement of the trains. Its limiting values of 95-115 mm for BG routes and 89-100 mm for MG routes.

(b) What is rail wear ? What are the type of wears on rail. Write the methods to reduce wear.

Ans. Rail Wear : Due to the passage of moving loads and friction betwen the rail and the wheel, the rail head gets worn out in the course of service. The impact of moving loads, the effect of the forces of acceleration, deceleration, and braking of wheels, the abrasion due to rail wheel interaction, the effects of weather conditions such as changes in temperature, snow, and rains, the presence of materials such as sand, the standard of maintenace of the track, and such allied factors cause considerable wear and tear of the vertical and latera planes of the rail head.

Types of Wear on Rails :

A rail may face wear and tear in the followin positions :

- On top of the rail head (vertical wear).
- On the sides of the rail head (lateral wear).
- On the ends of the rail (battering of rail ends).

Methods to Reduce Wear :

Based on field experience, some of the methods adopted to reduce vertical wear and lateral wear on straight paths and curves.

- Better maintenance of the track to ensure good packing as well as proper alignment and use of the correct gauge.
- Reduction in the number of joints by welding.
- Use of heavier and higher UTS rails, which are more wear resistant.
- Use of bearing plates and proper adzing in case of wooden sleepers.
- Lubricating the gauge face of the outer rail in case of curves.
- Providing check rails in the case of sharpt curves.
- Interchanging the inner and outer rails.
- Changing the rail by carrying out track renewal.

(c) Write short notes on :

(i) Hogged Rails

Ans. Due to battering action of wheels over the end of the rauls, the rails get bent down and get deflected at the ends. These rails are called "Hogged Rails". This hogging of the rails at the ends is due to loose packing under the joints and/or loose fhish plates. This defet causes rough riding and the following measures are taken to rectify the hogged rails.

Cropping : In this the hogged ends of the rails are cut-off and fresh holes for fixing the fish plates are provided. This cutting of rails either is done in workshop or at site. This former method of cutting the rails at workship is both tedious and uneconomical. So the hogged portion is desired to be cut at the site by use of protable drilling machine and power saws. After cutting the defective ends, the rails are pulled back equal to the length of the cut off. This method is very common in advanced countries.

Replacing : In this, the hogged rails are completely removed and replaced by new rails. However, this method is very uneconomical.

Welding : Hogged rails are brought to the level by welding over the worn out or bent portions at the ends.

Dehogging : This is the method of straightening the end by means of jim crow or by using a dehogging machine. But it is seen that jim crow cannot straighten it satisfactority. So cropping of rails becomes the only satisfactory method to remove this defect.

(ii) Kinks in Rails

Ans. When the ends of adjoining rails move slightly out of position, "shoulders" or "kinks" are formed. The causes of formation of kinks may be the following :

(i) Loose packing at joints, (ii) Defect in gauge, and alignment, (iii) Defect in cross level at joints, (iv) Uneven wear of rail head, where kinks are formed at joints.

The kinks produce the following undesirable effects :

- These kinks cause unpleasant jerks in vehicles passing over them.
- Due to uneven wear of rail heads, these kinks appear at places other than the joints and obstruct the smooth running of trains.
- A series of kinks are seen at curves due to which defect in gauge, alignment and camber may occur. This involves, sometimes, a serious risk in turning operations of trains.

The following measures are generally taken to remove this defect :

(iii) Damaged Rails

Ans. These are the rails which should be removed on accunt of their becoming unsafe for a railway track due to any of the following causes :

(i) The wear of rails, (ii) The defect, due to manufacture of rails, (iii) Defect of hogging in excess, (iv) Due to damage caused to the rails.

The defect of wear will be dealt in subsequent articles. The defects due to manufacture in India are comparatively few. The hogging of rails is discussed in preceding articles. Damage to the rails may also be caused by one or moe of the following reasons :

- Careless unloading or handling of rails.
- Bending of rails to sharp curves.
- Improper striking of rails while fixing to the sleepers.
- Poor maintenance of track, such as loose sleepers at joints, loose fish bolts, incorrect superelevation at curves, etc.

Cross Drainage : Whenever streams or
es have to cross the track facility for cross-
s to be provided. The water from the side-
en across drains in order to divert the water
the track. Generally the cross drainage
onsists of drain pipes, culverts or the bridges.

**te the necessity of maintenance and
ntages of maintenacne.**

**Necessity and Advantages of Track
ne :** The railway track should be maintained
order to enable trains to run safely at the
missible speeds and to provide passangers a
level of comfort during the ride.
intenance becomes a necessity due to
reasons :

to the constant movement of heavy and
n-seepd trains, the packing under the
pers becomes loose and track geometry
s disturbed. The gauge, alignment, and
gitudinals as well as cross levels of the
k thus get affected adversely and the safety
he tack is jeoparadized.

e to the vibrations and impact of high-
ed trains, the fittings of the track come
done and there is heavy wear and tear of
track and its components.

e track and its components get worn out as
esult of the weathering effect of rain, sun,
d sand. A well-maintained track offers a safe
d comfortable journey to passengers. If the
ck is not maintained properly, it will cause
scomfort to the passangers and in extreme
ses may even give rise to bazardous
nditions that can lead to derailments and a
nsequential loss of the life and property.
rack maintenance ensures that such
uations do not arise. The other advantages
track maintenance are as follows :

If the track is suitably maintained, the life of the track as well as that of the rolling stock increases since ther is lesser wear and tear of their components.

– Small maintenance jobs done at the appropriate time such as tightening a bolt or key, hammering the dog spike, etc., helps in avoiding loss of the concerned fitting and thus saving on the associated expenditure.

– When track maintenance is neglected for a long time, it may render the track beyond repair, calling for heavy track renewals that entail huge expenses.

(c) Categorize and briefly describe the various duties of a permanent way inspector.

Ans. Duties of a Permanent Way Inspector :

The PWI is generally responsible for the following:

- Maintenance and inspection of the track to ensure satisfactory and safe performance.
- Efficient execution of all works incidental to track maintenance, including track relaying work.
- Accounts and periodical verificaion of the stores and tools in his or her charge.
- Maintenance of land boundaries between stations and at important stations as may be specified by the administration. The PWI also carries out inspections of the following facets of a track.

Testing the track. He or she should run a test check on the foot plate of the engine of fast trains at least twice a month and in a rear brake van of a fast vehicle once a month, and make a note of sections where the quality of running is defective and get them rectified.

Inspection of track and gangs. The PWI should inspect the entire section with the help of a push trolley at least once a week or more often if necessary.

Level Crossing Inspection :

– He or she should check the equipment assigned to the gateman once a month.

- He or she should periodically examine knowledge of safety rules.
- He or she should ensure that all level crossins are safe.

Points and Crossings Inspection.

The PWI should inspect the points and crossings on passanger lines once in three months and those on other lines once in six months.

Curve Inspection : The PWI should check the versines and superelevation of each curve once in six months. Based on his or her observations, the PWI should take the appropriate action to correct the curve, if necessary.

Inepection Diagram : The PWI should maintain an inspection diagram of all inspections carried out during the month as per the schedule laid down in the proforma and submit the same every month to the divisional engineer via ther AEN, brinding out the reasons for failure in adhering to the schedules of inspections, if any.

Safety of Track : The PWI is directly responsible for the safety of the track. He or she should be vigilant so as to promptly locate faults in the permanent way and get them repaired without delay. In addition to the inspections, a PWI also carries out the following duties.

- To accompany high officials during their inspections along with the relevant records. The PWI should carry all the important measuring equipment such as the gauge-cum-level, flange gauges, fishing chord, tape, and inspection hammer on these inspections.
- To accompany any track recording and oscillograph can that runs in his or her section.
- To check the proximity of trees that are likely to damage the track and get them removed.
- To check night patrolling at least once a month by train as well as by trolley.
- To take the necessary safety measures while executing maintenance work that affects the safety of the track.
- To rush to the site of an accident and take the necessary measures to safeguard the line and restore traffic.
- To periodically inspect and supervise LWR tracks to ensure their safety.
- To ensure the cleanliness of station yards.
- To keep proper records of the training out of ballast.
- To witness the payments made out to the staff every month.
- To look after all establishment work, including the welfare of the staff working under this charge, and to mainain their service records.
- To ensure the safety of the track during the execution of work that affects the track. Based on the system of maintenance, the permanent way inspector in charge of the section should prepare detailed short-term plans covering a month's work at least a month in advance of the commencement of actual work. The PWI should ensure that adequate arrangements have been made for the requisite tools, materials, and manpower for the allotted task and that work is executed within the specified time. The following procedure of track maintenance is followed on Indian Railways.

- Each mate should be supplied with a gang chart and a gan register. The gang chart should have a record of the day-to-day tack maintenance work to be done over the gang length, maintained by the permanent way inspector (PWI) according to specified instructions. The gang registors contain a record of the weekly programmer of the work to be carried out, also maintained entered by the PWI in charge of the section. At the end of the week, the PWI should qualitatively and quantitatively assess the completed work and record his/her observations in the gang register after a detailed inspection of the work done during the previous week.
- Gang charts or gang registers should be checked by the assistant engineer and divisional engineer during their inspections. After inspecting the section by trolley, they should record their observations in the gang register.

– On withdrawal of old gang charts or gang registers and supply of fresh ones, the PWI should carefully analyze the work done and make a note of those stretches of the track that frequently gave trouble during the year, with a view to formulate such special measures as may be necessary.

6. (a) Classify different types of bridges.

Ans. Different Types of Bridges :

Permanent Bridge :

- Stone masonary and plane C.C.
- RCC bridge.
- Iron and culverts
- Pre-stressed concrete

Temporary Bridge :

- Truss
- Bridges on piles
- Pontoon
- Raft
- Lift

(b) Give brief description of various types of causeway in use.

Ans. Causeways : A road causeway is a puccadip which allows floods to pass over it. It may or may not have opening or events for low water to flow. It if has vents for low water to flow than it is known as high level causeway to submersible bridge. Otherwise a low level causeway.

Low Level Causeway : It is also known as Irish bridge. The beds of small rivers or streams, which remain dry for most of the year, are generally possible without a bridge. This involves heavy earth work in cutting for bridge approaches. Banks of such types of streams are cut down at an easy slope. For streams or rivers in plains having sandy beds. It is often sufficient to lay bundles of grass over and across the sandy track. The bundles may be of 20 to 25 cm in diameter whose ends are secured by longitudinal facines pagged down by stakes.

For crossings important from traffic point of view its essential to lay a metal or pucca paving of stone or brick set in li me mortar on a substantial bed of concrete. The pavement against possible scour and determing a cut off or dwar wall usually 60 cm deep on the unsteam side and 120 to 150 cm on downstream side is provided.

High Level Causway : A high level causeway is submersible road bridge designed to be overlapped in floods. Its formation level is fixed in such as way as not to cause interruption to traffic during floods for more than three days at a time not for more six times in a year.

A sufficient number of openings are provided to allow the normal flood discharge to pass through them with the required clearance. They are provided with abutments and piers, floors and slabs or arches to form the required number of opernings. The slope of the approaches is kept as 1 in 20. When the velocity is high and stream bed is soft the sprons could be of concrete or harder masnoary upto a certain distance. Similarly, the load can be formed of a cement concrete slab or stone blocks set in cement mortar.

A typical type of creep is defined as the longitudinal movement of rails with respect to sleepers is a track. Creep is common to all railway tracks but veries in magnitude considerably, the rail, in some place, moves by several centimetres in a month while in other locations the movement of rails may be negligible. It is observed that the rails have tendency to move gradually in the direction of dominant traffic.

(c) Write down the factors affecting selection of bridge site. Also list out various design data to be collected and the purpose of surface investigation for construction of bridge.

Ans. Selection of Bridge Site : The choice of the right site is a crucial decision in the planning and designing of a bridge. It may not be possible always to have a wide choice of sites for a bridge. This is particularly so in case of bridges in urban areas and flyovers. For river bridges in rural areas, usually a wider choice may be available.

The characteristics of an ideal site for a bridge across a river are :

(i) A straight reach of the river.

(ii) Steady river flow without serious whirls and cross currents.

(iii) A narrow channel with firm banks.

(iv) Suitable high banks above high flood level on each side.

(v) Rock or other hard inerodible strata close to the river bed level.

(vi) Economical approaches which should not be very high or long or liable to flank attacks of the river during floods, the approaches should be free from abstacles such as hills, frequent drainage crossings, sacred places, graveyards, or built up areas or troublesome land acquisition.

ould collect the following information :
the stream, road and the identification
ted to the crossing and location in km to
crossing.
of the nearest GTS (Great Trigonometric
ench mark with its reduced level.
nd anticipated future volume and nature
on the road at the bridge site.
c data pertaining to the river, including
st flood level (HFL), ordinary flood level
nd low water level (LWL), size, shape,
l nature of the catchment, possibility of
ent changes in the catchment like
ation, deforrestation, and urban
ent intensity and frequency of rainfall
chment, and probability of large tress or
ebris floating down the stream.
ile along the probable bridge sites over
n of the bridge and approaches.
onal requirements, if any, for the stream.
large scale river training works.
of the site to earthquake disturbances.
ity, quality and location of the nearest
for stones for masnory and for concrete
es.
lace of availability of cement, steel and

f transport for materials.
ity of unskilled and skilled labour for
trades required for construction.
s required for housing labour during
tion.
t details of the bridges, if any, crossing
river within a resonable distance of the
bridge.
ity of electric power.
f any utilities and services to be provided
telephone cables, power cables, water
ipes) along with relevant information on

- Failure of the fill material in the embankment.
- Failure of the formation top.

(b) What are the requirements of a good track drainage system ?

Ans. Requirements of a Good Track Drainage System : A good drainage system shudl satisfy the following requirements.

(i) Surface water should not percolate to track : One of the basic requirements of a good track drainage system is that surface water from rains and adjacent areas should not percolate and seep into the formation of the track.

(ii) Effective side drains : The size of the side drains should be adequte with a proper slope, so that they effectively carry all the surface water away.

(iii) Longitudinal drains to be saucer-shaped : The longitudinal drains provided between two tracks should preferably have a soucer-shaped cross section so that they can collect water from both sides.

(iv) Provision for clearing and inspection : The drains provided for drainage should be such that they can be inspected and cleared periodically.

(v) Drain top to be below cuss level. Normally, the drain top should not be above the curss level for the effective drainage of the ballast bed.

(vi) No erosion of banks. The flow of water along the slope and across the track should not cause erosion of the banks or the slopes of the banks.

(vii) Formation to be of good soil : Ideally, the formation and subgrade should be made of a previous, coarse-textured soil. Such soils are more permeable, retain less capillary water, and respond more favourably to a surface drainage system.

(viii) Proper sub-surface drainage : Arrangements should be made for a good subsurace drainage system to drain of the water being retained is the track. This is more relevant in the case of defective formations.

(ix) Proper outfall : Longitudinal drains should be designed so as to provide a proper outfall, from where the water can eventually drain off.

(x) Special arrangements for water-logged areas and other difficult situations. A good track drainage system should have special arrangements for the drainage of water-logged areas and for all other related perennial problems.

(c) Explain the duties of a assistant engineer.

Ans. Duties of Assistant Engineer : The assistant engineer is generally responsible for the maintenance and sfafety of all way and works under his or her charge, for the accuracy quality, and progress of any new work that may be undertaken and for controlling all expenditure with respect to the budget allotment.

The essential duties of an AEN are as follows :

- Inspection and maintenance of track and all track structures to ensure satisfactory and safe performance.
- Preparation of plans and estimates, execution and assessment of work.
- Verification of stores held by stock-holders.
- Submission of proposals for inclusion in the track renewal programme, estimates of revenue budget, and work programme.

An AEN is also required to carry out the following inspections.

(i) Trolley inspection : The entire sub-division should be inspected once a month by assistant engineer, as far as possible with the help of a push trolley. This inspection should be intensive and should include the checking of gang attendance, the work done by the gang, the equipment used, and an examination of gang chart/ diaries with reference to the prescribed track maintenance schedule. During the inspection, the assistant engineer should check the work done by one or two gangs under each PWI and record his or her observations.

(ii) Fast train inspection : Either the foot plate of the engine or the last vehicle of a fast train should traverse the entire length of the sub-division once a month.

(iii) Inspection of level crossings : The assistant engineer should inspect all manned level crossings once every six months. He or she should examine the gatemen's knowledge of the rules and check the equipment, track, road approaches, and all the other safety aspects of each crossing.

(iv) Checking of curves. The AEN should verify the versine and superelevation of at least one curve under the jurisdiction of every PWI every quarter.

(v) Checking of points and crossings : Once a year the AEN should inspect all the points and crossings on passenger lines and 10% of the points and crossings on other lines.

(vi) Monsoon patrolling : During monsoon patrolling, the assistant engineer should use either a train, push trolley, or motor trolley once every month to check the patrolman's work.

(vii)Scrutinizing of registers during inspection : The AEN should scruitnize the various registers maintained by the PWI such as the creep register, curve register, and the points and crossings register.

(viii) Inspection of bridges : The AEN should inspect all the bridges of his or her sub-division once every year after the monsoon is over and record the inspection details in the bridge register. Tracks on girder bridges should also be inspected as part of the annual bridge inspection.

(ix) Inspection of office and stores : The AEN should inspect each office and store of all the PWIs and IOWs under his or her charge at least once a year. When checking stores, he or she should pay particular attention to the allcation of the impressed engineering indictors, protection equipments, and other important items in the stores.

An AEN also has the following additional duties.

(i) To ensure that all work is done as per the standard plans and specifications.

(ii) To witness the payments made under one inspector once every month.

(iii) To record the measurements of the ballast or to carry out a thorough check of its quality and quantity if the same has already been recorded by an inspector. Also, to test check the measurements of other works.

(iv) To reach an accident site as early as possible and to take the necessary measures to restore traffic on the affected track.

(v) To accompany any track recording or oscillograph car runs in his or her section.

(vi) To exercise control on expenditure so as to contain it within the allotted budget.

(vii) To train probationers in their work.

(viii) To inspect water purification systems once every three months.

(ix) To inspect all steel structures once every six months.

(x) To look after the welfare of the staff and to inculcate discipline in them.

(xi) To accompany the GM or other senior railway officials during inspection.

(xii) To co-ordinate with officials of other departments.

SET – 1

(CET - 603)

Full Marks : 70 **Time : 3 hours**

Answer any **five** questions

The figures in the right-hand margin indicate marks.

1. (a) What do you mean by Throw of switch ? [2
   (b) What is rail wear ? What are the type of wears on rail. Write the methods to reduce wear. [5
   (c) Write short notes on : [7
   (i) Hogged rail
   (ii) Kinks in rail
   (iii) Damaged rail
2. (a) Classify different types of bridges. [2
   (b) Give brief description of various types of causeway in use. [5
   (c) Write down the factors affecting selection of bridge site. Also list out various design data to be collected and the purpose of surface investigation for construction of bridge. [7
3. (a) Define cross drainage. [2
   (b) Write the necessity of maintenance and advantages of maintenacne. [5
   (c) Categorize and briefly describe the various duties of a permanent way inspector. [7
4. (a) Write the causes of failure of embankment. [2
   (b) What are the requirements of a good track drainage system ? [5
   (c) Explain the duties of a assistant engineer. [7
5. (a) Define gauge with neat sketch. [2
   (b) What do you understand by loading gauge ? How is it different from the construction gauge ? [5
   (c) Write the advantages of railway. [7
6. (a) Write the types of rail section used in our country. [2
   (b) Write down the requirements of an ideal rail section. [5
   (c) What is failure of rail ? Write the causes of rail failure. [7
7. (a) What is tilting of rail ? [2
   (b) Discuss the theories of creep. [5
   (c) What are the effects of creep ? Write about adjustment of creep. [7

SET – 2

(CET - 603)

Full Marks : 70 **Time : 3 hours**

Answer any **five** questions

The figures in the right-hand margin indicate marks.

1. (a) Write the components parts of crossing. [2
   (b) Write the requirement and characteristics of a good crossing. [5
   (c) Discuss about inspection and maintenance of points and crossings. [7
2. (a) Write the types of sleepers use in railway track. [2
   (b) Explain the various functional requirements of sleepers. [5
   (c) Why concrete sleepers are use in railway ? Write the advantages and disadvantages of concrete sleepers. [7
3. (a) Define grade compensation. [2
   (b) Describe briefly the purpose of providing fish plate with sketch. [5
   (c) Calculate the maximum permissible speed on a curve of a high speed BG group A route having the following particulars; degree of the curve = 1°, super elevation = 80 mm, length of transition curve = 120 m, maximum speed likely to be sactioned for the section = 160 km/h. [7
4. (a) What do you mean by coffer dam ? [2
   (b) What is creep of rail ? Write its effects on railway track. [5
   (c) What are the causes of creep ? How can creep be adjusted ? [7

5. (a) Find out scour depth by Leey's formula for a bridge over a stream whose discharge is 500 m^3/ sec and silt factor 1.1. [2

(b) Describe buckling of rails. Why and how it occurs ? [5

(c) Decribe briefly about failure of rails with neat sketch. [7

6. (a) What is fitting of rails ? Why it is provided ?[2

(b) Describe briefly about the selection of gauge.[5

(c) What are the different types of rails ? Write the functions of rail. [7

7. (a) What is an approach slab in bridge construction ? [2

(b) What is super elevation or cant ? Write the objects of providing super elevation. [5

(c) Establish a relationship between the super-elevation (e), with Gauge (G), and radius of the curve (R). [7

SET – 3

(CET - 603)

Full Marks : 70 **Time : 3 hours**

Answer any **five** questions

The figures in the right-hand margin indicate marks.

1. (a) Define permanent way. [2

(b) What do you understand by deep screening of ballast ? Describe the procedure. [5

(c) What is the need for the proper maintenance of a track ? Discuss the various methods that ensure that a track is well maintained. [7

2. (a) What do you mean by crossing ? [2

(b) What are the various points required to be checked during the inspection of points and crossings ?[5

(c) Calculate the lead and radius of a 1 in 8.5 BG turnout for 90 R rails using Coles method. [7

3. (a) What is boxing ? [2

(b) Draw a neat sketch of simple right hand and left hand turnout show various components used in it. [5

(c) What is the ballast ? Why is it used in the railway track ? Briefly describe the various types of ballasts used. [7

4. (a) What do you mean by linear waterway ? [2

(b) Explain briefly the necessity of providing bearing in bridges. [5

(c) Classify and describe briefly each classification of steel and concrete bridges. [7

5. (a) What do you mean by Afflux ? [2

(b) Discuss the various factors which should be considered while selecting site for bridge. [5

(c) Draw a neat sketch of permanent way. Explain the function of each component. [7

6. (a) What is coning of wheel ? [2

(b) List the requirements of an ideal rail joint. [5

(c) Name the different methods of welding rails. Describe any one method. [7

7. (a) What are the two types of switches used in Railway point and crossing ? [2

(b) What are the main causes of failure of a railway embankment ? [5

(c) Prepare a neat sketch of a typical cross section of an embankment with the ballast section for a single-line or double-line broad gauge. [7

SET – 4

(CET - 603)

Full Marks : 70 **Time : 3 hours**

Answer any **five** questions

The figures in the right-hand margin indicate marks.

1. (a) What is Sand piling ? [2

(b) What are the effects of creep of rails ? [5

(c) What are the main causes of failure of a railway embankment, draw a neat figure and failure of formation ? [7

2. (a) What do you mean by grade compensation ? [2

(b) Explain Transition curve with a diagram. Write the requirements of an ideal transition curve.[5

(c) Enumerate the parameters which affect the geometrical design. Write the necessity of geometric design. [7

3. (a) What do you mean by super elevation or cant ?[2

(b) Describe briefly negative super elevation with neat sketch. [5

(c) Calculate the maximum permissible speed on a curve of high speed B.G. track having the following particulars : [7

(i) Degree of the curve = 1

(ii) Amount of super elevation = 8.0 cm.

(iii) Length of transition curve = 130 meters.

(iv) Maximum speed of the section likely to be sactioned = 153 k.m.p.h.

4. (a) Write the different types of crossing. [2

(b) Draw a neat line diagram of right hand and left hand turnout and show its component parts. [5

(c) What is turnout ? Describe the design of turnouts and fittings with turnouts. [7

5. (a) What is ballast crib ? [2

(b) Write down the types of ballast briefly. [5

(c) What are the functions of ballast ? Write Comparison of different types of ballast. [7

6. (a) What is rail failure ? [2

(b) What is bearing plates ? Write its advantages and dis-advantages. [5

(c) Illustrate the various types of rail failures with sketches. [7

7. (a) Mention different types of movable bridge. [2

(b) What is wing walls ? Write at least three function of wing wall. [5

(c) Write the classification of bridge and describe its components. [7