

Promotion from Group 'C'
to Group 'B' (AEN 70%)

Question Bank
of
Subjective Questions

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1. REGULAR TRACK MAINTENANCE

Question 1 Write in detail about the annual programme of regular track maintenance?

Answer The annual programme of regular track maintenance and works incidental thereto shall be based on the programme given as under:

	Period	Work
1.	Post monsoon attention: For about six months after end of monsoon	(a) Attention to run down lengths in the entire gang beat to restore the section to good shape. (b) One cycle of conventional systematic through packing/ systematic directed track maintenance from, one end of the gang length to the others including overhauling of nominated sections. (c) Normally 4 to 5 days per week should be allotted for works under item (b) and the remaining days for picking up of slacks, attention to bridge approaches, level crossings and points and crossings over the entire Gang beat. Works such as lubrication of rail joints, joint gap adjustments as required and realignment of curves should be done during this period.
2.	Pre monsoon attention for about 2 months prior to break of monsoon.	Normally 2 to 4 days in a week should be devoted to clearing of side and catch water drains, earthwork repairs to cess, clearing water ways and picking up slacks. In the rest of the days normal systematic maintenance will be carried out.
3.	Attention during monsoon for about four months	Attention to track as required. This will consist. Primarily of picking up slacks and attention to side and catch water drains and water ways. During abnormally heavy rains, patrolling of the line by gangs should be carried out addition to regular monsoon patrolling.

Maintenance Planning: Every Permanent Way Inspector must prepare a perspective maintenance plan of his section one month in advance. The plan should include, apart from normal inspection, inspection of point and crossings, curves and level crossings, realignment of curves, adjustment of creep, deep screening, casual renewal, renewal of points and crossings, welding of joints, destressing of long welded rails etc. so that optimum utilization of time and labour resources is possible. He should also ensure that

arrangement are made for adequate materials, tools, labour, man power and necessary caution orders / books, as may be necessary.

Question 2 Explain in detail the procedure for deep screening of ballast.

Answer A day's length will be deep screened as per the procedure detailed below:-

Stage I The ballast should be removed from space 'A' and 'B' on either side of the sleeper '1' down to final formation level and wooden blocks provided to support the rail for passing trains.

Stage II The ballast is removed from under sleeper '1' down to final formation level/sub-ballast level.

Stage III The ballast should then be screened and placed back under sleeper '1' which should then be packed.

Stage IV The wooden blocks from space 'A' should then be removed.

Stage V The ballast from space 'C' down to formation level should be removed and after screening, be placed in space 'A' upto bottom of sleeper. The balance may be taken outside the track and screened. The rail in space 'C' should be supported with wooden blocks.

Stage VI The ballast should be removed from under sleeper '2' down to formation level.

Stage VII Screened ballast should be provided under sleeper '2' and sleeper well packed.

Stage VIII The ballast from space 'D' down to formation level should be removed and after screening, be placed in space 'B' upto bottom of sleeper; the balance may be taken outside the track and screened. The wooden blocks should be removed from space 'B' and placed to support the rail in space 'D'

Stage IX The ballast from under sleeper '3' should be removed and so on till the whole rail length is provided with screened ballast upto level of the bottom of sleepers.

Final Stage: The track should be lifted to provide additional cushion where required. The track should be packed in the final position and then boxed.

Question 3 Write short notes on i) Operations of through packing ii) Lifting of track iii) Fouling marks iv) Combination Fishplate

Answer i) Through Packing: Through packing shall consist of the following operations in sequence.

- (a) Opening of the road.
- (b) Examination of rails, sleepers and fastenings.
- (c) Squaring of sleepers.
- (d) Slewing of track to correct alignment.
- (e) Gauging
- (f) Packing of sleepers.
- (g) Repacking of joint sleepers.
- (h) Boxing of ballast section and tidying.

ii) Lifting of Track:-

- (1) Lifting of track will become necessary during regarding and for elimination of minor sags, which develop through improper maintenance or yielding soil, to keep a good top.
- (2) Correct level pegs should be fixed at suitable intervals, before lifting is commenced.
- (3) Heavy lifting should always be carried out under suitable speed restriction and under the protection of corresponding engineering signals. Lifting should not exceed 75 mm. at a time so as to allow proper consolidation. The easement gradient for the passage of trains should not be steeper than 25mm. in one rail length of 13 meters. The operation should be repeated until the required level is attained when the track should be finally ballasted, through packed and boxed, the cess being made up to proper level.
- (4) Lifting should commence from the down hill end carried out in the direction of rising grade in case of single line. It should proceed in the opposite direction to traffic, in case of double line, care being taken not to exceed the easement grade.
- (5) While lifting track under bridges and overhead structures and in tunnel it should be ensured that there is no infringement of standard dimensions.

- (6) In case of curve, it is usual to set the inner rail to the correct level and grade and to raise the outer rail to give the required super elevation, care being taken to see that the cant gradient is within the permissible limit.

iii) Fouling Marks

- (1) Fouling marks should be distinctly visible and difficult to remove.
- (2) These should be fixed at the point at which the spacing between the tracks, begin to reduce to less than the minimum as laid down in the schedule of dimensions.
- (3) The fouling marks should consist of a stone/cement concrete block about 1500 mm. in length, 250 mm. wide and 125 mm, thick, with the top edge rounded off and the top surface white-washed or of unserviceable rail pieces embedded in concrete support & painted white. These should be laid level with the top line of the ballast section.
- (4) The number of wagons which can be accommodated in a siding or a loop should be marked on each fouling mark

iv) Combination Fish-Plates:-

Rails at joints should butt against each other and fish bolts tightened. A set of four combination fishplates is to be used at joints of two different rail sections. The 4 fishplates are different from each other and are marked I.R., OR., I.L. or O.L. apart from their part number. On either side of combination fishplates, full length of rail should be used. Combination rails prepared by welding two rail section as per standard drawings should, preferably be used in place of combination fish-plates.

Question 4 Explain in detail the procedure for lubrication of rail joints

Answer

- (1) The purpose of lubrication rail joints is not only to facilitate expansion of rails but also to retard wear on the fishing planes of the rail and the fish plate.
- (2) A stiff paste of plumbago (Graphite) and kerosene oil, made in the proportion of 3 Kg. of plumbago to 2 Kg. of kerosene oil may be used. Black oil or reclaimed oil may be used for fish bolts and nuts.
- (3) All rail joints should normally be lubricated once a year on a programmed basis during the cold weather months after the monsoon, from October to February. Lubrication should not be carried out in extremes of weather both hot and cold.
- (4) Creep in excess of 150 mm, should be adjusted before the work of lubrication of rail joints is undertaken.

(5) The lubrication of rail joints should normally be carried out by gangs working under the direct supervision of at least a qualified Permanent Way Mistry. The work should be carried out under caution orders arranged to be issued daily by the Permanent Way Inspector and under protection of engineering signals. In this case the procedure to be followed for lubrication of rail joints will be as follows:-

- (i) The nuts are unscrewed and the fish bolts and fish-plates are removed.
- (ii) The fishing surface of the fish-plates and rail are then cleaned with a wire brush.
- (iii) The rail ends are inspected for cracks, and the fishing surface of rails and fish plates are checked for wear. A magnifying glass and a mirror should be used for detecting cracks in rail ends and fish-plates.
- (iv) The fishing surfaces of the rails and fish-plates are then lubricated.
- (v) The fish bolts are then put back in reverse position and tightened using a standard fish bolt spanner, the inner two bolts being tightened first.
- (vi) While tightening overstraining of bolts shall be avoided.
- (vii) Spare fish-plates and bolts should be available for replacement of cracked ones.

Question5 Describe in detail the various Causes of Rail Deterioration.

Answer: The principal factors causing rail deterioration are factors causing rail deterioration are detailed below:-

- (1) **Corrosion and rusting-** Corrosion is caused not so much by the dampness as by acid gases dissolved in the film of moisture which frequently coats the rails. Corrosion is generally heavy in the following locations:-
 - (a) Platform lines where trains make prolonged halts.
 - (b) Sidings where saline or corrosive goods are dealt with.
 - (c) Where the rails are affected by the dropping of engine ashes, such as at ash pits.
 - (d) Near water columns due to insufficient drainage.
 - (e) Tunnels and damp cuttings.
 - (f) Areas near the sea coast.
 - (g) Industrial belts.
- (1) **Wear on Rail Table-** Normally this is of a very small order. The amount of wear increases with heavy traffic density as in suburban section, though not proportionately.
- (2) **Flattening of rail table-** This mostly occurs on the inner rail of a curve by high contact stresses combined with horizontal forces. The vertical pressure may be due to heavy axle load, large unsprung mass or under equilibrium speed on canted track.
- (3) **Wear on Gauge Face-** The outer rail of a curve has to withstand heavy pressure from the wheels which results in the running edge becoming worn or 'side-cut'.

- (4) **Hogging of rail end-** A hogged rail is one with its end or ends bent in vertical direction. A hogged rail end in the track is ascertained by unfastening the joints, removing the fastenings and then measuring the extent of hog at the rail end by placing a 1 metre long straight edge over the rail table.
- (5) **Battering of rail ends-** Rail end batter occurs where the joint gaps are excessive. It is caused by the impact of wheels on end of a rail particularly if the fish-plates do not fit snugly.
- (6) **Wheel burns-** Wheel slipping occurs usually on adverse gradients or while starting on rising grades when considerable heat is generated and top of the rail is torn off in patches, causing depressions known as wheel burns, from which cracks may develop.
- (7) **Corrugation-** In certain locations, rail table develops ridges and hollows called corrugation and when vehicles pass over these rails, a roaring sound ensues. Such rails are called “roaring rails”.

Q6 Write in detail the procedure for Chamfering of bolt holes in rails including the list of equipments used for chamfering.

Ans:

- (i) Chamfering of bolt holes work hardens the periphery of holes and thereby delays the formation of star cracks. Each drilled hole shall be chamfered.
- (ii) Existing bolt holes in fracture prone zones should be chamfered if not elongated. In case of elongated holes, the chamfering bit will not be in contact with the full edge of the bolt holes and there will be uneven hardening of the metal resulting in stress concentration in weaker-zones. Therefore, such portion of rail should be removed holes should be drilled and chamfered.
- (iii) **Equipment for chamfering of bolt holes:** Work hardening of bolt holes should be done with chamfering kit of approval make. The Chamfering kit consists of the following:

a)	<u>Description of instrument-</u>	<u>Qty.</u>
(i)	High tensile bolt M-20	1 No.
(ii)	High tensile nut for M-20 bolt	1 No.
(iii)	Sets of 2 H.S.S. chamfering bits	1 Set
(iv)	19 mm sq. drive sockets size 32 mm	8 Nos.
(v)	Set of packing pieces (Sleeves)	1 Set.
(vi)	T-400 torque-wrench with built-in ratchet mechanism 1.25 m length.	1 No.

(iv) Procedure for chamfering of bolt holes:

- (i) The nut of high tensile steel bolt is removed and one packing piece is inserted in the shank followed by one side of the H.S.S. chamfering bit.
- (ii) The high tensile steel bolt is inserted with 2 pieces in the rail hole.
- (iii) On the other face of the rail hole, the second half of the HSS chamfering bit is inserted over the shank followed by the second packing piece.
- (iv) The nut on the high tensile steel bolt is replaced.
- (v) Pre-set torque-wrench on nut at torque value of 52 kg.m equivalent to an axle force of 12.5 tonnes, is applied. The nut is tightened with the torque wrench. As soon as the preset torque is attained, the torque wrench will automatically trip indicating complete tightening to pre-set torque value.
- (vi) The nut by reversing the top wrench is unscrewed and HTS bolt is removed.

The process is repeated on other rail holes.

Chamfering of each hole should be done under the supervision of Mate/Keyman.

Q.7) What are the precautions to be taken while working in Track Circuited Areas?

Ans: Precautions to be taken while working in Track Circuited Areas are as under:

- (1) The Permanent Way Inspector should instruct the staff not to place across or touching two rails in the track, any tool or metal object which may cause short circuiting.
- (2) All gauges, levels, trolleys and lorries used on the track circuited length should be insulated.
- (3) Steel or C.I. pipes used for carrying water/gas under the track should run sufficiently below the rails to prevent any short circuiting.
- (4) While carrying out track maintenance, care should be taken to see that no damage of track circuit fittings like rail bonding wires, lead wires to rails, bott legs, jumper wires etc., takes place.
- (5) Use of steel tapes should be avoided in track circuited section.
- (6) Pulling back of rails should be done in track circuited areas in the presence of S&T staff, where signaling connections are involved.

- (7) Proper drainage should be ensured so as to avoid flooding of track, during rains, particularly in yards, where watering of coaches is done and in water columns and ash pits. It would be desirable to provide washable concrete aprons on platform lines at originating stations, in track circuited areas.
- (8) Ballast must be kept clean throughout the track circuited section and care should be taken to see that the ballast is kept clear of the rails and rail fastenings. The clearance from the foot of the rail should not be less than 50mm. During every packing this point should be taken note of.

2. TRACK RENEWAL WORKS

Q.8 What are the various Classification of track renewal works?

Ans

(1) All track renewals can be classified generally into one of the following categories:-

(1) Complete Track Renewal (Primary) C.T.R.(P)

(2) Complete Track Renewal (Secondary) C.T.R (S)

(3) Through Rail Renewal (Primary) T.R.R.(P)

(4) Through Rail Renewal (Secondary) T.R.R (S)

(5) Through Sleeper Renewal (Primary) T.S.R.(P)

(6) Through Sleeper Renewal (Secondary) T.S.R.(S)

(7) Casual Renewals.

(8) Scattered Renewal

(9) Through Turn-out renewal (TTR)

(10) Through Fitting Renewal (TFR)

(11) Through Weld Renewal (TWR)

(12) Through Bridge Timber renewal (TBTR)

2) **Primary renewal** are those where only new materials are used and **secondary renewals** are those where released serviceable materials are used.

3) **Scattered Renewal** : In this case, unserviceable rails, sleepers and fastenings are replaced by identical sections of serviceable and nearly the same track components. These are carried out in isolated locations and not more than 10 rails / or 250 sleepers in a gang beat per year. Such renewals are a part of normal maintenance operations.

4) **Casual Renewal**: In this case, unserviceable rails, sleepers and fastenings are replaced by identical sections of serviceable and nearly the same vintage or new track components. These are carried out in isolated locations of continuous but small stretches. Such renewals are not part of normal maintenance operations and cannot be covered under scattered renewals.

Q.9 What are the various factors Governing Permanent Way Renewal for BG Track?**Ans:****(1) Criteria for Rail Renewal :-** The following are the criteria of rail renewals;-

Incidence of rail fractures/ failures

Wear on rails

Maintainability of track to prescribed standards.

Expected service life in terms of Gross million tonnes (GMT) carried.

Plan based renewals.

(a) Incidence of Rail Fractures/ Failures. A spate of rail fractures on a particular length showing an abnormally upward trend will have priority while deciding rail renewals.**(b) Wear on Rails****(i) Limiting Loss of Section-** The limiting loss in rail section, as a criterion for recommending rail renewals shall be as under-

Gauge	Rail Section	Loss in Section in percentage
B.G.	52 Kg./ metre	6
	90 R	5

Rail wear may be determined by actual weighment, taking rail profiles at ends after un-fishing joints and taking rail profiles with special profile measuring gadgets.

(ii) Wear due to corrosion- Corrosion beyond 1.5 mm in the web and foot may be taken as the criterion for wear due to corrosion. Existence of the localised corrosion such as corrosion pits, specially on the underside of the foot, acting as stress raisers from the origin of fatigue cracks and would necessitate renewals.**(iii) Vertical Wear-** When the reduction of the depth of the rail head reaches a point beyond which there is a risk of wheel flanges grazing the fish-plates, such rails should be renewed. Limits of vertical wear from relaying consideration are as under:

Gauge	Rail Section	Vertical Wear
B.G.	60 Kg./ metre	13.00 mm.
	52 Kg./ metre	08.00 mm.
	90R	05.00mm

Vertical wear is to be measured at the centre of the rail either by measuring the height of the worn out rail by callipers or by plotting the profile.

- (iv) **Lateral Wear-** Limits of lateral wear from relaying consideration are as under:-

Section	Gauge	Category of track	Lateral wear
Curves	B.G.	Group 'A' & 'B' Routes	08 mm.
		Group 'C' & 'D' Routes	10 mm.
Straight	B.G.	Group 'A' & 'B' Routes	06 mm
		Group 'C' & 'D' Routes	08 mm

Lateral wear is to be measured at 13 to 15 mm. below the rail top table.

(c) Maintainability of track to prescribed standards-

- (i) There may be cases, where renewals may be necessary on the following considerations viz.,
- (1) Poor running quality of track in spite of extra maintenance labour engaged for maintaining the same,
 - (2) Disproportionate cost of maintaining the portion of track in safe condition.
- (ii) The condition of rails with regard to hogging/battering, scabbing and wheel burns and other conditions such as excessive corrugation of rail as can be ascertained by visual inspections. which affects the running quality of track, and make the track maintenance difficult and uneconomical should be taken into account while proposing renewals.
- (iii) Renewals of rail due to hogged and battered rails ends should be considered only if other remedies have not been found to be effective.

(d) Renewals on consideration of service life in terms of total G.M.T. of traffic carried

– The rail shall be planned for through renewal after it has carried the minimum total traffic as shown below-

Gauge	Rail Section	Total G.M.T. carried for T.12 Med. Manganese rails	Total GMT carried For 90 UTS rails
B.G.	60 Kg./metre	550	800
	52 Kg./metre	350	525
	90 R	250	375

(e) **Plan based Renewals-** Renewals to pre-determined plan with the objective of modernising the track structure on selected routed in the quickest possible time may be planned even if it involves premature renewals.

(2) **Secondary Rail Renewals**

- (a) In the case of Secondary Renewals, if the condition of rail ends and weld lines. The rails should be ultrasonically tested before use.
- (b) Building up of chipped rail ends by welding will also improve the service life.
- (c) The rails released from primary relaying and not fit for use in secondary relaying should be used in sidings.

(3) **Criteria for Renewal of Sleepers:-** Generally a sleeper is serviceable if it can hold gauge, provide satisfactory rail seat and permit rail fastenings being maintained in tight condition , and retain the packing underneath the sleepers. Such sleepers that are not likely to fulfill the above functions even after reconditioning should be renewed. Where re-sleeping only is justified this should be carried out in continuous stretches.

On girder bridges when several sleepers are defective, renewals should be carried out for the full span.

Q.10) What is the schedule of Speed Restrictions for track renewal work by manual as well as machine packing ?

Ans

The speed restrictions to be imposed during various sequences of work are as under:

Broad Gauge–Manual Packing

Day	Sequence of events	Speed in Kmph.
1 st	Opening, relaying and initial packing	20
2 nd	1 st through packing	20
3 rd	2 nd through packing	20
4 th to 9 th	Picking up of slacks as required	45(after second Through packing)
10 th	3 rd through packing	45
11 th to 19 th	Picking up of slacks as required	75(after third through packing)
20 th	4 th and final through packing	75
21 st		Normal section-al speed

Broad Gauge- Machine Packing

Day	Sequence of events	Speed in Km.ph.
1 st	Opening, relaying and packing	20
2 nd	1 st tamping	20
3 rd to 5 th	Attention to track as required	45 (after completion of 1 st tamping)
6 th	2 nd tamping	45
7 th to 8 th	Attention to track as required	75 (after completion of 2 nd tamping)
9 th	3 rd tamping	
10 th	Normal sectional speed.

Note: - The work of Track renewals on double line should normally proceed in the direction opposite to Traffic.

Q.11) What are the track laying standards to be achieved during primary renewal of track?

Ans:

- (1) Utmost care should be taken during linking to ensure good quality of work, which on no account should be allowed to suffer.
- (2) As a good practice, the following laying standards of track geometry measured in floating condition during primary renewals for Broad Gauge should be achieved (Track laid with new materials). The track geometry will be recorded three months after the speed is raised to normal-

(a) Gauge	Sleeper to sleeper variation	2 mm.
(b) Expansion gap	Over average gap worked out by recording 20 successive gaps	± 2 mm.
(c) Joints	Low joints not permitted High joints not more than.. Squareness of joints on straight	± 2 mm. ± 10 mm ± 20 mm
(d) Spacing of Sleepers	With respect to theoretical spacing	± 3 mm
(e) Cross level	To be recorded on every 4 th sleeper.	± 2 mm
(f) Alignment	'On straight on 10M. Chord.. On curves on Radius more than 600 M. On 20M. Chord. Variation over theoretical versines: On curves of Radius less than 600M. On 20M. Chord. Variation over theoretical versines:-	5 mm 10 mm 50 mm
(g) Longitudinal level	Variation in longitudinal level with Reference to approved longitudinal Sections.	

Q.12) Describe in detail the procedure for Classification and Disposal of Released Materials.**Ans.**

(1) **Basis for Classification-** For the purpose of classification, Permanent Way materials should be divided into three classes depending upon the section and condition as detailed below-

(a) **Class I material** is that which is new and of standard section. New items of obsolescent sections which are interchangeable with standard materials and are purchased from time to time to prevent wastage of other serviceable material, should be brought on to the stock account as Class I material.

No other material of an obsolescent section is to be treated as Class I, even though it may never have been put in the road.

(b) **Class II material** includes all new material of obsolescent sections other than those included under Class I and all standard and obsolete material released from the road and fit for further use on track.

Class II released rails should be classified and sub-divided as under-

Class II(a) rails fit for use in running lines.

Class II(b) rails fit for use in non-running lines.

(c) **Class III materials** shall include all materials that has become unserviceable. This is either metal scrap or unserviceable timber. This class will include all rails which are neither Class I nor Class II.

Class III sleepers, wooden or steel should be further sub-divided as follows:-

(i) **Wooden sleepers-** Class-III-A not fit for use in track but fit for walling of enclosures or for paving.

Class III-B not fit for use in track but fit for scantling or manufacturing keys or plugs.

Class III-C fit for fire-wood only.

(ii) **Steel sleepers-** Class III-A unserviceable, suitable for reconditioning or conversion to smaller gauge. Class III-B unserviceable scrap.

3) Accountal of released P.Way materials :

1. The quantity of released materials from every work included for track renewal/gauge will be based on yardsticks for loss of weight to be fixed on the basis of data collected during foot by foot survey. If there is more than one work on the same route, near to each other and under similar ground conditions, only one set of yardsticks would suffice.
2. List of materials likely to be released will be prepared indicating the quantum of such materials separately as second hand (SH) and scrap.
3. While second hand materials will be indicated only in length/Nos. in case of scrap materials, the accountal will be as follows:-
 - i. Rails- in length, then converted to weight.
 - ii. Sleepers- Nos. separately as whole and in parts and then converted to weight.
 - iii. Fittings and fastenings- by weight.
4. During foot by survey, actual observation will be recorded jointly by PWI and ISA/Stock Verifier giving the percentage loss of weight over the maximum percentage loss of weight over the new component for each weighment of few representative samples.
5. The yardsticks will then be approved by the Sr. DEN/DEN personally based on the report only test checked by AEN or DEN. These will specify the maximum percentage loss of weight for different components under different ground conditions.
6. The conversion to weight in case of each of the items for purpose of accountal will then be done by the Section Engineer (P.Way) on the basis of the specified percentage loss of weight over the new components. In case, however, some abnormal variation of weight is observed after the materials have been released and the percentage loss is more than that specified for that category, specific justification will have to be recorded for the same by the Senior Section Engineer (P.Way) and all such cases would have to be certified by DEN/Sr. DEN after actual sample checking at site.
7. In case however, the actual loss after release is seen to be lower than the yardstick the accountal will be done on the basis of actual.
8. After actual releases of materials, the Section Engineer (P.Way) will take the releases on books.
9. The sectional AEN will carry out test checks to the extent of 20% of each item and make entries to the effect in the summary sheet. The sectional DEN/Sr. DEN will also carry out random checks to ensure that the category and weight of releases are correct to the maximum possible extent.
10. In case where the track work is to be done by contractor, the list of released materials shall be jointly prepared on the basis of a field survey to be conducted by the Sr. Sectional Engineer (P.Way) and contractor's representative after the work has been awarded but before the dismantling work is allowed to commence. The contractor shall be bound to hand over the materials according to the said agreed list and should be responsible for any shortages.

3. CATEGORIES OF ENGINEERING WORKS

Q.13) What are the various categories of Engineering Works?

Ans.: Engineering works can be broadly divided into three categories-

(1) Category 1- Works of routine maintenance, requiring no speed restriction, not necessitating exhibition of hand signals and involving no danger to trains or track etc.

These include works of routine maintenance such as through packing, picking up slacks and overhauling of track etc.

(2) Category 2- Works of short duration-

(a) Works such as casual renewals of rails and sleepers, adjustment of creep and lubrication of rail joints which are completed by sunset of the day of commencement and no restriction of speed thereafter is required, are termed “works of short duration”.

(b) Hand-signal and banner flags and fog-signals shall be used at specified distances to afford protection to trains.

(3) Category 3 – Works of long duration –

(a) Works such as relaying, bridge construction, diversions which extend over a few days, or weeks during which period a continuous restriction of speed is to be in force, are termed as “works of long duration”

(b) Temporary Engineering fixed signals shall be used at specified distances to afford protection to trains. These works should be carried out to a programme, about which all concerned will be advised in advance.

Q.14) Describe in detail the procedure for protection in block section & procedure for passing of trains for works of short duration on BG section.

Ans.: **Protection in block section and procedure for passing of trains-** Before commencing any work of such category the Permanent Way Inspector or authorised Railway servant should issue a notice to the Station Master/Block hut in-charge at each end of the Block section and obtain their acknowledgment. Depending as to whether the train is to be passed through the work site, after stopping or at a restricted speed, the line should be protected in the following manner:-

(1) When the train is required to stop at the site of work (in Block section)-

(a) Post a flagman with hand signals at a distance of 30 meters in rear of the place of obstruction, to show stop hand signals.

- (b) Post a flagman with hand signals and place a banner flag, across the track at a distance of 600 meters on Broad Gauge in rear of the work. The flag man will show stop hand signals.
 - (c) Post a flagman with hand signals and detonators at a distance of 1200 meters on Broad Gauge in rear of the work. The flagman shall fix three detonators on the line 10 meters apart and take stand at a place not less than 45 meters from the three detonators, from where he can obtain a clear view of the approaching train. He will show stop hand signals.
 - (d) The man at the site of obstruction shall give proceed hand signal to indicate to the Driver, when he may resume normal speed after the train has been hand signalled past the obstruction
- (2) **When the train can pass over the work spot at restricted speed in Block section-** The following protections should be adopted in the above cases :-
- (a) Post a flagman exhibiting caution hand signals at a distance of 30 meters from the place of obstruction.
 - (b) Post a flagman exhibiting caution hand signals at a distance of 1200 metres for Broad Gauge from the place of obstruction.
 - (c) Post a intermediate flagman with hand signals at a distance of 600 metres for Broad Gauge from the place of obstruction. He will also place a banner flag across the track. The intermediate banner flag must be kept across the line until the speed of the train has been reduced, after which the banner flag shall be removed and the train hand signaled forward.
 - (d) The railway servant at the site of work should give proceed hand signals to indicate to the Driver, that he may resume normal speed after the train has been signaled past the site of work:
- (3) The following points should be kept in view, while protecting the track in the cases mentioned.
- (a) On single line, the line must be so protected on both sides of the work.
 - (b) At places where there are curves or falling gradients and at times of poor visibility the distances laid down in sub-paras (1) and (2) above may be suitably increased wherever necessary and intermediate flagman posted to relay hand signals.
 - (c) The location of the banner flag, detonators and hand signals should be so selected as to avoid stopping of trains, as far as possible, on continuous steep rising gradients.

- (d) If in an emergency, it becomes necessary to carry out such works at night, the provisions for protection of line as detailed in sub-para (1) and (2) must be complied with except that red light must be exhibited in the direction of approaching trains in place of red hand signaling flags and banner flags.
- (e) In an Emergency, where it is necessary on considerations of safety, the Permanent Way Inspector, or authorised railway servant may commence such work after protecting the line before issuing notice to the Signaller. If the work is likely to be prolonged he should notify the Signaller as soon as possible.

Q.15) Explain in detail about the custody, use, life, testing and disposal of detonating signals.

Ans. Detonating signals- Detonating signals otherwise known as detonators or fog signals are appliances which are fixed on the rails, and when an Engine (or vehicle) passes over them, they explode with loud report so as to attract the attention of the Driver.

Care and Custody- (1) Detonators should be protected against damp. They should be stored in tin cases with papers wrapped over them.

- (2) In one tin case not more than twelve detonators should be kept.
- (3) The tin cases should be stored in wooden boxes which should be kept in dry places and not left in contact with the brick walls, damp wood, chloride of lime or other disinfectants; these should not be exposed to steam or other vapours.
- (4) Unexploded detonators should not be as far as possible sent from place to place by consignment; they should be conveyed personally or by a messenger.

Stock with Engineering Staff- (1) Each way, Works & Bridge inspector shall have a stock of detonators sufficient to recoup the number annually tested and any which may be exploded for works and emergency. The Permanent Way Inspector shall ensure that all Gangs, Gatemen, Keyman, Patrolmen and Watchmen are equipped with the specified number of detonators.

- (2) Every Assistant Engineer, Gangmate, Keyman, Gateman, Patrolman and Watchman, whose duties include protection of track shall carry the specified stock of detonators with him on duty, for use during an emergency.
- (3) The month and year of manufacture are shown on the label outside each case and also stamped on each detonator. Detonators should be used in the order of the dates stamped on them, the oldest being used first. To facilitate ready withdrawal in this sequence, they should be stored also accordingly.

Use of Detonators-(1) Engineers and Inspectors are responsible to ensure that the staff working under them know how and when to use detonators.

- (2) A detonator when required to be used shall be placed on the rail with the label or brand facing upwards and shall be fixed to the rail by pending the clasps around the head of the rail.

Testing- (1) Once a year, one detonator shall be taken by the Permanent Way Inspector from his own stock and from Gangmate, Keyman, Gateman, Patrolman and Watchman for testing, one also from each of the lots in the personal custody of Divisional Engineer, Bridge Engineer, Assistant Engineer, works and relieving Permanent Way Inspector where the headquarters of these officials falls within the P.W.I.'s jurisdiction. The oldest detonators should be selected for the test.

- (2) The testing of detonators should be done under an empty 4-wheeled B.G./M.G/N.G. wagon propelled by an engine and moving at walking speed under the direct supervision of the Permanent Way Inspector, who shall ensure safety range during testing. Results of tests should be entered in a Register.
- (3) The P.W.I. shall submit by the end of the year (31st December) a certificate in duplicate to the Assistant Engineer to the effect. "I certify that I have tested the detonators from stocks mentioned below ending.....and append a list of those that failed to explode."

Life of detonators-The normal life of detonators is seven years. The life of the detonators can be extended to ten years on an yearly basis subject to the condition that two detonators from each lot of over 7 year old ones are tested for the explosive content and the results being found satisfactory. Such time extended detonators can be used on all sections after satisfactory testing. In case the results are not satisfactory, they should be destroyed. In any case no detonator should be kept in use after ten years.

Disposal of time-barred Detonators- No detonator that bears any sign of rust and is time- barred shall be held in stock. Such detonators shall be destroyed by one of the following methods:-

- (1) By soaking them in light mineral oil for 48 hours and then throwing them one by one into fire with due precautions.
- (2) By burning them in incinerator.
- (3) By detonating them under wagon during shunting operations.
- (4) By throwing them in deep sea.

Safety Range –When detonators are being tested, no persons should be allowed within a radius of 50 meters from the detonators to be exploded; the engine crew shall remain well within the cab.

4. TRACK PATROLLINGS

Q.16 What are the various type of track patrollings?

Ans. The following are the types of patrolling in vogue:

- (a) **Keyman's daily patrol.**
 - (b) **Gang patrol during abnormal rainfall or storm.**
 - (c) **Night patrolling during monsoon.**
 - (d) **Security patrolling** during civil disturbances and for movement of VIP specials.
 - (e) **Hot weather patrolling** for long welded rails/continuous welded rails.
 - (f) **Cold weather patrolling** for long welded rails/continuous welded rails.
 - (g) **Watchmen at vulnerable locations.**
- (2) **Keyman's Daily Patrol**-Every portion of the permanent way shall be inspected daily on foot by the keyman of the beat in which the portion of the track falls. Provided that the interval between such inspections may, under special instructions, issued by Chief Engineer be increased to once in two days in the case of specified section lines with light and infrequent traffic.
- (3) **Gang Patrol during Abnormal Rainfall or Storm**- In the event of abnormal rainfall or storm during day or night, the Mate should, on his own initiative organise patrolling over the length affected, independently of other patrolling, if any being done. This patrol should, in case of heavy rainfall, confine its inspection to known points of danger, such as cutting or culverts likely to scour, bank affected by tanks likely to breach and bridge approaches. In case of high winds, the patrolman should inspect the length of track likely to be fouled by falling of tree etc.

Arrangements exist with the Meteorological Department of the Government of India for issuing telegrams of warning, wherever storms, gales, or heavy rainfall are expected. On receipt of such information from the Control, the Permanent Way Inspector will arrange to advise monsoon patrolmen, watchmen and gangmates to be extra vigilant and be prepared to introduce patrolling, as necessary.

- (4) **Night Patrolling during Monsoon**- During the monsoon, certain section of the railway line, as may be specified, shall be patrolled to detect damage by

flood, such as breaches, settlements, slips and scours and immediate action taken to protect trains, when so warranted.

- (5) **Security Patrolling during Civil Disturbance and on Special occasions-**
- (a) On apprehension of a Civil disturbance, the Divisional authorities should contact the local Civil authority and arrange, as circumstances may warrant for security patrolling of the railway line. This may be arranged on the pattern of the monsoon patrolling with modifications, as deemed necessary, in consultation with Civil authorities.
- (b) Security patrolling on special occasions should be carried out according to the special instructions issued by the administration.
- (c) The primary duty of the patrolman employed on Security patrolling shall be to protect trains against any condition of danger, such as tampering with track or obstruction placed on line.
- (6) **Hot weather Patrolling for L.W.R./C.W.R.-** Hot weather patrol is carried out when the rail temperature reaches $t_d + 20$ degree or above.
- (7) **Cold weather Patrolling for L.W.R./C.W.R.-** Cold weather patrol is carried out when the rail temperature reaches $t_d - 30$ degree or below.
- (8) **Watchmen at vulnerable locations.** In addition to patrolmen, stationary watchmen are posted at known or likely locations of danger or trouble.

Q.17). Explain in details the procedure for monsoon patrolling giving details of preparation of patrol charts & patrol books, duties of patrolman & Equipments required for patrolling.

Ans.: Preparation of Patrol Charts- (1) The Divisional Engineer will prepare patrol charts for each of the sections where monsoon patrolling is required to be done, taking into consideration the train timings of the time table in force during this period. The principles governing the preparation of patrol charts shall be.

- (a) Ordinarily patrolling will be carried out by a single patrolman, but regions where danger from wild animals, dacoits and other risks as in ghat sections exist, patrolling in pairs may be introduced with the approval of the Chief Engineer.
- (b) All trains carrying passengers between sunset and sunrise get the maximum protection possible.
- (c) As far as possible, each block section will be treated as a unit and the length will be divided into equal beats. The length of each patrol beat should not normally exceed 5km. Where the block section is more than 10 Km. an intermediate flag station, if

- any,, or any other suitable point may be fixed as intermediate station, to keep the length of beat at about 5 km.
- (d) The walking speed of a patrolman may be taken as 3 km. per hour.
 - (e) The maximum distance covered by a patrolman should not normally exceed 20km. in a day.
 - (f) A period of at least $\frac{1}{2}$ hour rest is desirable between consecutive beats.
 - (g) If the frequency of train services is high, and one set of patrolmen is not able to cover all the trains in the section, a second set of patrolmen may be introduced to reduce the interval.
 - (h) For giving better protection to all passenger trains, between sun-set and sun-rise it would be advantageous to plot the scheduled paths of all passenger trains and then plot the patrol movement in such a way, so as to minimise the time interval between patrolling of the beat and passage of train.
 - (i) Patrol charts should show all vulnerable locations where stationary watchmen are posted.

Patrol books and Systematic Patrolling- A patrol book containing sufficient number of pages should be supplied to each patrol with a tin case.

The books shall be serially numbered to correspond with the number of patrol on each section. The first page of the book shall contain the name of patrolman, kilometrage of patrol section and its number. The remaining pages will contain columns for date, station, time of arrival and departure and signature of Station Master.

The patrolman whose beat commences/terminates at a station shall present the patrol-book in his possession to the Station Master/Block hut-in-charge who will enter therein the time of arrival and departure and sign the book. The Station Master/Block hut-in-charge will also record the time of arrival and departure in his Diary/Train Register Book. The patrolman shall then patrol his length at the end of which, he will exchange his patrol book with that of the next patrolman and retrace his beat. The intermediate patrols do likewise. In this way each patrol-book will be conveyed from one station to the other and back again.

If a patrolman on arrival at the end of his beat does not find the next patrolman to take over the book, he must proceed ahead, until he meets him.

Equipment of Patrolman-(1) Each patrolman shall be provided with the following equipment and such other, as may be prescribed by special instructions:

- (a) One staff.
 - (b) Number plate 15 cm. Square (to be numbered consecutively from the beginning of each permanent Way Inspector's length in white letters on black background).
 - (c) 12 fog signals in a tin case.
 - (d) Two tricolour hand signal lamps.
 - (e) Protective clothing according to local dress regulations.
 - (f) One match box.
 - (g) Two red flags and one green flag (day patrol only).
 - (h) Patrol book in a tin case.
 - (i) One three cell Electric torch.
 - (j) Whistle thunderer.
 - (k) One haversack.
- (2) Three flare signals fusees in ghat, suburban, automatic and absolute permissive block territories, double and multiple line sections in other than suburban sections.
- (3) Where patrolling is undertaken in pairs or stationary patrol consists of two men. the equipment need not be duplicated but the additional patrolman will be provided with an extra hand signal lamp, whistle thunder and protective clothing.

Duties of Patrolmen- (1) The duties of a patrolman shall be as follows:-

- (a) Walks to and fro over the beat in with the accordance with the chart pertaining to his "patrol-section" looking out for subsidence, slips, signs of erosion, trees blown across the track during storms or any other causes likely to endanger the safety of line. Bridges and their approaches should be especially watched.
- (b) Apprehend damage to line when
 - (i) the flood exceeds danger level at any of the bridges.

- (ii) when there is damage to the protection work or on approaches even before danger level is reached.
 - (iii) the water on one side of the embankment is at a much higher level than on the other side.
 - (iv) when any obstruction such as a fallen tree is blocking the water-way of a bridge.
 - (v) the track shows signs of a settlement.
- (c) Take immediate steps to stop train when any portion of the line is likely to be rendered unsafe due to abnormal rain or flood or any other cause.
 - (d) When no danger is apprehended, stand on the cess on the left hand side facing the train and exhibit his number plate, turning the light of his lamp on to it, so that the number can be seen from the passing train. He should also blow the whistle, when the engine and the brake-van of the train pass him.
 - (e) Obtain the signature of the Station Master/Block Hut-in-charge on duty at the Station Mater/Block Hut concerned for his arrival and departure and exchange patrol books with adjacent patrolmen.
 - (f) Exchange the reports as to the conditions on their beats with adjacent patrol men and stationary watchmen on the way.
 - (g) Heed instructions from drivers who may report a condition of danger at a kilometrage and proceed to the place indicated and take necessary measures.

Q.18) What action is to be taken by patrolman in the event of any portion of the line being breached or otherwise rendered unsafe for traffic on a Broad Gauge (BG) track where one patrolmen is employed? What is the prescribed schedule of inspection of night patrolling by PWI/Section & PWI/Incharge

Ans. In the event of any portion of the line being breached or otherwise rendered unsafe for traffic the following procedure shall be observed-

- 1) **Protection of line**
 - a) When damage is detected on single line-
 - (i) Place a red lamp during the night and a red flag during the day in a prominent position to warn a train which may approach from one direction. Then run in the opposite direction from which direction train is likely to come, with a danger signal (red flag by day and red light by night) and place one detonator at 600 M

on Broad Gauge and three detonators at 10 meters apart at 1200 M. on Broad Gauge from the site of obstruction/damage.

- (ii) Return to the site of obstruction/damage and protect the other side with detonators similarly.
- (iii) In the event of it being impossible to get the other side of the obstruction/ damage (as in a wash away) place the red lamp so that it can be seen from as great distance as possible by a train approaching from that direction and protect the other side with the detonators etc. as detailed in sub-para(a) (i)

(b) When damage is detected on double line-

- (i) Place the red flag/ lamp in prominent position so as to warn an approaching train on one track. Then run along the other track on which train is expected first and place the detonators as in sub-para (a) (i)
 - (ii) Run back and protect with detonators the line on which the lamp/flag was prominently placed earlier.
- 2) **Reporting the damage to the Station Master-** The patrolman will return to the site of obstruction after protecting the line in both the directions and shall remain at the place of obstruction and send work about the danger through the first railway employee or other persons he is able to contact at the spot itself.

Schedule of inspection of night patrolling by PWI/Section & PWI/Incharge is as under:

Official	By Train/Trolley
P.W.I. Gr.III/II	Once a fortnight
P.W.I. in-charge	Once a month

4. CRS SANCTION & PQRS

Q.19) What are the various works requiring the sanction of Commissioner of Railway Safety?

For the commencement and opening of the following works, when they are connected with or form part of Railway already opened, the sanction of the Commissioner of Railway Safety shall be obtained-

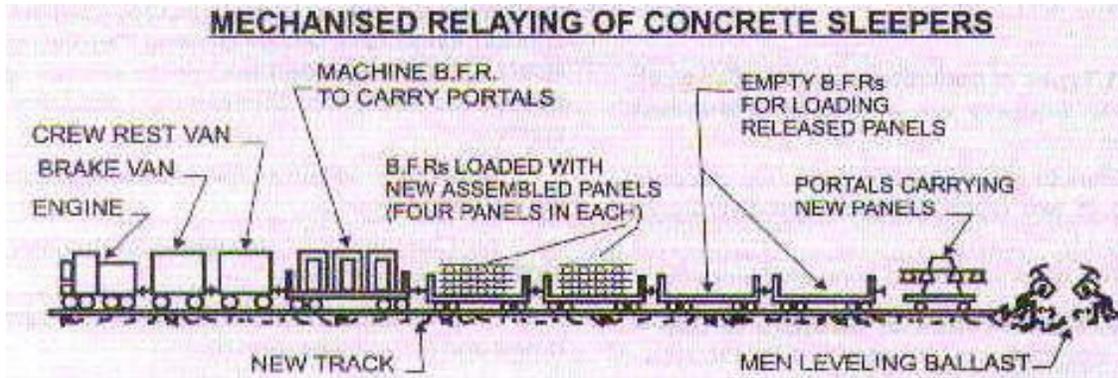
- Additions, extensions or alternations to running lines.
- Alterations to points and crossings in running lines.
- New signalling and interlocking installations or alterations to existing installations.
- New stations, temporary or permanent.
- The construction (but not the removal) of an ash pit on a running line.
- Heavy regarding of running lines involving lowering/raising of track in excess of 500mm.
- New bridge including road over and under bridges, foot over-bridges, strengthening, raising, reconstruction or extension of existing girders, including provision of temporary girders.
- Provision of new level crossing, shifting of existing level crossing on running lines.
- Permanent diversion (deviation) more than 2Kms. in length without any station in between and irrespective of length, when a new station is involved.
- Temporary diversion irrespective of length, except those laid for restoration of through communication after accident
- Addition or alterations .to the electrical installations of tracks equipped for electrical traction.

Q.20) Explain the various operations in connection with Track Renewal of Concrete sleepers with PQRS.

Ans:

- Concrete sleepers are heavy and manual handling is not only difficult but may even cause damage to the sleepers. Mechanical handling of concrete sleepers, therefore, become necessary. For this purpose, the Mechanical Relaying Systems consisting of portal cranes are used. Normally a set will consist of two portal cranes.
- Operations connected with Relaying-
 - Preparatory work at site of relaying-(a) Since concrete sleepers are laid with L.W.R./C.W.R. all preparatory works as listed in L.W.R. Manual should be carried out before laying concrete sleepers. In addition, longitudinal section showing the existing rail levels should be plotted and proposed rail level determined taking into consideration the following points:-
 - 300mm. ballast cushion is available below the concrete sleepers.
 - Clearances to structures are maintained within the accepted limits.
 - The track and the road surface are suitably raised and approaches regraded.
 - Where lifting of track is not possible at places like-below over line structures, on girder bridges and in yards, etc., suitable ramping out should be done.
 - The proposed predetermined rail level should be indicated at suitable intervals along the track.
 - Auxiliary track should be laid at 3.4 M gauge keeping its centre line same as that of the existing track.
 - The existing welded rails should be converted into panels of suitable lengths such that the capacity of the portal crane is not exceeded by handling the old panel.
 - Pre-assembly of Panels- Sleepers received from the Concrete Sleeper plant are unloaded and stacked at the base depot. Handling of Concrete Sleepers is done by portal cranes or separate cranes provided for the purpose. These sleepers are assembled into panels making use of service rails. While assembling the panels, elastic fastenings complete in all respects should be provided and correct uniform spacings of sleepers should be ensured. The assembled panels are stacked and are later loaded in BFRs in three to four tiers.
 - Formation of relaying train- The relaying train shall consists of two empty BFRs for loading released track panels, adequate number of BFRs loaded with pre

assembled panels, BFRs loaded with portal cranes, one equipment and tool van, one crew rest van, one brake van an engine. A typical marshalling order of the relaying train is indicated in the figure below:-



- Actual Relaying- A speed restriction of 20 Km. p.h. is imposed at the place of relaying and preliminary works such as loosening of fastenings, removal of ballast etc. are carried out in advance. On the day of relaying, traffic block is imposed and the relaying train enters the block section. After the relaying train is positioned, the portal cranes unload by themselves on the auxiliary track. The new and existing tracks are joined by closure rails. After the last panel is laid, a ramp is made in two rail lengths between the existing track and the new track, to run out the difference in levels. The relaying train returns to the base depot where the old track panels are unloaded.
- Post relaying works- In subsequent blocks the service rails should be replaced by welded panels.
- The newly laid track is tamped and speed restrictions relaxed in stages. Before relaxing the speed to normal, provisions of proper L.W.R. ballast profile should be ensured.

5. LEVEL CROSSINGS

Q.1. What are the facilities to be provided in order of priority under revised classification of gates?

Ans.1. i) Provision of telephone
ii) Provision of lifting barrier and will be provided with retro reflective tapes and strip to improve the visibility of gate to road users.
iii) Interlocking of manned level crossing gates.

Q.2. What are the requisites for changing normal position from close to road traffic to open to road traffic?

Ans.2.

- Level crossing should not be on a suburban section.
- Section concerned should not have automatic block signaling or automatic permissive block signaling.
- Level crossing should be equipped with lifting barriers.
- Level crossing should be provided with a telephonic connection with station master and should have a system of exchange of private number.
- Railway track at level crossing should be straight on either side to afford a clear view of an approaching train.
- As long as gates are kept open to road traffic a red flag by day time and red light (by using trolley lamp during night should be deployed towards the approaching train on either side of level crossing)
- Level crossing shall be provided with whistle board on either side at adequate distance to enjoin driver of approaching train to give audible warning of the approach of the train to the road users.

Q.3. Describe the working procedure of non-inter locking level crossing gate provided with telephone with normal position close to road traffic.

Ans.3

- Gateman must seek permission from Station Master/Switchman/Cabinman for opening the gate.
- Station Master/Switchman/Cabinman shall ensure that there is no train movement within the station section. Thereafter Stationmaster/Switchman/Cabinman shall give his private number to the gateman allowing him to open the gate for purpose of clearing road traffic.
- Suitable entries shall be made by the Station master/Switchman/Cabinman in the Train Signal Register/Cabin Operation Register, Private Number Book and Log Book in red ink.

- After passage of road traffic, the gateman shall close the gate and confirm this to Station Master/Switchman/Cabinman, under exchange of private number.
- Gate once closed for road traffic must on account be opened unless this is authorized by the Station Master/ Switchman/Cabinman under exchange of private number.
- When a train has to be piloted to and from the station yard or any shunting movement is to be done the staff deputed to pilot the train or to perform the shunting across the gate shall be personally responsible to ensure that the gate shall be against road traffic before allowing any movement across the gate.

Q.4 What are the criteria for manning of unmanned level crossing?

Ans.4. Category I- Clear visibility level crossing where TVU is more than 6000 and road vehicles > 180.
 Category II- Restricted visibility level crossing where TVU is more than 6000 and road vehicles > 120.
 Category III-Restricted visibility level crossing where TVU is between 3000-6000.

Q.15. Who will check the equipment of gateman in routine?

Ans.15. Permanent Way Inspector (SSE/SE/JE) shall check the equipment of Gateman's equipment once in a month and Assistant Engineer should inspect the equipment at every manned level crossing on subdivision once in 6 month.

A] Questions Related to Accidents, Level Xings and formation problems

Q-1 What is temporary and semi permanent diversion?

Ans.:

- (a) Temporary diversion is constructed around on obstruction to traffic and Not likely to be in use for more than 10 days.
- (b) A semi permanent diversion is constructed for special purpose for facilitate the reconstruction of the line and bridges etc. and likely to be in use for a period of more than 10m days.

Q-2 What do you understand by flooding of track?

Ans.: When track gets flooded with water, the train should be permitted to proceed at a speed of stop dead and 8 kmph subject to the following conditions:

- (i) If water rises over ballast but below rail level. Two men will walk over the track on either end, train will be allowed to pass if track is not disturbed.
- (ii) When water overtops the rails, the PWI should certify by walking over and probing that track is safe and then only the train should be allowed to pass.

Q-3 What do you understand by formation trouble?

Ans: A derailment may take place due to failure of formation such as unequal settlement, slip, submergence or water pockets etc. such troubles are more likely to be developed in monsoon.

Q-4 What is positive angularity?

Ans: Longitudinal distance between the tread of flange contacts being called positive eccentricity such angularity is called positive angularity.

Q-5 What do you understand by unusual occurrence?

Ans: Every railway servant should take immediate steps to prevent an accident and where necessary advise the nearest station master by the quickest possible means the following unusual occurrences:

1. Any defective signal
2. Any obstruction, failure or threatened failure of any part of the way or works.
3. Anything wrong with a train or
4. Any unusual circumstances likely to interfere with the safe running of trains or the safety of the public.

Q-6 Specify different no. of hooters in case of accidents.

Ans: It is the practice on the Railways that different number of hooters is sounded according to the type of accident, as indicated below:

S.N.	Description of accident	No. of hooters to be sounded.
1.	When an accident takes place in the loco shed or traffic yard adjoining the loco shed	2 long
2.	When an accident takes place at out-station but main line is clear	3 long
3.	When an accident takes place at outstation but main line is clear and relief train is to be turned out with the medical car	3 long & 1 short
4.	When an accident takes place at outstation and main line is blocked and relief train is to be turned out without medical car	4 long
5.	When an accident takes place at outstation and main line is blocked and relief train is to be turned out with medical car	4 long & 1 short

The duration of the long hooter is 30 seconds and that of the short hooter is 5 seconds.

Q-7 There is indication of sabotage in case of accident. What are the requisite steps prior to initiation of restoration?

Ans: In all cases of accidents, the cause of which might possibly be due to sabotage, it is essential that the clearance and restoration operations are not commenced till the police officials arrive at the site and intimate their agreement to the commencement of clearance and restoration work after making thorough investigations.

A factual note of the conditions obtaining at the site prior to restoration work should be prepared and signed jointly by the senior most police and railway officials. Difference of opinion, if any, may be recorded on the joint factual note.

This should not, however, be allowed to interfere with rendering of first aid to the injured, which is the first essential in all accidents.

Q-8 What is negative angularity?

Ans: In this case the wheel set makes flange contact near its trailing edge. The flange contact trails the tread contact. It is a case of trailing contact; the longitudinal distance between the two contacts is called negative eccentricity. Such angularity is called negative angle of attack.

Q-9 What is deep flange? Specify the Limits.

Ans: A deep flange tends to ride on fishplate and damage or check blocks and damage the track particularly if there is a vertical wear on railhead. Rejection limit is depth of flange greater than 35mm for BG and 32mm for MG measured at 63.5mm for BG (57mm for MG) away from back of wheel.

Q-10 What do you understand by flat tyre?

Ans: When tyre of wheel becomes flat at anywhere in entire circumference is called flat tyre. It causes hammering action on the rails. This hammering action may lead to fractures. The rejection limits of flat tyre are:

▪ BG Goods stock	75mm
▪ BG misc. stock e.g. Box, CS, BOB X, BWL & BRS type	63.5mm
▪ BG coaching stock	51mm
▪ MG all stock	51mm

Q-11 What action will you take if you observe a flat tyre?

Ans: Action to be taken in case of flat tyre – whenever we observe flat tyre, we shall immediately inform the nearest Station Master indicating the approximate position of bogie/wagon. The Station Master will stop the train and shall inspect the flat tyre. He shall take specific action in this regard.

PWI shall trolley the section to check whether the rail has not subjected to any harm and he shall impose speed restriction in the section in case of damage to track has taken place.

Q-12 What is false flange or hollow tyre?

Ans: The false flange causes excessive hunting and oscillation and increases the flange force. It may split open the points while traveling in trailing direction, the rejection limit is that outer edge of wheel tread below hollow tyre becomes more than 5mm for BG & MG

Q-13 What are rejection rules for axle box?

Ans:

- More than one loose liner used for taking up wear in a groove of an axle box.
- Axle box loose liner, when filled to take up wear, not bent over the top and bottom of axle box.
- Hot box
- Axle box broken
- Axle box over due oiling.
- Axle box due repacking.
- Axle box face place deficient or with a rivet broken or deficient.

Q-14 How less ballast can be cause of accident?

Ans: Inadequate quantity of ballast coupled with other reasons such as jammed joints etc. may cause buckling of track, leading to derailment. Also, in case of LWR/CWR track it is very important that the ballast should be available in adequate quantity otherwise stresses developed in summer may lead to buckling of track.

Q-15 What are the essential equipments of level crossing?

Ans:

- (1) 2 hand signal lamps (tricolor) provided with bright reflector
- (2) One green and 2 red hand signal flags.
- (3) One staff suitable for exhibition of red lamp as also red flag.
- (4) 2 long spare chains with 'stop' marked disc.
- (5) 2 spare small chains.
- (6) 2 pad lock.
- (7) 12 detonators.
- (8) 1-gate lamps.
- (9) One tin case for detonators, one tin case for muster sheet, 1 case for flags.
- (10) One can for kerosene oil.
- (11) One Tommy bar, one mortar pan, one phowrah, one rammer, one pick axe, one bucket, one wall clock.

- (12) 1 tool list, 1 book for safety rules, duty roster, 1 complaint book for road users, 1 inspection book, 1 level crossing working instruction book.
- (13) Diagram indicating the method of protection to be adopted, in case of obstruction in the level crossing.
- (14) 3 flare signal in ghats, suburban, automatic and absolute permissible block territories and double and multiple lines in other than suburban sections.

Q-16 What are the important duties of gateman?

Ans:

1. He should be alert and prepared to take immediate action in case of an emergency.
2. The keys of gate should be in his personal custody.
3. The gateman should stand facing the track on the gate lodge side of the approaching train.
4. No gateman should leave his gate unless another gateman has taken charge of it. If it is necessary to leave his gate in case of an emergency, he should close and lock the gates against road traffic before leaving the gate.
5. The gateman should ensure that the way for the flanges of the wheels is kept clear.
6. The gateman should keep the road surface well watered and rammed.
7. The gateman should report all unusual occurrences including the damage of gates to nearest SM & the PWI.
8. If a gateman notices that the train has parted, he shall not show a stop hand signal to the driver, but shall endeavor to attract the attention of driver and guard by shouting, gesticulating or by other means.
9. If a gateman notices any unusual occurrences at the gate, he should protect the track.
10. Every gateman shall as far as possible prevent trespassing by persons or cattle.
11. The gateman should ensure that the gate lamps and lamps of all gate signals are lighted and kept burning continuously from Sunset to Sunrise.

Q.17 Write short notes on:

Ans.

(a) Flange climbing:

Whenever the track or vehicle defect, or operating features contribute towards the derailment, the plainly show themselves at the rail wheel contact. Due to wheel tread track irregularities, elastic characteristics of the track, suspension characteristics of rolling stock, vehicle loading characteristics, vehicle operation characteristics etc., the wheel set travels along the track executing a variety of oscillations. The level oscillation cause the wheel set to make the wheel contact either with the left rail or right rail and consequently, flange force results. Flange force is one of the derailing force and when the instantaneous wheel load is unfavorable, the wheel flange will start sliding up the rail cage called flange climbing thus causing derailment.

(b) Eccentric Loading:

Eccentric loading as revealed from its nomenclature is the uneven loading in the wagon causing adverse effect on rail wheel contact. This feature has very abnormal effect at especially on points and crossings and on curves, where centri-fugal force act thus multiplying the wheel mounting force causing derailment.

(c) Thin Flange:

The thin flange increases clearance between wheel flange and rail, which increases the derailment proneness due to the following:

Oscillations increase due to greater play resulting in instability of the vehicle. If the flange is too thin, the back of the wheel may damage the tongue rail. Its rejection limit 16mm for BG and 13mm for MG from flange tip.

(d) Diversion:

Diversion means the diversion of the traffic by linking new line either temporary or semi-permanent.

Temporary; diversion is one which is not likely to be in use for more than 10 days. All trains must “stop dead” before entering a temporary diversion and proceed at 10 kmph speed.

Semi-permanent; it is one which is constructed for special purpose of facilitating the reconstruction of the line and/or bridges likely to be in use for a period of more than 10 days. On a semi-permanent diversion, train may proceed at a non-stop reduced speed after adequate period of consolidation.

(e) Descending Note:

When an accident takes place, the observations of the accidents are recorded jointly by Engineering, Traffic, Signal, carriage and wagon. If any of the officials does not agree with the observations of all others, he may give a noting mentioning his part of observations called the descending note.

Q-18 Precautions to be taken to avoid an accident on Engineering account:

Ans

At all locations, where rainfall is heavy, special attention should be given to various aspects of monsoon problems, like patrolling, watching of vulnerable locations, functioning of side-drains and catch –water drainage of yards etc. as well as picking up slacks, especially low joints, pumping locations trolley, footplate and rear vehicle by PWIs, AENs & Sr.DENs. The work of each being monitored by the next higher official. Effective supervision at track renewal site and monitoring the observance of speed restrictions should be done in order to reduce derailments at such locations.

Old and worn-out tongue rails should be reconditioned or replaced, with priority for locations where a large number of trains negotiate the turnout. On BG heavy-density routes, 60kg. Points and crossings should be provided, as far as possible, along with track renewal with 60 kg rails. In any case, 90R turnouts on the BG should be eliminated urgently, with priority for BOX N routes.

All busy routes should be provided at least two hours nominated traffic block daily for maintenance purposes. PWIs should plan and carry out their track repair works, such as permanent rectification of rail fractures, welding of rails, casual and through renewals, transporting of materials etc. during the nominated block period.

Sections of the track prone to derailment, like curves, turn-in and turnout curves and tracks at renewal sites should be lubricated on the gauge faces. The frequency of lubrication when done by hand or trolley should be varied according to the degree of curvature and the type and density of traffic.

In case of jerks, abnormal lurches etc. being reported by Drivers or Guards, the PWI who inspects the location should not feel satisfied merely by inspection of track parameters under no-load condition; He should instead, look for signs of blowing, pumping etc. with particular attention to rail joints. Staggered joints on curves are especially vulnerable in this regard.

Guard rail arrangement and the condition and spacing of bridge timbers on major bridges must also receive special attention. Side by side, the approach tracks on either side should also be well maintained.

(b) Safety measures on Indian Railways

Some of the important safety measures taken by railways are indicated below. These measures are regularly reviewed by the Railway administration and new measures are adopted based on these reviews as well as on the recommendations of commission of railway safety and departmental enquiry committees.

Rehabilitation of assets like track, bridge, rolling stock etc.

Inspections of signaling gear wagon and loco maintenance depots and quality checks on out-turn from workshops.

Monitoring the performance of operational staff and their rigorous training.

Counseling the drivers in their driving techniques.

Extension of technical aids i.e. Auxiliary Warning System, Axle Counters route Relay Interlocking and Track Circuiting.

Surprise checks on carrying of inflammable or explosive substances in passenger trains.

Q-19 You are the first officer to reach at the site of accident what action you will take? Explain in sequence.

Ans. In case of derailment, the first engineering official arriving at the site of accident should take the following action:

(i) Protect the train: Any Engineering staff available at the site of accident shall assist the guard and driver to protect the train. The Inspector should ensure that protection has been afforded to the train in front and in rear. In the case of double line, if the other line

is also affected by the accident, steps should be taken to protect both the lines. If no infringement exists, trains must be controlled and passed cautiously on the unaffected track.

(ii) First aid and rescue: The inspector should arrange for first aid to injured passengers and railway staff and rescue of trapped persons. If there is any Medical practitioner on the train, his assistance should be obtained.

(iii) Examine the entire site: Examine the entire site inclusive of the track over which the train has passed immediately before derailing, noting down any unusual features observed, specially any part of vehicles or other materials lying on or near the track.

(iv) Advice to nearest Station Master: After a rapid survey of the position, particulars should be sent to the nearest stationmaster about the accident. In case of controlled sections, a field telephone should be got commissioned at once.

(v) Derailed examination: Carrying out a detailed examination of the wheel marks on the rail head, fastenings, sleepers and ballast, the wheel trail marks and the corresponding marks on the wheel sets of derailed and other vehicles to identify the wheel set which derailed first and to establish the initial point of derailment.

(vi) Dimensional sketch: Prepare a dimensional sketch giving the full particulars of the site of accident including the track leading up to the point of derailment, path followed by derailed vehicles, place of mounting and drop, which pair of wheels and of which vehicles were first derailed and the position at which the derailed vehicle came to a stand.

(vii) Preserve Clues: Preserve Clues which bear evidence of wheel marks specially at the point of mount and drop or any other such clues which may help in analyzing the cause of accident. In particular, it should be ascertained whether the derailment has occurred due to flange climbing the rail or due to wheel set suddenly jumping the rail, leaving no mounting marks.

(viii) Recording of track geometry: Record the details of track and measurement of track geometry in the prescribed manner in presence of representatives of other departments.

(ix) Gang charts: Examine the gang charts to ascertain the date when the track was last attended.

(x) Vehicle measurements: Record the measurement of the vehicle and its deficiency, if any, in the prescribed manner in the presence of representatives of two other departments. Also find out the history of repair of the above vehicle.

(xi) Operating features: Investigate and record various operating features such as speed, train formation, loading conditions of the vehicle etc. and the factors which might contribute to the derailment.

(xii) Preliminary report: Make out a preliminary report to be passed on to the immediate superior. The report should contain the following information.

1. The nature of the accident.
2. Cause, if known.
3. Particulars of loss of life, injuries to passengers and staff.
4. Extent of damage to Way and Works.
5. Steps taken for resumption of traffic.
6. Probable date and time when normal working is likely to be resumed.

7. Whether transshipment is necessary and if so, how long.
8. Whether diversion is necessary and if so, when it is likely to be opened.
9. Details of any assistance required, such as additional labour, ballast train bridging material etc.
10. Follow up action: Take action to collect men and material to repair the track and restore the traffic. The actual repair work should be started only when the measurements of track have been completed.

6. Duties of P.way officials

Q.1 Describe in details the important inspections to be carried out by ADEN

Ans: The important inspections to be carried out by the Assistant Engineer are summarized below:

- (1) Trolley Inspection – The entire sub-division should be inspected by trolley once a month, as much inspection as possible being done by push trolley. The inspection by trolley should be intensive, which should include checking of attendance of gang, gang work and equipment and examination of gang charts/diary books with reference to the prescribed schedule of track maintenance. During his inspection, he should check the work done by one or two gangs in each PWI's jurisdiction and record the results of his inspection.
- (2) Fast Train Inspection – The entire sub-division should be covered by Engine (Foot plate) or by last vehicle (Brake-van or inspection carriage) of a fast train once in a month.
- (3) Inspection of Level Crossings- He should inspect all the manned level crossings once in six months. He should examine the Gateman's knowledge of rules; check the equipment, track, road approaches and all other safety aspects.
- (4) Checking of Curves- The Assistant Engineer shall check at least one curve in each PWI's jurisdiction every quarter by verifying its versine and super-elevation.
- (5) Checking of Points and Crossings- He shall inspect once a year all points and crossings on passenger lines and 10 percent of the points and crossings on other lines.
- (6) Monsoon Patrolling- When Monsoon Patrolling is introduced he should check the work of patrolman at night once in a month, either by Train or Push Trolley or Motor Trolley
- (7) Track on Bridges- The train on Girder Bridges should be inspected as a part of the annual Bridge inspection, besides normal track inspections.
- (8) Scrutiny of Registers during inspection- He should scrutinize the registers maintained by PWI such as Creep register, Curve register, Point and Crossing register, SEJ and Buffer rail register, Gap Survey register and Section register during his regular trolley inspection, to see whether the schedules of inspection are being adhered to by the inspectors and whether the necessary follow up action has been taken.
- (9) Inspection of LWR/CWR Track- The Assistant Engineer shall inspect the SEJs/Buffer rails provided in the LWR/CWR track once in every six months. He shall check creep records of LWR/CWR regularly. The duties of the Assistant Engineer with reference to the maintenance of LWR/CWR are detailed in LWR Manual.

Q.2 What is the equipments to be carried out by Keyman on his daily inspection and what is the duties of keyman?

Ans: The keyman shall carry with him on his rounds the following equipments:

- (i) Two red flags
- (ii) One green flag
- (iii) Ten detonators
- (iv) Flare signal (in those sections where its use is prescribed)
- (v) A keying and spiking hammer
- (vi) A fish bolt spanner
- (vii) Flange way gauge & other tools such as gauge cum level as required

Duties of Keyman:

(1) While walking over his length, he should look for defects, such as loose spikes, keys, chairs, fish bolts, and fittings on girder bridges and open top culverts, broken or burnt sleepers, broken plates or tie bars, and attend to them as necessary. If he finds that fittings are consistently working loose even after repeated attention he should report the matter to the Mate and the PWI. If the defects are serious, he should at once inform the Mate of the gang, protecting the line in the meantime, if necessary, according to rules.

(2) If he should notice any condition of danger, such as broken rail or wash-away of ballast, he shall at once protect the line as per rules, take such action as is possible and report the matter to the Mate, the nearest Station Master and the PWI.

(3) At unmanned level crossings, he shall maintain the flange ways between the check and the running rails clear of obstruction.

(4) After completing inspection of the Gang length, the Keyman should assist the Mate in the day's work being done.

(5) When materials, such as dynamo-belts, engine tools and personal articles of passengers, are found on line, the keyman should collect them and arrange for handing them over to the nearest Station Master.

(6) The Keyman should ensure that, in addition to his normal duty of inspection and tightening of fittings, he proceeds in a systematic manner from one end and he must ensure that keys and fittings in at least 3 T.P. lengths are made perfect every day, with a view to complete the beat in a month.

Q.3 What is the duties of PWI (Not in overall charge)

Ans: 1. Every PWI shall have in possession upto date copies of the following codes and manuals with all correction slips upto date

- a) Indian Railway Permanent Way Manual, Bridge Manuals and works manuals
- b) Indian Railway General & Subsidiary Rules
- c) Indian Railway Track Manual
- d) Indian Railway Code for the Engineering Department
- e) Schedule of dimensions
- f) Circulars issued by the higher authorities.

2. General Responsibilities: The Permanent Way Inspector is generally responsible for: Maintenance & inspection of train in a satisfactory and safe condition for traffic. Efficient execution of all works incidental to track maintenance, including track relaying works.

Accountal and periodical verification of stores and tools in his charge

Maintenance of land boundaries between stations and at unimportant stations as may be specified by the administration.

3. Co-ordination with works, Bridge and staff of other departments; he should keep close co-ordination with the Works, Bridges, Signaling and Electrical Staff, when required to work jointly with them.

4. Routine inspection of Track;

4.1 PWI-section should inspect the entire section in his charge by push trolley inspection of gangs in details.

4.2 He should spend as many days in the week as possible with the gangs. He should cover all the gangs within a month. He should train the permanent way mistries, Mates, keyman, gangman & gateman in their duties. He should teach them the maintenance practice.

4.3 He will carry out inspection of points and crossings on passenger running lines once in three months and other lines once in six months, by rotation along with the PWI in over all charge. He will arrange for the rectification of defects noticed during inspection.

4.4 He along with the PWI/In charge will arrange to check the versine and super-elevation of all the curves once in six months by rotation, except for group A & B routes, where the check should be conducted every four months. He should take action to correct the curves based on the readings.

4.5 He will arrange to inspect all the level crossings in his jurisdiction once in a month and check the equipment. He will examine gateman in rules periodically

- 4.6 He will arrange Foot plate inspection once in a month
5. Annual maintenance works: he will carry out maintenance works such as curves realignment, attention to points and crossings, adjustments of creep etc. as assigned to him PWI/In charge.
6. Check on Patrolling: He will cover his section once in a fortnight by train and check the night patrolling. He will also check the night patrolling by trolleying in the night as per schedules laid down. During inspections, he will check the patrol books, the knowledge of rules of patrolman, their equipments etc.
7. Maintenance of LWR/CWR Track: Duties and the responsibilities of PWI/in charge of a sub-section with reference to maintenance of LWR are laid down in LWR Manual.
8. Witnessing Permanent Way Staff: when PWI/Sectional is deputed to make payments to staff, he will follow the provisions of Para 132 of IRPWM.
9. Action in case of emergency: The PWI should proceed to site by the quickest available means on the way. He should collect information regarding the damage the men and material required at site.

**A] NEW POLICY FOR NEW LEVEL CROSSING/MANNING/DEMANNING/
ELIMINATION OF GATE**

Q.4 What is the new policy for New Level Crossing/Manning/Demanning/
Elimination of gate?

Ans: a) Provision of the new Level crossings: If, provision of new level crossing is inescapable, then only manned level crossing is to be provided. This is applicable to all existing lines, new constructions and gauge conversions. However, these instructions are not applicable in case of private sidings

b) Manning of Unmanned Level Crossing:

i) Based on traffic density, visibility and regular plying of buses etc. unmanned level crossings have been categorized into I-V categories for manning at Railway's cost in a phased manner on a programmed basis as per following priority

- Category-I Clear Visibility Level Crossings where TVU is more than 6,000 and Road vehicles > 180.
- Category-II Restricted visibility Level crossings where TVU exceed 6,000 and Road vehicles > 120.
- Category-III Restricted visibility Level crossings where TVU is between 3000 - 6000.

Further it has been decided that no manning of any unmanned level crossing shall be done if motor vehicles do not ply regularly.

Manning of Category-III will be considered once manning of first two categories is over. Priority to be followed will be route-wise, 'A' route followed by 'B', 'C', 'D Spl', 'D', 'E Spl' and 'E'

(ii) All unmanned level crossings on Rajdhani and Shatabdi routes where maximum permissible speed is 120 kmph or more should be manned on priority.

(iii) For manning of unmanned level crossings with traffic density more than 10,000 TVUs, Board's approval is not required. However, in all other cases Board's sanction is required.

(c) De-manning/Elimination of the Level crossing:

The existing manned Level crossings should not be demanded. However, the detailed review/survey of the existing level crossings both manned and unmanned to be carried out with a view to eliminate them by either passing the road through an existing bridge or by constructing link roads to combine two or more level crossings etc.

7. NUMERICAL & OTHER RELATED QUESTIONS: ON CURVES

Q.1 Calculate the super elevation to be provided and the maximum permissible speed for a 2° BG. Transitioned curve on a high speed route having maximum sanctioned speed of the section as 110 kmph.

The speed for calculating the equilibrium super elevation has been decided by Chief Engineer as 80 kmph and booked speed of goods train is 50 kmph.

Solution

$$R = 1750/D = 1750/2 = 875 \text{ meters}$$

$$\text{Super elevation for equilibrium speed} = GV^2/127 R$$

Where, $G = 1750 \text{ mm}$ (c/c distance of 52 kg rail)

$$V = 80 \text{ kmph} \ \& \ R = 875 \text{ m}$$

$$\text{S. E.} = 1750 \times 80^2 / 127 \times 875 = 100.8 \text{ mm}$$

Super elevation for maximum sanctioned speed (110 kmph)

$$= \quad GV^2/127 R = 1750 \times 110^2 / 127 \times 875 = 190.6 \text{ mm}$$

Cant deficiency = $190.6 - 100.8 = 89.8 \text{ mm}$, which is less than 100 mm and hence permissible

Super elevation for goods trains speed (50 kmph)

$$= \quad GV^2 / 127 R = 1750 \times 50^2 / 127 \times 875 = 39.4 \text{ mm}$$

Cant excess = $100.8 - 39.4 \text{ mm} = 61.4 \text{ mm}$, which is less than 75 mm and hence permissible.

Maximum speed potential or safe speed of the curve as per theoretical consideration, being a high speed route.

$$V = \quad \{(Ca + Cd) \times R / 13.76\}^{1/2} = 0.27 \ \ \{(Ca + Cd \times R)\}^{1/2}$$

Where, $Ca = 100.8 \text{ mm}$, $Cd = 89.8 \text{ mm}$, and $R = 875 \text{ m}$.

$$= \quad \{(100.8 \times 89.8) \times 875 / 13.76\}^{1/2} = 100.1 \text{ kmph}$$

The maximum permissible speed over the curve is least of following:

Maximum sanctioned speed i.e. 100 kmph.

Maximum or safe speed over the curve based on theoretical consideration i.e. 110.1 kmph.

There is no constraint on speed due to transition length of curve.

Ans. (i) Maximum permissible speed over the curve is 110 kmph.

Super elevation to be provided is 100.8 mm or say 100 mm.

Q.2 Calculate super elevation, maximum permissible speed and transition length for a 3° curve on high speed BG section having maximum sanctioned speed of 110 kmph. Assume the equilibrium speed as 80 kmph and booked speed of goods train as 50 kmph.

Solution

Radius of curve = $1750/D = 1750/3 = 583.3$ meters.

Equilibrium super elevation (for 80 kmph)

$$= GV^2/127 R = 1750/80^2 /127 \times 583.3 = 151.2 \text{ mm}$$

Equilibrium super elevation for max. sanctioned speed (110 kmph)

$$= 1750 \times 110^2 / 127 \times 583.3 = 285.5 \text{ mm}$$

Cant deficiency = $285.8 \text{ mm} - 151.2 \text{ mm} = 134.6 \text{ mm}$. This is more than 100 mm (permitted Cd)

With 100 mm cant deficiency, actual cant = $285.8 - 100 = 185.8 \text{ mm}$.

But actual cant is limited to 165 mm and this value, therefore, will be adopted.

(v) Equilibrium super elevation for goods train speed (50 kmph)

$$= \frac{1750 \times 50^2}{127 \times 583.3} = 59 \text{ mm}$$

(vi) Cant excess = Actual cant – 59 mm, which is in excess of 75 mm permitted value. With 75 mm cant excess, actual cant now to be provided = $75 + 59 \text{ mm} = 134 \text{ mm}$.

So, provide cant 135 mm (rounding off to higher multiple of 5 mm).

(vii) Safe speed or speed potential (for high speed route)

$$= \sqrt{\{(Ca + Cd) \times R / 13.76\}} = \sqrt{\{(135 + 100) \times 583.3 / 13.76\}}^{1/2}$$

$$= 99.6 \text{ kmph say } 100 \text{ kmph.}$$

Maximum permissible speed on the curve is least of the following:

(a) Maximum permissible speed of the section i.e. 110 kmph.

(b) Safe speed on the curve as per theoretical consideration i.e. 100 kmph.

Maximum permissible speed on the curve is, therefore, 100 kmph.

Length of transition is maximum of the following:

From consideration of rate of change of cant (35 mm/sec.)

$$L = 0.008 Ca \times Vm = 0.008 \times 135 \times 100 \text{ metres} = 108 \text{ metres}$$

From consideration of rate of change of cant deficiency (35 mm/sec.)

$$\begin{aligned} L &= 0.008 Cd \times Vm \\ &= 0.008 \times 100 \times 100 \text{ metres} \\ &= 80 \text{ metres.} \end{aligned}$$

From consideration of cant gradient (1 in 720)

$$L = 0.72 \times E = 0.72 \times 135 \text{ m} = 97.2 \text{ m}$$

Provide transition length of 108 meters

Ans.	(a)	Super elevation to be provided	...	135 mm
	(b)	Maximum permissible speed over the curve	...	100 kmph
	(c)	Length of transition curve	...	108 meters

Q.3.0 What is transition curve? What are the objectives of a transition curve?

Ans. As soon as a vehicle enters a circular curve taking off from a straight, it is subjected to a sudden centrifugal force, which not only causes discomfort to passengers, but distorts track alignment and affects the stability of rolling stock. In order to provide smooth entry to the curve, transition curves are provided on either side of a circular curve so that the centrifugal force is built up gradually by running out the super-elevation slowly at a uniform rate. A transition curve is, therefore, an easement curve in which the degree of curvature and gain of super-elevation are uniform throughout its length, starting from zero at the tangent point to the specified value at the circular curve.

The followings are the objectives of a transition curve:

1. To decrease the radius of curvature gradually in a planned way from infinity at the straight to that of the circular curve to help the vehicle to negotiate a curve smoothly.
2. To provide a gradual increase of the super-elevation starting from zero at the straight to the desired super-elevation at the circular curve.
3. To enable the vehicles to negotiate a curve smoothly ensuring a gradual increase or decrease of centrifugal forces.

Q. 4 What are the requirements of an ideal transition curve?

Ans.

- 1) It should be tangential to the straight i.e. it should start from straight with zero curvature.
- 2) It should join the circular curve tangentially i.e., at the end it should have the same curvature as that of the circular curve.
- 3) The curvature should increase at the same rate as the super elevation increases.
- 4) The length of the transition curve should be adequate to attain the full super elevation, which increases gradually at a specified rate.

Q.5 How do we decide the length of Transition Curve?

Ans. The length of transition curve, prescribed on Indian Railways, is maximum of the following three values:

$$L = 0.008 Ca X Vm \text{ or } L = Ca X Vm/125$$

$$L = 0.008 Cd X Vm \text{ or } L = Cd X Vm/125$$

$$L = 0.72 Ca$$

Where, L = Length of the curve in metres.
 Vm = Maximum permissible speed in kmph.
 Ca = Actual cant or super-elevation in mm.
 Cd = Cant deficiency in mm.

The formula (a) and (b) as given above are based on rate of change of cant or cant deficiency of 35 mm per second. The formula (c) is based on maximum cant gradient of 1 in 720 or 1.4 mm per metre.

The following other provisions exist to meet special situations:

(i) For designing length of transition curves particularly on high speed routes, future high speeds such as 160 kmph for group A routes and 130 kmph for group B routes may be taken into account.

In exceptional cases, where space is not available for providing full length of transition curves particularly on high speed routes as per above calculations, the length of transition curve may be reduced to $\frac{2}{3}$ of the desirable length as worked out by the formula (a) and (b) above. This is based on the assumption that rate of change of cant or cant deficiency will not exceed 55 mm per second and the maximum cant gradient will not be steeper than 1 in 360 or 2.8 mm per metre. This relaxation is permitted only for BG. For MG and NG sections, however, the cant gradient should not be steeper than 1 in 720 or 1.4 mm per metre.

For MG, the change of cant or cant deficiency should not exceed 35 mm per second.

(ii) At location where length of transition curve is restricted and as such may be inadequate to permit the same maximum speed as calculated for the circular curve, the design should be so made as to select a lower cant and lower cant deficiency, which will reduce the maximum speed on transition curves. In such cases, the cant should be so selected as to permit the highest speed on the curve as a whole.

Q.6.0 What are reasons of realignment of curve?

Ans. A Railway curve is likely to get distorted from its original alignment in course of time due to the following reasons:

- Unbalanced loading of inner rail and outer due to cant excess with slower speeds or cant deficiency with higher speeds than the equilibrium speeds for which cant has been provided.
- Effect of large horizontal forces on the rails by passing trains.
- These forces tend to make a curve flatter at few locations and sharper at others and radius of the curve thus varies from place to place. These give rough riding on the curve due to change in radial acceleration from place to place. Realignment of curve, therefore, becomes necessary to restore smooth running on curves.

Q.7 What are criteria for realignment of curves on BG?

Ans. The Indian Railways Way and Works Manual had earlier prescribed that the curve should be realigned when as a result of an inspection, the running on a curve is found to be unsatisfactory. No hard and fast rule was laid earlier as to when a curve should be realigned but subsequently Railway Board has prescribed the following criteria for realignment of curve:

(i) Cumulative Frequency Diagram: For Group A and B routes the need for curve realignment should be decided by drawing cumulative frequency diagram showing versine variation over the theoretical versine. For Group A and B routes, the versine variations as measured on 20 metre chord shall be limited to 4 mm and 5 mm respectively. Realignment should be taken up when the cumulative percentage of versines lying within these limits is less than 80.

(ii) Station to Station Versine difference: The running over a curve depends not only on the difference between the actual versine and the designed versine but also on the station to station variation of the actual versine values. This is because it is the station to station variation of versine which determines the rate of change of radial acceleration on which depends the riding comfort. The following stipulations have been made in this connection:

(iii) Broad Gauge: On curves where speeds in excess of 100 kmph are permitted the station to station variation of versines at station 10 m apart shall not exceed 15 mm and for speeds 100 kmph and less variations shall not exceed 20 mm or 20% of average versine of the circular portion whichever is more.

(iv) Metre Gauge: On curves where speeds in excess of 75 kmph are permitted, the station to station variation of versines at stations 10 metres apart shall not exceed 15 mm. For speeds of 75 kmph and less, such variations shall not exceed 20 mm or 20% of the average versine of the circular portion whichever is more.

The decision for complete realignment of a curve shall be taken on the basis of the running on the curve, cumulative frequency diagram or on the basis of distribution of variation of versines between stations as indicated in paras above.

Unsatisfactory Running of Track: For other routes, curve realignment will be taken in hand when as a result of inspection by trolley or from the footplate of locomotive or by rear carriage or as a result of track tests carried out, the running on the curve is found to be unsatisfactory.

Local Adjustment: When there is abrupt variation of versines between adjacent stations local adjustments should be done to obtain versine variation between adjacent stations within reasonable limits. Such corrections should be carried in advance of complete curve realignment.

Correction Slip

(1) When as a result of inspection by trolley or from the foot plate of locomotive or by carriage or as a result of Track Recording carried out, the running on a curve is found to be unsatisfactory the curve should be realigned.

(2) The running over a curve depends not only on the difference between the actual versine and the designed versine but also on the station-to-station variation of the actual versine values. This is because it is the station to station variation of versine which determines the rate of change of lateral acceleration, on which depends the riding comfort.

Service limit for station to station versine variation for 3 speed group viz. 120 kmph and above, below 120 kmph and upto 80 kmph and below 80 kmph and upto 50 kmph should be considered as tabulated below:

Speed Range	Limits of station to station variation (mm)
120 kmph and above	10 mm or 25% of the average versine on circular curve whichever is more.
Below 120 kmph and upto 80 kmph	15 mm or 25% of the average versine on circular curve whichever is more.
Below 80 kmph and upto 50 kmph	40 mm or 25% of the average versine on circular curve whichever is more.

In case exceedence of the above limit is observed during an inspection, local adjustments may be resorted to in cases where the variation of versines between adjacent stations is only at few isolated locations, at the earliest possible. If more than 20% of the stations are having versine variation above the limits prescribed, complete realignment of the curve should be planned within a month.

Q.8 Describe:

1. Cutting of rails on curves,
2. Joints on curves,
3. Provision of check rails on curves,
4. Method to reduce wear on outer rail of curves.

Ans.8.

1) Cuttings of rails on curves:

Rails are usually laid with square joints on curve. On curved track the inner rail joints gradually lead over the outer rail joints. When the inner rail of the curve is ahead of the outer rail by an amount equal to half the pitch of bolt holes, cut rails should be provided to obtain square joints. Cut rail is a rail, which is shorter than the standard length of rail by an amount equal to the pitch of the bolt holes. The excess length 'd' by which the inner rail gains over the outer rail is calculated by the formula –

$$d = LG/R$$

Where 'd' is the length in mm by which the inner rail joint is ahead of the outer rail joint over the entire length of the curve, if cut rails are not provided.

L = Length of the curve in meters.

R = Radius of the curve in meters.

$G =$ The gauge + width of the rail ahead in mm.

The number of cut rails for a particular curve is worked out by the formula –

$N =$ d/pitch of the bolt holes in mm.

Rail joints must be square at beginning and at the end of the curve.

2) Joints on Curves:

Rails joints on curves normally be laid square. On the sharp curves less than 400 meters on the Broad Gauge and 300 meters on the Metre Gauge the rail joints may be staggered, where elbows and kinks are likely to develop if rail joints are laid square.

3) Provision of Check Rails on Curves:

Check rails should be provided on the inside of the inner rail of the curve as stipulated in the schedule of dimensions.

Appropriate clearances should be provided between the check rail and the running rail as stipulated in the schedule of dimensions. Check rails reduce the risk of derailment on the sharp curves.

Location where check rails should be provided shall be decided by the Chief Engineer taking into consideration the negotiability of the rolling stock and the curve geometry.

4) Method to reduce wear on outer rail of curves:

(1) This can be reduced effectively:
by lubricating the gauge face of outer rails on the curves;
by maintaining correct curve geometry and super-elevation; and
provision of the suitable check rail.

(2) Rail flange lubricators should be provided on curves of radius 600 meters and less on Broad Gauge and of radius 300 meters and less at Meter Gauge to avoid rail face wear, the first lubricator being provided a little ahead of the curve.

8. BALLAST RELATED QUESTIONS

Q.9.0 Write down the specification of track ballast for BG route of a machine maintained section.

Ans. 1.0 Scope:

These specifications will be applicable for stone ballast to be used for all types of sleepers on normal track, turnouts, tunnels and deck slabs etc. on all routes.

2.0 Detailed Specification

General

2.1.1 Basic Quality: Ballast should be hard, durable and as far as possible angular along edges/corners, free from weathered portions of parent rock, organic impurities and inorganic residues.

2.1.2 Particle Shape: Ballast should be cubical in shape as far as possible. Individual pieces should not be flaky and should have generally flat faces with not more than two rounded/sub-rounded faces.

2.1.3 Mode of Manufacture: To ensure uniformity of supply, machine crushed ballast should be preferred for broad gauge and metre gauge routes. Procurement of hand broken ballast shall be resorted to only with the prior personal approval of CTE/CE. CTE/CE should record reasons while granting such approval before calling of tender in each case for ballast supply on broad gauge and metre gauge routes.

However, no such approval need be taken for supply on narrow gauge routes.

2.2 Physical Properties

2.2.1 Ballast sample should satisfy the following physical properties in accordance with IS: 2386 Pt.IV – 1963 when tested as per the procedure given in Annexures 1 & 2.

	BG & MG	NG
- Aggregate Abrasion Value	30% max.*	35% max.
- Aggregate Impact Value	20% max.*	30% max.

* Relaxable upto 35% & 25% respectively on techno-economic grounds by CTE/CE.

The shape parameter “Flakiness Index” as determined in accordance with IS: 2386 Pt.I-1963 following the procedure given in Annexure-3 should not be more than 50%. This test may be dispensed with for ballast supply on narrow gauge routes.

The “Water Absorption” Tested as per IS: 2386 Pt.III-1963, following the procedure given in Annexure-4 should not be more than 1%.

This test may be dispensed with for ballast supply on narrow gauge routes.

2.3 Size and Gradation:

2.3.1 Ballast should satisfy the following size and gradation:

(a) Retained on 65 mm sq. mesh sieve	Nil
(b) Retained on 40 mm sq. mesh sieve	40% to 60%
(c) Retained on 20 mm sq. mesh sieve	Not less than 98% for machine crushed. Not less than 95% for hand broken.

Over size Ballast:

- In case ballast retained on 65 mm square mesh sieve is at variance from 2.3.1 (a) specified above, the stack shall be rejected.
- In case ballast retained on 40 mm square mesh sieve exceeds 60% limit prescribed in 2.3.1(b) above, payment at following reduced rates shall be made for the full stack:
 - 95% of quoted rates if retention on 40 mm sq. mesh sieve is between 60% (excluding) and 65% including).
 - 90% of quoted rates if retention on 40 mm sq. mesh sieve is between 65% (excluding) and 70% (including).
- In case retention on 40 mm sq. mesh sieve exceeds 70%, the stack shall be rejected.

Undersize Ballast:

- ◆ The ballast shall be treated as undersized and shall be rejected if retention on 40 mm square mesh sieve is less than 40%; and retention on 20 mm square mesh sieve is less than 98% (for machine crushed) or 95% (for hand broken).

Method of Sieve Analysis

- ◆ The screens for sieving of ballast shall be of square mesh and shall not be less than 100 cm in length, 70 cm in breadth and 10 cm in height on sides.
- ◆ While carrying out sieve analysis, the screen shall not be kept inclined, but held horizontally and shaken vigorously. The pieces of ballast retained on the screen shall not be pushed through the screen openings.
- ◆ The percentage passing through or retained on the sieve shall be determined by weight only.

Q.10.0 What are basis of assessment of ballast requirements?

Ans. (1) The requirement of ballast are assessed separately for:

- (a) making good the deficiencies as existing in track,
- (b) making good deficiencies arising out of overhauling, through packing and deep screening;
- (c) for providing adequate cushions in the case of mechanical tamping; for providing extra cushion while converting into LWR.

(2) The ballast required for maintenance purposes shall be estimated by assessing the quantity approximately if necessary by a survey, over a rail length in every 1 km. Care should be taken that the cores under the sleepers are not disturbed.

(3) In case of deep screening, assessment of ballast required for recoupage and providing standard section should be made by deep screening the ballast section to the full depth in a rail length for two to three sleepers at every $\frac{1}{2}$ to 1 km. In this case screening is done under the sleepers as well.

(4) In new line construction, ballast requirements will be assessed as per the profile (to be adopted) given in para 263 (1).

(5) The quantities assessed vide sub-para in (2), (3) and (4) above will be the net quantities of ballast required to recoup the deficiencies or to provide required profile/section. The above net quantities may be enhanced suitably (say 8%) to arrive at gross quantities of ballast for the purpose of procurement action in case measurements are proposed to be taken in stacks or in wagons at originating station.

Q.11.0 What are instructions for collection, loading and training out of ballast in case of Depot Ballast?

Ans.

(1) Register of ballast collection and training out:

The Inspector-in-charge of the depot shall maintain a register showing all transactions in respect of stone ballast, moorum and sand ballast. If the depot deals with boulders also, the same should also find a place in a register.

(2) Loading from the Depot:

At all depots, the following instructions should be followed:

(a) The space along the sides of the Railway siding, meant for stacking, should be divided into convenient number of zones and demarcated.

(b) For each depot, a depot diagram shall be maintained, which should indicate the site details of all the measured stacks.

(c) Each stack in each zone should be serially numbered.

(d) The operations of collecting and training out materials should not be carried out at the same time in any one zone.

The ground on which the stacks are made should be selected and levelled.

Where practicable, no stack should be less than one metre in height.

Measurements should be taken of complete stacks. The measured stacks should be identified suitably by lime sprinkling or any other method.

Before training out of Ballast or other material is undertaken on contract, a copy of each of the depot diagram should be kept with the permanent Way Inspector, the Ballast Train Guard and the Contractor, the original being with the Assistant Engineer. As each stack is lifted, this should be recorded on the depot diagram which should always be kept up-to-date. Challans should be prepared after loading the ballast into wagons.

(3) Quantity trained out:

When settling accounts for training out ballast, checks should be made by comparing the quantities as per stack measurements recorded in the measurement books, with those deduced from wagon measurements as recorded in the ballast train reports, due allowance being given for sinkage as per rules.

Should the wagon measurements differ from the recorded measurements by more than 5 percent, the matter should be investigated immediately and reported to the Divisional Engineer. In special cases, direct measurement of ballast in wagons may be resorted to with the approval of the Chief Engineer.

9. SLEEPER RELATED QUESTIONS

Q.12.0 What are basic functions of sleepers?

Sleepers are transverse ties on which the rails are laid. The main functions of sleepers are as follows:

- (i) Holding rails to correct gauge and alignment.
- (ii) Giving a firm and even support to rails.
- (iii) Transferring the load evenly from the rails to wider area of the ballast.
- (iv) Acting as an elastic medium between the rails and the ballast to absorb the blows and vibrations of moving loads.
- (v) Providing longitudinal and lateral stability to permanent way.
- (vi) Providing means to rectify the track geometry during its service life.

Q.13.0 What are requirements of an ideal sleeper?

Apart from performing the functions as indicated in previous para, the ideal sleeper should normally fulfill the following requirements:

1. The initial cost as well as maintenance cost should be minimum.
2. The weight of the sleeper should be moderate so that it is possible to handle the same.
3. The design of sleeper and fastenings should be such that it is possible to fix and remove the rails easily.
4. The sleeper should have sufficient bearing area.
5. The sleeper should be such that it is possible to maintain and adjust gauge properly.
6. The material of sleeper and its design should be such that the sleeper does not break or get damaged while packing below the sleeper.
7. The design of sleeper should be such that it is possible to have track circuiting.
8. The sleeper should be capable of resisting vibrations and shocks due to passage of fast moving trains.
9. The sleeper should have anti-sabotage and anti-theft qualities.

Q. 14.0 Write advantage and disadvantages of Concrete Sleeper.

Ans. *Advantages*

- (i) Concrete sleepers, being heavy, lend strength and stability to track and are specially suited to L.W.R. due to the great resistance they offer to the buckling of track.
- (ii) Concrete sleepers with elastic fastenings provide a track which can maintain better gauge, cross level and alignment. It retains packing also very well.
- (iii) The concrete sleepers, because of their flat bottom, are best suited for modern methods of track maintenance like M.S.P. and mechanical maintenance, which have their own advantages.

(iv) Concrete sleepers can be used in track circuited areas, being poor conductor of electricity.

(v) They are neither inflammable nor subjected to damage by pests or corrosion in normal circumstances.

(iv) The life of concrete sleepers is very long, probably 40 to 50 years. Rail and sleeper renewals as such can be matched, which is a very big economic advantage. The concrete sleepers can generally be mass produced from local resources.

Disadvantages

(i) Handling and laying of concrete sleepers is difficult due to their being heavy. Mechanical methods have to be normally adopted for handling which involve considerable initial expenditure.

(ii) The damages to concrete sleepers is very heavy at the time of derailment.

(iii) There is no scrap value for the concrete sleepers.

(iv) The sleepers are not suitable for beater packing.

(v) The concrete sleepers are preferably to be maintained by heavy "On Track" tampers.

Q.15.0 What are permitted locations for laying concrete sleepers? Write about maintenance of concrete sleepers.

Ans. Concrete sleepers because of heavy weight and rigidity of structure, are not suited to yielding formations, fish plated joints and places where uniform packing cannot be achieved. Concrete sleepers as such are normally laid at only those locations where LWR is permissible. Concrete sleepers should not be laid at the following locations:

(i) New formation in banks unless specially compacted.

(ii) Any rock cuttings except where a minimum depth of 300 mm of ballast cushion has been provided.

(iii) Un-ballasted lines in yards.

(iv) Curves of radius less than 500 metres.

(v) Troublesome formations.

(vi) Near ash-pits and other locations where drivers habitually drop fire.

At locations where excessive corrosion is expected.

(a) On un-ballasted bridges.

(b) On arch bridges, where the height between arch and bottom of ballast section is less than one metre.

(c) On slab bridges, where the ballast cushion between the bottom of sleepers and top of slab is less than 300 mm.

Concrete sleepers should not generally be used with fish plated track and should be used only with long welded rails. Fish plated joints on concrete sleepers track, where unavoidable, should have wooden sleepers at joints.

Maintenance of Concrete Sleepers

(i) Concrete sleepers should normally be maintained with heavy on-track tampers. For spot attention, measured shovel packing (MSP) or off-track tampers may be used. The size of chips for MSP should be 8 mm to 30 mm as required.

(ii) Only 30 sleepers spaces are to be opened out at a time between two fully boxed stretches of track of 30 sleepers length each in case LWR track exists.

(iii) The concrete sleepers should be compacted well and uniformly to give a good riding surface. Centre binding of mono block concrete sleepers should be avoided and for that purpose the central 800 mm of the sleeper should not be hard packed.

(iv) Both ends of concrete sleepers should be painted with anti corrosive paint periodically to prevent corrosion of the exposed ends of prestressing wires. In case of two block sleepers, tie bars should be examined every year and if any sign of corrosion is noticed, the affected portion should be painted with an approved type of paint.

(v) The laying and maintenance of concrete sleepers should be done by mechanical equipments as far as possible.

(vi) Wherever casual renewal of concrete sleepers is to be done, normal precautions required for LWR track should be taken as given in para 11.10.2 of Chapter 11.

(vii) The elastic rail clip should be driven properly to ensure that the leg of the clip is flush with the end face of the insert. Over driving and under driving should be guarded against as this causes eccentric loading on the insulations and this results in their displacement and variation of the load.

(viii) A vigilant watch should be kept to ensure that no creep take place in any portion of the concrete sleeper track or there is no excessive movement near SEJ.

(ix) Rubber Pads: It must be ensured that the rubber pads are in correct position. Whenever it is found that the rubber pads have developed a permanent set, these should be replaced by new ones. Such examination can be done at the time of destressing. Loss of toe load can also be due to ineffective pads.

Insulating Liners: Nylon or composite insulating liners used with pandrol clips should be examined periodically for sign of cracking and breakage. Adequate care should be exercised while driving the clip at the time of installation to prevent damage.

Special attention to seizure of Elastic Rail Clips

One of the biggest problem of maintenance of concrete sleeper track is that elastic rail clips get seized with MCI Inserts not only in regular maintenance, but also during destressing, other incidental works and derailments etc. Following remedial measures are suggested:

Measures to prevent corrosion and seizure of ERCs with M.C.I. Inserts: At the base depot, all the elastic rail clips and MCI Inserts should be thoroughly cleaned Grease should then be applied on the central leg of the E.R.C. and eye of the MCI Insert and then the clip should be driven at the time of assembly of the service panel.

All the elastic rail clips are to be taken out during service from the MCI inserts and should be cleaned with wire brush and emery paper specially on the central leg. The eyes of the MCI inserts are also to be cleaned of any debris or rusted materials. The central leg of the E.R.C. should then be applied with proper quality of Grease to IS:408-1981. The

eye of the MCI inserts should be smeared with the same grease before the treated E.R.Cs are driven back. This has to be repeated every one year in corrosive prone areas. In other locations, the frequency should be 4 years and one fourth length in each gang should be greased annually.

Action in case of Derailments

(i) When the damage to concrete sleepers is not extensive and it is possible to pass traffic at a restricted speed, suitable speed restriction should be imposed after assessing the damage to track. Sleepers should be replaced as in the case of casual renewals taking all precautions. After all the damaged sleepers are replaced, the affected portion and 100 metres on either side adjacent to it should be destressed and normal speed should be restored after consolidation.

(ii) When the damage to concrete sleeper is extensive and track is distorted in such a way that it is not possible to pass traffic even at a restricted speed, the affected portion should be isolated by introducing buffer rails on either end of the affected portion. The distorted track should be removed and replaced by track laid on single rail panels with available type of rails and sleepers. The section should then be converted into long welded Rails by using concrete sleepers taking usual precautions as laid down in L.W.R. Manual.

10. Tounout Related Questions.

Q. 16.0 What are factors affecting speeds over turnouts? What are main features of modern turnouts for higher speed?

Ans. The main factors, which are responsible for limiting speeds over turnouts on the Indian Railways, are as follows:

- (i) Sudden change in direction of the running edge at the entry to the switch from a straight track.
- (ii) Absence of a transition between the curved lead and the straight Switch.
- (iii) Non-transitioned entry from the curved lead to the straight crossing.
- (iv) Absence of super-elevation over the turnout curve.
- (v) Gaps in the gauge face and running table at the crossing.
- (vi) Variation in cross level caused by raising of the switch rails.

For achieving higher speeds on the turnouts, it is necessary that the above limitations of the design of the turnout should be overcome as far as possible. In the European countries lot of progress has been made in designing the turnouts suitably and the speed over 100 kmph is permitted on the turnout curves. The main features of design of such turnouts are:

- (i) Long curved switches have been provided to avoid abrupt change in the direction on entry.
- (ii) The switches and crossings are curved to the same radius as the lead curve or alternatively transition curve is provided between the toe of the switch and the nose of crossing. This provides a smooth passage to the trains on the turnout curve.
- (iii) Permitting higher cant deficiency so that the disadvantage of not providing super-elevation on the turnout curve is duly compensated.

Q.17.0 What are the important points of inspection & maintenance of points & crossings?

Ans. The points and crossings should be inspected in detail as quality of riding depends very much on their maintenance. The following important points should be checked:

1. Condition of tongue rails and stock rails

There should be no wear on top as well as on gauge face side of the tongue rail. Badly worn out rails should be replaced. It should be ensured that the turnout side stock rail is provided with the requisite bend ahead of the toe of the switch, otherwise alignment at this spot is bound to be kinky.

2. Condition of Fittings of Tongue & Stock rails.

The fittings should be tight and spherical washers provided at correct locations. The slide chairs should be cleaned and greased with graphite for smooth operations of the

points. The fish plates should be given correct amount of bend at the loose heel joint. Gauge tie plate should be provided if it does not exist.

3. Gauge and cross level at switch assembly.

The gauge and cross levels should be checked at the following locations:

- (i) At stock joint.
- (ii) 150 mm (6") behind toe of switch.
- (iii) At mid switch for straight road and for turnout side.
- (iv) At heel of switch for straight road and for turnout slide.

The gauge and cross level should be correct at all above locations.

4. Clearance between stock & tongue rails at heel of switch

Correct divergence at heel of switch should be as follows:

	1 in 16 or 1 in 12	1 in 8 ½
B. G.	133 mm (5 ¼ ")	136 mm (5 ⅜ ")
M. G.	117 mm (4 5/8 ")	120 mm (4 ¾ ")

5. Throw of Switch

The throw of switch should be as follows:

	Recommended	Minimum
B. G.	115 mm (4 ½ ")	95 mm (3 ¾ ")
M. G.	100 mm (4")	89 mm (3 ½ ")

6. Conditions of Crossing and tongue rail

The condition of crossings & fittings should be checked. Maximum vertical wear permitted on point rail or wing rail is 10 mm or (3/8 ") and reconditioning should be done when wear is 6 mm (1/4"). The burrs should also be removed. The fittings should be tightened.

Maximum vertical wear permitted on tongue rail is 6 mm, whereas lateral wear permitted is 8 mm for 90 Rs and 52 kg rails and 5 mm for 60 R and 75 R rails. The tongue rail should be replaced or reconditioned before this value is reached.

New wear limits for crossings:

The Railway Board have since decided that maximum vertical wear on wing rails and nose of crossing shall be limited to 4 mm on Rajdhani and Shatabadi routes and 6 mm on all other routes. The wear limits for CMS crossings are, however, limited to 5.5 mm for Rajdhani & Shatabadi routes and 7.5 mm for all other routes.

7. Gauge and cross level of crossing assembly

Gauge and cross level should be checked at the following locations and which should be correct:

- (i) 1 m ahead of nose on nose on straight road and on turnout.
- (ii) 150 mm (6") behind ANC on straight road and on turnout.
- (iii) 1 m behind ANC on straight road and on turnout.

8. Check Rails

The condition of check rails should be checked.

Check rail clearances should be as follows:

	Maximum	Minimum
B. G.	48 mm (1 ⁷ / ₈ "	44 mm (1 ³ / ₄ ")
M. G.	44 mm (1 ³ / ₄ ")	41 mm (1 ⁵ / ₈ ")

9. Lead Curvature

The curvature should be checked either by offset method or by versine method. The curvature should be correct and uniform.

10. Cross levels on straight road and turnout

These should be correct at all places.

11. Sleepers

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

12. Ballast and Drainage

Enough quantity of clean ballast should be available to provide adequate cushion. The drainage should be proper.

13. Any other defects

If there are any other defects in the layout, these should be checked and corrected.

Special attention is required to ensure that sleepers are well packed, all fittings are tightened, gauge and cross levels are properly maintained, the wear on tongue rail and on the crossing is within permissible limits. It should also be ensured that proper distance blocks are provided at correct locations.

14. Schedule of Inspections

PWI III & PWI (In-charge): Once in 3 months in rotation for passenger running lines and once in 6 months in rotation for other lines. Interval between two inspections for passenger lines of the same turnout should not exceed 4 months.

A.E.N.: Once in 12 months for all passenger running lines and test checking 10% of other points and crossings.

D.E.N.: Test checking of certain number of points and crossings particularly in running lines and those recommended for renewals.

Q.18 Explain the need and benefits of CMS crossings

Ans. 1. General information about CMS Crossings

Due to increase in traffic and use of heavier axle loads, the ordinary built up crossings manufactured from medium manganese rails are subjected to very heavy wear and tear specially in fast lines and suburban sections with electric traction. Past experience has shown that the life of such built-up crossings varies from 6 months to 2 years depending on the location and service conditions. Manganese steel possesses higher strength and resistance to wear and consequently has longer life. The average life of CMS crossing is expected to be about four times than that of an ordinary built-up crossing. In addition, they are free from bolts as well as loose components which may work loose or wear under traffic and their use, therefore, helps in reducing maintenance costs especially in locations of heavy traffic density.

In view of this, the provision of CMS crossings on Indian Railways has been standardised. On account of limited availability of CMS crossings in the country, their use have, however, been restricted for the time being for Group A routes and to such other lines of other routes, where traffic density is over 20 GMT. These should also be reserved for use on heavily worked lines in busy yards on all the groups.

Q.19 What are the important points of laying and maintenance of CMS crossings?

Ans. Laying of CMS Crossings

The following points should be specially kept in view at the time of laying CMS crossings:

(i) The formation under the turnout should have adequate drainage and be firm and stable. In no case should the crossing assembly be deficient in ballast.

(ii) The CMS crossings are susceptible to breakage under impact and should be handled carefully during laying so as to avoid damage to the crossings.

(iii) Careful planning is essential while replacing built-up crossing by a CMS crossing. Where room permits, it would be advantageous to assemble the turnout adjacent to the site and slew it to its final position after removing the old layout.

(iv) When crossings are renewed, new running rails should invariably be installed immediately adjacent to the crossings to prevent batter of the rail ends at the crossing.

(v) The CMS crossings are shorter in length than built-up crossings and these crossings cannot be used on steel sleeper layouts. Also, where an existing built-up crossing is to be replaced by CMS crossing, adjustment of lead rails has to be undertaken.

Maintenance of CMS Crossings:

(i) The procedure followed for inspection and maintenance of ordinary points and crossings should be followed in the case of CMS crossings also.

(ii) Due to heavier weight of the CMS crossings, the sleepers under the crossings are likely to develop a concave shape in the central portion tending to minimise the life of wooden sleepers. It is, therefore, important that the crossing sleepers are well-packed.

(iii) Incorrect gauge at the crossing may lead to excessive wear on the nose or check rail and may result in possible derailment. The gauge, therefore, at the crossing should always be correct. There is likelihood of gauge faces of wing rails developing sharp corners due to wear and inadequate flange-way clearance which would result in rapid wearing of the wheels passing over them. In such cases, the gauge faces should be rounded off to 10 mm radius by grinding.

(iv) The flange-ways of the CMS crossings should be ground to proper radius after it has been in service from 3 weeks to 3 months, depending on the traffic. A second grinding two or three months later is also recommended as this will increase the life of the crossing before it will need further attention.

(v) Whenever the metal has flown out on nose or wing rails, the extra metal should be filed in such a way that the contour profile is not disturbed. Where filing becomes difficult, the only alternative is to try grinding by means of a portable pneumatic or electric grinder taking care that the location does not get excessively heated up.

(vi) No attempt should be made to make holes in the CMS crossings by flame-cutting, as this will lead to cracking of the crossing.

When laid in locations subjected to heavy traffic density, a careful watch should be kept to find out development of hair cracks and wavy corrugations. If these develop, the crossing should be replaced and sent for metallurgical investigations.

After laying the CMS crossing, an initial speed restriction of 50 kmph should be imposed for about 3 weeks or the passage of 50,000 axles. The crossings should, then be inspected for cracks, defects and if they are found to be free from any cracks, defects etc the speed restrictions may be withdrawn at the discretion of the Chief Engineer.

Q.20 What are instructions for laying of concrete sleepers for fan-shaped turnouts?

Ans. Laying of fan-shaped turnouts sleepers

1. Loading of PSC turnout sleepers in BFRs:

- (a) Sleeper of the approach and sleepers meant for lock bar crank will be loaded at right angles to the track.
- (b) The remaining sleepers will be loaded paralleled to the track on the BFRs.
- (c) Suitable nos. of wooden battens to support the sleepers in between layers of turnout sleepers will be used as in case of main line sleepers to prevent damage.

2. Unloading:

- (a) Depending upon the process of laying of the turnout adopted, the sleepers shall be unloaded either near the proposed location on firm and level ground or adjacent to a nearby siding or on a goods platform by means of a crane.
- (b) While unloading due care shall be taken that the sleepers or the inserts are not damaged.

3. Site preparation for laying:

- (a) Ensure that a clean ballast cushion of 30 cm below the bottom of sleeper is available.
- (b) These turnout sleepers are to be laid where the approach track is also laid with PRC sleepers. Thus there would be no need to lower the formation to provide adequate ballast cushion.
- (c) The ballast bed has to be perfectly level. Any variation in level may affect the gauge adversely.
- (d) Enough ballast shall be stacked along the cess to enable the filling of ballast in the cribs on the same day.
- (e) Longitudinal and cross drains may be provided in turnout area to avoid accumulation of water.
- (f) The site preparation to be completed well before laying turnout ensuring deep screening of ballast in turnout length and 30 m either side along the track.

4. Assembling:

(a) Ensure the availability of all fittings at site strictly as per requirement of latest drawings for switch portion, lead and crossing portion.

(b) The complete turnout will be assembled on a level ground adjacent to the site of laying or on the loop line corrected to turnout.

(c) Red/blue roundel marking on the sleepers should invariably be kept on the right hand side irrespective of left hand or right hand turnout.

(d) Spacing of sleepers should be strictly as per layout drawing.

(e) the sleepers shall be perpendicular to the straight track in switch portion only.

(f) In lead portion, the sleepers will be inclined at half the angle between the normals to straight and curved track at that point. Proposed disposition is appended as Annexure – 14/1.

(g) To ensure correct layout, laying of sleeper falling at transition from switch to lead and lead to crossing portion should be paid special attention. Sleepers in the witch portion, lead portion and crossing portion are as under:

Turnout	Switch	Lead	Crossing
1 in 8 ½	1 –13	14 – 41	42 – 54
1 in 12	1 –20	21 – 64	65 – 83

(h) The spacing of the sleepers in the lead portion should be as per layout drawing to make a radial or fan-shaped layout. The spacing has been worked out separately for both the rails. This separate spacing on two rails make the layout fan-shaped in lead portion.

(i) The sleepers in the crossing portion shall be perpendicular to bisecting line of crossing.

(j) Sleeper no. 3 & 4 may be placed for housing motor with the extended portion of sleeper in reverse direction only in circumstances where it can not be avoided.

(k) The approach sleeper in advance of switch portion should be provided without fail, they are for gradual elimination of slope of rail top (1:20).

(l) The exist sleepers behind the crossing portion should also be provided for gradual introduction of rail slope (1:20).

5. Insertion of pre-assembled turnout:

The complete assembled turnout shall be inserted in position after breaking it into three panels viz. Switch, lead and crossing portions by means of cranes or rollers.

6. Manual Insertion:

In case the PSC turnout sleepers are to be manually inserted, then the same must be done sleeper by sleeper ensuring that at no time the alignment and level is

beyond permissible limits. This work may be done under a suitable speed restriction if necessary and adequate mechanical means for packing the sleepers must also be available.

AJ ELASTIC FASTENINGS

Q. 21 What are main requirement of an ideal elastic fastening? Write name of 10 types of elastic fastening.

Ans. An ideal elastic fastening should be able to meet the following requirements:

1. It should hold gauge well.
2. It should have adequate toe load which should not reduce under service.
3. It should provide sufficient elasticity to absorb the vibrations and shocks caused by moving loads.
4. It should keep the track parameters well maintained.
5. It should offer adequate resistance to lateral forces for maintaining the stability of track.
6. It should provide adequate resistance to longitudinal forces caused due to acceleration of moving loads and other miscellaneous factors. These longitudinal forces tend to develop creep in the track.
7. It should be of 'fit and forget' type to require least maintenance.
8. It should be of the type that it can be used and re-used without losing its properties.
9. It should have as few parts as possible which are easy to be manufactured, laid and maintained.
10. It should be of the type that it cannot be taken out and as such is free from sabotage or theft.
11. It should be of universal type so that it can be used on wooden, steel or concrete sleepers.
12. It should be cheap and have a long life.

Types of Elastic Fastening

- ◆ Pandrol Clip or Elastic Rail Clip.
- ◆ IRN-202 Clip.
- ◆ Double Shank Elastic Spike.
- ◆ Lock Spikes
- ◆ Spring Steel Clip.
- ◆ Sigma Clip for C. I. Sleepers
- ◆ New Type of Elastic Fastenings with S. T. Sleeper.
- ◆ New Resilient Clip RD-3.
- ◆ RD-6 Assembly (Drawing No.RT/M/8206-A).
- ◆ Elastic Rail Clip MK-III
- ◆ H. M. Fastening and Nabla Fastening.

- ◆ Triple Elastic Fastening.

11. Subjective Questions on Track Machines

(1) Question:- Describe in brief the aspects of machine working to be looked for by the inspecting officers of division.

Answer:- When open line officers carry out inspection of tamping machines, they should specifically look for the quality and quantity of the output. They should, in addition, look for the following parameters in the machines:

- (i) Quality of pre-tamping works.
- (ii) Squeezing pressure of tamping unit be approximately as given below:
 - (a) PSC sleepers - 110-120 Kg/sq.cm
 - (b) ST, Wooden sleepers - 100-110 Kg/sq.cm
 - (c) CST-9 sleepers - 90-100 Kg/sq.cm
- (iii) vibration motor pressure.
- (iv) Number and condition of tamping tools.
- (v) Setting of tamping depth.
- (vi) Number and condition of lifting rollers.
- (vii) General lift and running in and running out of ramps.
- (viii) General condition of the machine.
- (ix) Output of the machines.
- (x) Track parameters after tamping.
- (xi) Quality of post tamping work.
- (xii) Actual working vis-à-vis programme.
- (xiii) Welfare aspects like staff accommodation and other facilities.
- (xiv) Adequate safety of staff working in block section against danger of incoming trains on adjacent lines.

(2) Question:- Describe the operations to be carried out before tamping (pre-tamping) by TTMs.

Answer:- The following preparatory works shall be completed before undertaking tamping of track:-

- (i) Field survey should be carried out to determine existing profile of track and to decide the general lift. In case of design mode working, the survey should be done.
- (ii) The beginning and the end of curves/transition curves should be marked on sleepers. Super-elevation and slew should be marked on alternate sleepers to act as guide for the operator.
- (iii) Ballast shall be heaped up in the tamping zone to ensure effective packing. However, sleeper top should be visible to the operator and the ballast should not obstruct the lifting rollers.
- (iv) Hogged, battered and low joints shall be attended.
- (v) Low cess should be made-up.

(vi) Track drainage should be improved for better retentivity of packing. Pumping locations should be attended. Rounded ballast should be replaced with clean and angular ballast.

(vii) Deficient fittings and fastenings should be good and all fittings and fastenings like fish bolts, keys, cotters, loose jaws, elastic rail clips, pads etc. should be properly tightened. Worn out fittings should be replaced.

(viii) Broken and damaged sleepers shall be replaced.

(ix) Sleepers should be squared, correctly spaced and gauge corrected.

(x) Destressing of rails, adjustment of creep, expansion gaps in joints, buffer rails and SEJs etc, if necessary, shall be carried out.

(xi) Guard rails at the approach of bridges and check rails shall be removed temporarily.

(xii) All obstructions such as rail lubricators, signal rods and cable pipes which are likely to obstruct the tamping tools should be clearly marked and made known to the operator before the start of work.

(xiii) Wooden blocks and joggled fish plates shall be removed temporarily ahead of tamping.

(xiv) In electrified sections, the earthing bond should either be removed or properly adjusted for tamping.

(3) Question:- What operations shall be ensured after tamping by TTMs, i.e., describe post-tamping operations.

Answer:- The Section Engineer (P.Way) shall pay attention to the following items after tamping by machines:-

(i) Checking and tightening of loose fittings.

(ii) Replacement of broken fittings.

(iii) The ballast shall be dressed neatly. Proper consolidation of ballast between the sleepers shall be done.

(iv) Final track parameters should be recorded with the help of recorders provided on the tamping machine. A copy of this record should be kept with the Section Engineer (P.Way) and the recorded values should not exceed the laid down limit.

If the recorder is not available, then track parameters of at least four stretches of 25 sleepers each per kilometer of tamped track should be recorded. In addition, the versines and super-elevation of curves shall be recorded for at least ten stations at a specified chord length.

(v) While working in LWR territory, the provisions of Manual of Instructions on Long Welded Rails – 1996 should be followed.

(vi) The fixtures like check rails removed during pre-tamping operation should be restored.

(4) Question:- What are the pre-requisites for a base depot for relaying track with portal cranes (PQRS)?

OR

What are the main aspects to be considered for base depot for relaying track with PQRS?

Answer:- Following are the pre-requisites for relaying track with portal cranes:-

(i) A well organized and properly laid out Base Depot is the back bone of relaying by portal cranes. Smooth functioning of the Base Depot will ultimately reflect in efficiency and productivity of the relaying work. The Base Depot is required to cater to the following activities:-

- (a) Unloading of PSC sleepers from the rake and stacking.
- (b) Fabrication of new panels.
- (c) Unloading of released panels from PQRS rake.
- (d) Dismantling of released panels.
- (e) Loading of pre-fabricated new panels.
- (f) Formation of PQRS rake.
- (g) Maintenance of machines.
- (h) Dispatch of released materials.
- (i) Loading/unloading of ballast, if the Base Depot is also to be used as ballast depot.

(ii) It is desirable to locate the Base Depot at a central place such that the distance of remotest work site on either side does not exceed 60-70 kilometers. At the same time, the site selected should be accessible by road, there should be electric power supply and watering facilities. The Base Depot may have facility of entry and exit on both sides from the running line.

(iii) For smooth working, the Base Depot should have at least three sidings of 500 meters each connected to a shunting neck of 350 metres. Of these, at least two sidings should be provided with auxiliary track for movement of portal cranes.

(iv) It is desirable to illuminate the Base Depot so that the activities listed in item (i) above can be undertaken safely at night.

(v) To strengthen depot working, it is desirable to install a few hand-operated/motorized gantry cranes moving on auxiliary tracks in addition to the third

portal crane in the depot. Some of these gantry cranes can be of 6.5 metres height from rail level to facilitate repair of portal cranes.

(5) Question: - What operations shall be ensured before actual relaying by portal cranes?

Answer:- Following operations should be ensured before actual relaying:-

(i) The requisite survey shall be carried out and the longitudinal profile and alignment shall be finalized as per relevant provisions in the Indian Railways Permanent Way Manual 1986 and Schedule of Dimensions-1939.

(ii) Track may be deep screened one or two days in advance of relaying. The ballast section should be built up to the bottom of sleepers to facilitate relaying. The balance quantity of screened ballast should be trained out after relaying.

(iii) Auxiliary track should be laid at 3400 mm gauge keeping the centre line same as that of main line track. CST-9 plates or wooden blocks of size 560 X 250 X 125 mm should be used at 1.5 to 2.0 metres distance for laying the auxiliary track. The length of auxiliary track should match with the daily progress of work.

(iv) The level of auxiliary track should be same as that of existing main line track and must have proper longitudinal and cross levels to avoid derailment of portal cranes. In no case, the auxiliary track should be more than 50 mm higher than the existing track.

(v) Removal of ballast from the crib and shoulders up to the bottom level of the sleepers should be ensured.

(vi) Full fittings of the old sleepers should be ensured to avoid their falling off while lifting released panels.

(vii) Sleepers must be in single piece. All broken sleepers should be removed or replaced in advance.

(viii) On girder bridges, the guard rails at the approaches on both ends should be removed temporarily.

(ix) In case a level crossing is to be encountered, it should be opened in advance.

(x) Proper planning and insertion of Switch Expansion Joints at correct locations should be ensured.

(xi) Cutting of LWR/SWR to single rails should be ensured for lifting released panels. Otherwise, replace the existing running rail by service rails for the stretches which are to be re-laid during the next day.

(xii) Temporarily disconnect or remove any other permanent obstructions such as cables, signaling rods and other obstructions like embedded rail piece, tie bar etc. to allow unhindered progress of work.

(xiii) Availability of under noted equipments should be ensured at site:-

- (a) One set each of rail cutting and gas cutting equipments in good working condition.
 - (b) Two sets of rail closures of the each rail section being laid, in various (from 0.5 m to 3 m) lengths.
 - (c) 4 sets of junction fish plates with bolts.
- (xiv) Portable walkie-talkie sets should be provided at each relaying site for effective communication between the site of work and the adjoining stations.
- (xv) Extra number of track panels should be fabricated in the base depot to maintain a buffer stock for one or two days of relaying work so that work at site does not suffer for want of depot working.

(6) Question: - What operations shall be ensured after relaying by PQRS portal cranes?

Answer:- Following post relaying operations should be ensured:-

- (i) Clearance of track from any obstructions before removal of traffic block.
- (ii) Complete track fittings including their correct positioning and tightness.
- (iii) Proper lifting, packing, ballast regulating and compaction/stabilization of track raise the speed of the different stretches as per the table II of para 308 of IRPWM.
- (iv) Training out of adequate quantity of ballast over the newly relayed track to full ballast section. Ballast recoument activity should be properly synchronized with the relaying activity so as to enable raising of speed to normal in three cycles of tamping by on-track tampers.
- (v) Picking up of left over released materials.
- (vi) Dismantling of auxiliary track and relaying the same in advance for the next day's work.
- (vii) Restoration of cables and other fixtures e.g. guard rails on bridges and check rails on level crossings which were removed temporarily.
- (viii) Tie tamping machine, BRM and Dynamic Track Stabilizer should be deployed to enable raising of speed to normal.
- (ix) Provision of SEJs as per approved plan, in-situ welding of panels and destressing of LWR should be done after welding of panels.

(7) Question:- List the safety equipments that shall be available on the machines.

Answer:- The following equipments complete in all respects and in working condition shall be available on the track machine before the machine is put on a running line:-

- (i) Two red and one green hand signal flags,

- (ii) Two tri-colour hand signal lamps,
- (iii) Two chains with padlocks,
- (iv) Two clamps with padlocks,
- (v) Twelve for signals (detonators) in a tin case,
- (vi) A copy of the working time table of the section where the machine is working,
- (vii) G&SR book with upto date amendment slips,
- (viii) One 4 cell flasher light,
- (ix) One portable field telephone,
- (x) Two banner flags,
- (xi) One first aid box,
- (xii) Two skids,
- (xiii) Petromax/LPG lamps,
- (xiv) Safety helmets for all machine staff,
- (xv) Protective clothings, safety shoes and safety gloves,
- (xvi) Track Machine Manual, and
- (xvii) Accident Manual.

(8) Question:- What are the equipments which shall be available on the machines during block working to meet the exigencies as per IRTMM?

Answer:- The following equipments should be available on the machines during bock working to meet the exigencies:

- | | | | |
|-------|-------------------|---|------|
| (i) | Fire extinguisher | - | one |
| (ii) | Hooter (manual) | - | two |
| (iii) | Jack 50 t | - | two |
| (iv) | Wooden blocks | - | four |
| (v) | Crow bars | - | four |
| (vi) | Tirfor (3t) | - | four |

- (vii) hydraulic hand pump - one
- (viii) Emergency pneumatic/
hydraulic hose of sizes
suited to different machines
(complete with end fittings) - one
- (ix) Wire roper with close
loops at both ends 2 metres
& 9 metres for BCM. -one each

(9) Question:- Write brief note on function and advantage of Dynamic Track Stabilizer (DTS) machine.

Answer:- During maintenance operations such as tamping, lifting, slewing, deep screening etc, the lateral resistance of track gets reduced which rebuilds gradually with passage of trains. This consolidation can also be achieved faster and more effectively by causing “controlled settlements” of track by means of a Dynamic Track Stabilizer.

The controlled settlement produced by the DTS has the following major advantages:-

- (i) Elimination of initial differential settlements which are caused by the impact of passing duration.
- (ii) The track geometry achieved by tamping machines is retained for a longer duration.
- (iii) Homogenous structure of ballast bed is built up.
- (iv) Lateral track resistance increases resulting in enhanced safety against track buckling.
- (v) Speed restrictions are relaxed faster.

(10). Question:- Write short notes on functions of following machines:

- (A) BCM (Ballast Cleaning Machine)
- (B) BRM (Ballast Regulating Machine)
- (C) TRT (Track Relaying Train)
- (D) RGM (Rail Grinding Machine).

Answer:-

(A) The function of the Ballast Cleaning Machine is to carry out cleaning of ballast by removing muck, thereby improving drainage of track and elasticity of the ballast bed. Basically, the machine excavates and picks up ballast by means of cutter chain and carries it to a set of vibrating screens where muck is separated and thrown out by a chute and the clean ballast is transferred back to the track.

(B) Ballast Regulators machines have their main application in ballast transfer, spreading and profiling operations. For this purpose, a front mounted one pass transfer plow, left

and right ballast wings and a rear mounted track broom are provided as standard equipments. The machine can move ballast towards centre of track or away from centre of track, transfer ballast across the track and transfer ballast from a surplus zone to deficient zone.

(C) Track Relaying Train (TRT)

TRT is a system for complete mechanization of track renewal process. It does the following jobs:

- (i) Threads out old rails from track.
- (ii) Removes old sleepers.
- (iii) Levels and compacts ballast bed.
- (iv) Places new sleepers.
- (v) Threads in new rails into track.

(D) Rail Grinding Machine

Rail Grinding helps in controlling the contact point between rail and wheel to reduce wear and tear of both rail and rolling stock. Eight grinding modules (stones) are located on each rail. Both the rails can be ground simultaneously. Microprocessor controlled hydraulic system, raise and lower each of the grinding stones in sequence at a specific point on the rail head.

The machine removes metal from rail head according to specified grinding pattern. All required patterns can be stored and recalled. Pattern changes can be made very quickly.

It removes long and short wave corrugations efficiently while minimizing rail head loss.

12. OTHER QUESTIONS RELATED TO CURVES

Q. No. 1 Name the different methods for setting a curve.

Ans. Different methods for setting a curve are: -

- By ordinates from the long chord
- By successive bisection of arcs
- By offsets from the tangents.
- By offset from the chord produced.

Q.No.2 Explain transition curve and advantages of providing transition curve at each end of a circular curve.

Ans. A non-circular curve of varying radius introduced between a straight and a circular curve for the purpose of giving easy changes of direction of a route is called a transition curve. It is also inserted between two branches of a compound or reverse curve.

Advantages of providing a transition curve at each end of a circular curve:
The transition from the tangent to the circular curve and from the circular curve to the tangent is made gradual.

It provides satisfactory means of obtaining a gradual increase of super-elevation from zero on the tangent to the required full amount on the main circular curve.

Danger of derailment, side skidding or overturning of vehicles is eliminated.

Discomfort to passengers is eliminated.

Q. No. 3 Explain super-elevation or cant?

Ans. When a vehicle passes from a straight to a curve, it is acted upon by a centrifugal force in addition to its own weight, both acting through the center of gravity of the vehicle. The centrifugal force acts horizontally and tends to push the vehicle off the track. In order to counter act this effect, the outer edge of the track is super-elevated or raised above the inner one. This raising of the outer edge above the inner one is called super-elevation or cant. The amount of super-elevation depends upon the speed of the vehicle and radius of the curve.

13. LWR

Q.1. What are the additional equipment required for maintenance of track in LWR/CWR Section.

Ans. Staff responsible for maintenance of LWR/CWR shall be trained in using and equipped with additional equipment as given below:-

Additional equipment with the gangs.

- (i) A pair of joggled fish plate with bolted clamps.
- (ii) Rail thermometer with markings for temperature ranges for maintenance.
- (iii) Special one meter long fish plates with screw clamps.
- (iv) Rail closure pieces.

Additional equipment with PWI

- (i) Four numbers of 6.5M or longer rail pieces.
- (ii) Two sets of SEJ with Sleepers and Fastenings.
- (iii) Adequate number of 1M long fish plates with screw clamps/joggled fishplates with slotted grooves and bolted clamps.
- (iv) Rail closures of suitable sizes.
- (v) 1M and 10cm Straight Edges.
- (vi) Calipers and feeler gauges (2mm to 0.1mm).
- (vii) Rail Cutting Equipment.
- (viii) Destressing Equipment.
- (ix) AT /Mobile Gas Pressure Equipment.
- (x) Equipment for protection of track.
- (xi) Equipment for night working.

Q.2. Write down procedure of regular track maintenance in LWR/CWR Track.

Ans. Regular track maintenance in LWR/CWR includes following operations:-

- (1) Tamping/packing
- (2) Lifting.
- (3) Aligning including minor realignment of curves.
- (4) Shallow screening/shoulder cleaning.
- (5) Casual renewal of sleepers.
- (6) Renewal of fastenings.
- (7) Maintenance of SEJs/buffer rails.

(i) Regular track maintenance in LWR/CWR shall be confined to the hours when the rail temperature is between $t_d + 10^{\circ}\text{C}$ and $t_d - 30^{\circ}\text{C}$ and shall be completed well before on set of summer. If rail temperature after a maintenance operation exceeds $t_d + 20^{\circ}\text{C}$, then during the period of consolidation as per para 1.18, a speed restriction of 50km/h on BG and 40 km/h on MG shall be imposed when shoulder and crib compaction has been done and 30km/h and 20 km/h respectively when shoulder and crib compaction has not been done, in addition to posting of mobile watchman.

Ballast section shall be properly maintained, specially on pedestrian and cattle crossings, curves and approaches to level crossings and bridges. Cess level should be correctly maintained. Dwarf walls may be provided on pedestrian and cattle crossings to prevent loss of ballast. Replenishment of ballast shall be completed before onset of summer. Shortage of ballast in the shoulder at isolated places shall be made up by the gangmate by taking out minimum quantity of ballast from the centre of the track between the two rails over a width not exceeding 600mm/350mm and a depth not exceeding 100mm/75mm for BG/MG respectively.

Sufficient quantity of ballast shall be collected to provide full ballast section before commencing any maintenance operation, specially lifting.

When crow bars are used for slewing, care shall be taken to apply these in a manner so as to avoid lifting of track. In this connection, the instructions in para 224(d)(ii) of IRPWM shall be followed.

Special attention shall be paid to maintenance of track at following locations.

- SEJs/breathing lengths.
- Approaches of level crossings, points and crossings and un-ballasted deck bridges.
- Horizontal and vertical curves.
- Special attention shall be paid to maintenance of fastenings in LWR/CWR especially on concrete sleepers according to para 1411 of IRPWM.
- All fastenings shall be complete and well secured.

Mechanised Maintenance:-

Maintenance tamping:-

Tamping in LWR/CWR with general lift not exceeding 50mm in case of concrete sleeper and 25mm in case of other sleepers including correction of alignment shall be carried out during the period when prevailing rail temperatures area together with precautions laid down therein.

Lifting of track:-

Lifting where needed, in excess of 50mm in case of concrete sleepers/25mm in case of other types of sleepers shall be carried out in stages with adequate time gap in between successive stages such that full consolidation of the previous stage as per para 1.18 is achieved prior to taking up the subsequent lift.

Cleaning of shoulder ballast:-

Mechanised cleaning of shoulder ballast shall be undertaken when prevailing rail temperatures are within the limits prescribed in para 6.2.1(i) together with the precautions mentioned therein.

Manual maintenance:-

At no time, not more than 30 sleeper spaces in a continuous stretch shall be opened for manual maintenance or shallow screening with at least 30 fully boxed sleeper spaces left in between adjacent openings. Maintenance of in between lengths shall not be undertaken till passage of traffic for at least 24 hours in case of BG carrying more than 10 GMT or 2 days in case of other BG and MG routes.

For correction of alignment, the shoulder ballast shall be opened out to the minimum necessary and that too, just opposite the sleeper end. The ballast shoulders shall then be put back before opening out crib ballast for packing.

In exceptional circumstances when more than 30 sleeper spaces have to be opened for any specific work, life through screening of ballast etc. during the period of the year when minimum daily rail temperature is not below $td-30^{\circ}C$ or maximum does not go beyond $td+10^{\circ}C$, upto 100 sleeper spaces may be opened under the direct supervision of PWI. It should however, be ensured that rail to sleeper fastenings on the entire length of LWR are functioning satisfactorily and SEJs do not indicate any unusual behavior.”

Changes in beat length and man power deployment as given above if found necessary, may be decided by the Chief Engineer depending on prevailing local conditions, frequency of train service, weather conditions etc.

Casual Renewal of Sleepers:-

Not more than one sleeper in 30 consecutive sleepers shall be replaced at a time. Should it be necessary to renew two or more consecutive sleepers in the same length, they may be renewed one at a time after packing the sleepers renewed earlier duly observing the temperature limits specified in para 6.2.1(i) together with precautions mentioned therein.

Renewal of Fastenings:-

The work of renewal of fastenings shall be carried out when rail temperature is within the limits specified in para 6.2.1(i) with following additional precautions:-

Renewal of fastenings not requiring lifting:-

Fastenings not requiring lifting of rails, shall be renewed on not more than one sleeper at a time. In case fastenings of more than one sleepers are required to be renewed at a time, then at least 15 sleepers in between shall be kept intact. Work shall be done under supervision of keyman.

Renewal of fastenings requiring lifting:-

Fastenings requiring lifting of rails i.e. grooved rubber pads, etc. shall be renewed on not more than one sleeper at a time. In case fastenings of more than one sleepers are required to be renewed at a time, then at least 30 sleepers in between shall be kept intact. Work shall be done under supervision of Gangmate.

Maintenance of SEJs/buffer rails:-

Once in a fortnight SEJs shall be checked, packed and aligned if necessary. Oiling and greasing of tongue and stock rails of SEJ and tightening of fastenings shall be done simultaneously. Movement of SEJs shall be checked and action taken for distressing if necessary.

During his daily patrolling, keyman shall keep special watch on the SEJs falling in his beat.

Buffer rails shall be maintained in accordance with Annexure-IX.

14.Welding.

Q1. What are the various method of welding a rail joint.

Ans.

- a. Gas Pressure Welding.
- b. Electric arc welding.
- c. Flash Butt Welding.
- d. Thermit Welding.

Q 2. What are the various post welding opeations.

Ans.

- (1) Controlled cooling is required to be done for 3 to 4 mts.
- (2) The finishing of the welded joint is done either with hand files or portable grinders to bring the welded joint to the correct rail profile.
- (3) Shifting of sleepers to their original position and its packing is required to be done before passing of first train.
- (4) USFD Testing of new AT Weld should be completed within 30 days of execution.

Q3. What is wider gap welding.

Ans. 50mm and 75mm welding are called wider gap welding.

Q4. Write down the finishing tolerances of AT Welding.

Ans.

- (1) Vertical Alignment.
 - i. +1mm (at the end of 1.0m).
 - ii. -0mm (straight edge).
- (2) Lateral Alignment.
 - i. +0.5mm on 1.0m Straight Edge.
- (3) Finishing on sides of head of welded joint.
 - i. +0.3mm on 10cm Straight Edge.
- (4) Finishing at top table surface.
 - i. +0.4mm (at the end of 10cm).
 - ii. -0.0mm (Straight Edges).

Q5. Write down precautions for carrying out of welding.

Ans.

- (1) It should be ensured that the portion being used matches with type and chemistry of rail.
- (2) Rail ends should be square.
- (3) Alignment of rail ends should be perfect as checked by Straight Edge.
- (4) Rail ends should be properly cleaned with kerosene oil and wire brushes.

- (5) Stop watch should be provided to the welding supervisor at each welding site.
- (6) Pressure in the tanks/cylinder should be properly maintained during pre-heating.
- (7) Correct gap between rail ends at head, web and foot shall be ensured.
- (8) Correct preheating time for rail ends shall be ensured.
- (9) Tightness of clips fitted with hose connections to Compressor tank and burner shall be checked before commencing preheating.
- (10) Nozzles of burners shall be cleaned periodically to avoid back-fire.
- (11) The compressor tank shall be kept at least 02 to 03 meters away from the burner to prevent fire hazard.
- (12) The tapping shall be done within the time specified for that particular technique.
- (13) Arrangements for giving first aid shall be available at site.
- (14) Welders should be provided with gloves and coloured glasses.
- (15) Boiling portion shall be out tapped.
- (16) No moist portion/torned portion bag shall be used for welding.
- (17) Portions should not have dampness.
- (18) Only approved contractor shall be allowed to execute welding work.
- (19) As far as possible disc cutters shall be used for cutting of rails.

Q6. Write the procedure of Flash Butt Welding Process.

Ans. Pre-Straightening of rails:

- Rails not meeting the geometrical standards are to be rectified before welding using a pre-straightening machine so as to conform to the standards.
- End-Cleaning:- Before welding end faces of the rails to be welded upto 150mm to 225mm shall be thoroughly cleaned by brushing and shot blasting. Cleaning of rail bottom shall be ensured by placing a mirror and watching the cleaned surface.
- Rail Alignment:-The running surfaces of rails at interface shall be aligned carefully to avoid any 'Step'.
- Welding Sequence:- The stationary Flash-Butt Welding Plant adopt following welding sequence.
 - Initial burn off.
 - Preheating.
 - Flashing.
 - Forging.
- Stripping:- As soon as the rails are welded, they are made to pass through a stripping machine, where all extra metal called upset metal is chipped off. In case there is no stripping machine available, extra metal on the rail head is chipped off manually by pneumatic chisel when the metal is still hot.
- Spray Cooling:- After the hot metal is chipped off, the rails are cooled by spray cooling by a sprayer at a distance of 60m 70meters from the welding machine.

- Profiling:-The rails are finally ground to correct profile preferably by means of a trolley grinder for the rail table and by hand grinders for the other portions.
- Post Straightening:-The rails are straightened by means of post straightening machine, which removes horizontal and vertical kinks.
- The rails as well as welds are given an ultrasonic examination to ensure that there are no flaws in the rails.
- Examination and inspection:- The rail ends are finally examined and inspected with regard to specified tolerances so as to have finally a good welded surface.

Q7. Write down the temperature of the following:-

Ans.

- Temperature upto which rail is heated before pouring of B material.(600⁰+20⁰C).
- Temperature of molten metal.(2540⁰C).

Q8. Write down the limitations of second hand rails to be welded.

Ans. Second hand rails:-For conversion of existing single rails! Short welded panels into SWP/LWR/CWR or during secondary rail renewal, old serviceable rails may be welded subject to the following conditions:-

Obsolete rail sections and rails older than 50 years shall not be welded. Specified approval of the Railway Board may, however, be obtained in special cases.

The Chief Track Engineer shall satisfy himself that second hand rails have a substantial rail life to make it a safe and economical proposal.

Rails shall be free from corrosion or excessive wear. The height of rail and width of rail head shall not be less than the values as indicated in Table:-

<u>Rail Section.</u>	<u>Normal ht. of new rail(mm).</u>	<u>Min. ht. of old (mm).</u>	<u>Width of head of flew rail(mm).</u>	<u>Min. Width of head of old rail (as measured at the gauge corner(mm).</u>
60kg.	172	163	72	66
52kg.	156	150	67	61
90R.	143	139	67	61
75R.	129	126	62	56
60R.	114	112	57	51

Rails shall be tested before welding, with ultrasonic flaw detector apart from visual inspection, so that rails having cracks and internal flaws are excluded from welding. Rails with excessive scabbing, wheel burns, corrugations and wear of rail seats shall not be used for welding. The rail flange bottom shall be visually inspected to ensure freedom from defects like dent, notch, corrosion etc.

Even where cracks/flaws have not been detected during visual USFD Examination before welding, the ends of second hand rails should be suitably cropped so as to eliminate fish bolt holes.

The rail ends shall be cut by sawing or using abrasive disc cutter and not by flame cutting.

Second hand rails shall be match-marked before releasing from track to enable matching of the rail ends at the time of welding. Kinks, if any, in the rails shall be removed before welding.

The rolling marks on the web of rails shall be checked before welding to ensure that generally rails of different qualities are not welded together. However in unavoidable circumstances, where rails of grade 710(72UTS) rail chemistry and that of grade 880(90UTS) chemistry are to be welded, the portion of grade 880(90UTS) chemistry shall be utilized for welding.

While using second hand rail panels for secondary renewal, released from LWR/CWR Sections the ends should be cropped to eliminate fish bolt holes. If rail ends do not have bolt holes, the ends may be cropped to a distance of minimize 150mm for AT Welds and 85mm for Flash Butt Welds from the centre of welded joint to eliminate heat affected zone of welds. End cropping may be suitably increased so as to ensure that rail ends are within the tolerances.

Q.9 Fill the blanks:

Lateral alignment before welding shall be within _____ mm on 1 mt. St. edge. (± 0.5).

Vertical alignment before welding shall be within _____ to _____ for 90 UTS rail on 1 mt. St. edge (2 to 2.4 mm).

Gap for 60 kg./90 UTS rail for welding is kept as _____ mm. (25 ± 1 mm).

Preheating time for Air-petrol preheating is _____ mts. (10-12 mts.)

Preheating time for Oxy-LPG preheating is _____ mts. (2-2.5 mts)

The distance between the tap hole and top of pouring gate is _____ mm (50 mm)

About _____ second should be allowed to pass on newly welded joint after _____ mts. (30 mts.)

Q.10 Write down the various steps involved in AT welding process and describe them in brief.

Ans. 1) Preparation of rail ends to be welded :- The rail end face and adjacent sides at foot, web and head up to 50 mm shall be thoroughly cleaned using kerosene oil and wire brush to remove all dirt, grease and rust before welding. Any burrs at the rail ends shall be removed by chiseling or grinding.

Normally, no alumino-thermic welded joint shall be located closer than 4 meter from any other welded or fish plated joint.

Gap between rail ends. : The two rail ends to be welded shall be held in position with a uniform and vertical gap as per gap specified. In case of SPW weld 25 ± 1 mm and wide gap $50 \pm 1/75 \pm 1$ mm.

Preliminary work prior to welding: In case of in-situ welding the rail fastenings for at least five sleepers on either side of the proposed weld shall be loosened. The sleepers adjacent to the joint to be welded shall be shifted to obtain a clear working space of 250 mm on either side to accommodate the moulds, clamps, preheating equipment, etc. The rails shall then be properly aligned, both horizontally and vertically.

When the welding work is carried out on cess, full rail length shall be leveled by supporting on at least ten wooden blocks on either side. The rails shall be properly aligned in horizontal and vertical direction and held in position.

Alignment of rail ends before welding.-The rail ends to be welded shall be aligned in horizontal and vertical planes to the dimensional limits indicated.

Below:-

Lateral, alignment the two rail ends, after alignment shall be within ± 0.5 mm when checked with a 1 straight edge at rail ends. Any difference in the widths of rail heads shall always be fully kept on the non-gauge side, correctly aligning the rail ends on the gauge face.

Vertical alignment the joint shall be kept higher by 3 to 4 mm for 72 UTS rails and 2 to 2.4 mm for higher UTS rails when measured at the end of 1 m straight edge.

Fixing of mould :- Only prefabricated shall be used for welding.

Before mounting on the rail ends to be welded, each pair of moulds shall be examined for defects, dampness, cracks, blocked vents etc. and defective moulds discarded.

During fixing the moulds, it shall be ensured that the centre line of the rail gap coincides with the centre line of the mold to avoid cross joint. The mould jackets/shoes holding the pre-fabricated mold in a snug fit condition, after fixing, shall be tightened by the application of adequate pressure.

After fixing the moulds, the gap between mould and the rail shall be packed firmly with luting sand to prevent leakage of liquid weld metal. To protect the rail top table from metal splashes during reaction, the adjacent rail surface on either side of the moulds shall be covered with metal cover or smeared with luting sand upto 15 cm on either side.

Preheating:-

After fixing and luting of the moulds, the rail ends shall be uniformly pre-heated throughout the rail section with air petrol/compressed air petrol/oxygen – LPG burner. The flame shall be properly adjusted to achieve the desired rail temperature. The pre-heating shall be done from the top of the mould box for stipulated period for welding technique adopted, so as to achieve a temperature of around $600 \pm 20^{\circ}\text{C}$.

In welding process using air petrol burner, the compressor tank pressure during operation of the burner shall be maintained at 7 ± 0.70 Kg/cm (100 ± 10 lbs per sq. inch). In case of pre-heating by Oxy-LPG process, pressure for Oxygen and LPG cylinders shall be adjusted in the range of 7.0-8.0 Kg./cm and 2.0=2-5 Kg/cm respectively.

Preheating time would be about 10 to 12 minutes and 2 to 2.5 minutes for Air petrol and Oxy-LPG pre heating techniques respectively. The actual preheating time would depend upon the rail section and welding technique.

Welding:-

The crucible lined with refractory material (magnesite/crushed alumina slag) and fitted with bottom stone and thimble shall be preheated before making the first weld of the day to ensure freedom from moisture.

Slag shall be cleaned from the crucible after each reaction. The crucible shall be positioned relative to the pouring gate with respect to its height from the mould after it has been placed on the stand mounted on the rail head. The tap hole in the crucible shall be sealed with closing pin, asbestos powder and slag powder.

The portion shall be thoroughly hand mixed and poured into the crucible. The crucible shall then be brought to the proper position over the mould in line with the pouring gate of the mould with a vertical distance of about 50 mm between the tap hole and sand core I top of the pouring gate.

After preheating the rail joint, the sparkler shall be ignited & inserted in the portion at the centre top to start the reaction. The reaction shall not be vigorous or boiling. By the time the reaction is complete, the burner shall be removed quickly, about 3 seconds shall be allowed for the separation of slag from the metal, Thereafter, the molten steel shall be tapped into the mould by striking the closing pin with a tapping rod.

After pouring, molten metal shall be allowed to cool and solidify with mould intact for the (mould waiting time) generally 4 to 6 minutes for 25 mm gap joints and 12 minutes for 75mm gap joints. After the mould waiting time has elapsed, the trimming should be done by using weld trimmer.

Before the passage of traffic, the wedges used for aligning should be removed and joint sleepers which were shifted shall be re-shifted to the original location and repacked. The first train should be allowed to pass on the newly welded joint only after 30 minutes have elapsed since pouring of weld metal.

Grinding:-

After the excess metal is trimmed of, the grinding of remaining metal on the rail table and the sides of the rail head shall be carried out only with rail profile grinding machine.

Finished welds:-

All the finished joints shall be checked to ensure that geometry is within the tolerances.

15. ROB/RUB

Q 1 Which undertakings are furnished by State Government for construction of ROB/RUBs on cost sharing?

Ans.1. Following undertakings should be furnished by State Government for construction of ROB/RUBs on cost sharing basis:

- i. The level crossing will be closed simultaneously with the commissioning of the bridge.
- ii. The State Government is willing to contribute towards their share of cost.
- iii. The site details will be finalized in advance and the site will be jointly agreed upon by both the parties.
- iv. Plans, designs and estimates for bridges and approaches will be finalized and accepted reciprocally.
- v. Advance action for land acquisition will be taken by the Road Authority, whenever difficulties are anticipated.
- vi. State Government will ensure that work on approach roads will be commenced and completed more or less simultaneously with the completion of the bridge proper by Railway.
- vii. State Government is willing to pay the cost of preparation of plans and estimates as per the Indian Railway Code for the Engineering department in the event of the proposal being abandoned or dropped at a later date.
- viii. In case of RUB, the State Government will construct, operate and maintain the sump well and pump house for the drainage of rainwater.

Q. 2. What are the steps for processing the proposal for construction of ROB/RUBs on cost sharing basis for Works Programme?

Ans. 2. The following steps are adopted for processing the proposal for construction of ROB/RUB for Works Programme:

Step-I: Proposal from State Government or any sponsoring authority for construction of ROB/RUBs in lieu of level crossing is processed on cost sharing basis if TVU of the said level crossing exceeds 1 lac. The proposal contains sketch showing the cross section of proposed ROB/RUB and undertakings for a) sharing the cost, b) closure of level crossing, c) simultaneously completion of approaches, d) advance action of land acquisition etc., e). finalizing the site details jointly and feasibility check.

Step-II: Based on the sketch submitted by sponsoring authority, conceptual profile sketch is prepared and sent to State Government for acceptance and returning one copy to Railway's Headquarters Office.

Step- III: After acceptance of conceptual profile sketch, the abstract estimate of Bridge portion is prepared in Headquarters Office and sent to State Government for acceptance. State Government is also requested to submit the abstract estimate of approaches and accept the abstract estimate of Bridge portion.

Step-IV: After receipt of both the abstract estimates, the proposal is sent for finance vetting in Headquarter Office.

Step-V: After finance vetting, proposal is sent to Railway Board for sanction and inclusion in Railway's Works Programme.

16. PRIVILEGE PASSES/PTOs

Q.3 What are different kinds of privilege passes and who are entitled for the same?

Ans. 3: There are four kinds of passes :
Ist Class 'A', Ist Class, II nd Class 'A' & II nd sleeper class.

Category	Class of Privilege pass /Privilege Ticket Order
I. <u>Group 'A' + 'B' (Gaz)</u>	Ist A
II. <u>Non Gazetted Group 'B' + Group 'C' employees.</u>	
a). Those who were appointed prior to 1.8.69.	
(i) Drawing pay of Rs. 5000/- or above provided the employees are in scale the maximum of which is Rs.6000/- or above.	Ist Class
(ii) Employees other than those covered under (i) above.	II nd sleeper class
b). Staff appointed during the period from 1.8.69 to 31.3.87.	
(i) Staff drawing pay of Rs. 5375/- or above provided they are in a scale the maximum of which is Rs. 7000/- or above.	Ist Class
(ii) Staff other than those covered in item (i) above.	II nd sleeper class
c). Employees appointed during the period from 1.4.87 to 1.2.99:	
(i) Staff drawing pay of Rs. 7250/- or above or those who are in the scale the minimum of which is Rs. 6500/-.	Ist Class
(ii) Staff other than those covered in item (i) above.	II nd sleeper class
d). Employees appointed after 1.2.99.	
(i) Staff in pay scale minimum of which is Rs. 6500/- or above.	Ist Class
(ii) Staff drawing pay Rs. 7600/- or above.	Ist Class
(iii) Staff in pay scale of Rs. 5000-8000 and 5500-9000 + drawing pay of Rs. 7250/- or above but less than Rs. 7600/-.	II nd class 'A'
(iv) Staff other than those covered under (i) (ii) and (iii) above.	II nd sleeper class.
III. <u>Group 'D'</u>	II nd sleeper class

Apprentices and trainees in Group 'C' post/Grade may be given the class of pass (for self only) on the basis of minimum of pay of the post or grade to which they are to be appointed on completion of their apprenticeship in accordance with the pay limits prescribed from time to time.

Q.4. What are the numbers of passes + PTOs admissible for Railway servant?

Ans.4. a). **Gazetted Officers:** 6 sets of passes and 6 sets of PTOs in a year. Special class Apprentices are entitled to two sets of passes (for self only) + 6 sets of PTOs (for self only) in a year.

b) **Non Gazetted staff including apprentices:** One set of passes during the 1st five years of service and 3 sets of passes from the 6th year of service. The number of recorded PTOs will be limited to 6 sets per annum.

Those of employees covered under (a) & (b) recruited after 30.6.87 will be eligible for 4 sets of PTOs in view of their being governed automatically under the scheme of entitlement of passes for widow/widower after their death while in service or after retirement. In case of pre 30.7.87 existing employees, they will be entitled for 6 sets of passes if they have already opted out of this scheme within the time limit for the same (i.e. 30.6.87).

Q.5. Which are the persons that may be included in a Pass/PTO?

Ans.5. Members of the family and dependent relatives of a railway servant that may be included in a pass or a PTO are as below:

Family (a) wife/husband (b) sons under 21 years of age provided they are wholly dependent on the employee (c) unmarried daughter of any age irrespective of whether she is earning or not (d) married daughter under 18 years of age or widowed daughters provided they are wholly dependent on the employee, (e) step sons/unmarried step daughter/married step daughters and one adopted child subject to age limit prescribed in (b) & (d) above provided. They are wholly dependent. The age restriction laid down in (b) above will not apply if the sons are bonafide students of recognized educational institutions. Passes/PTOs may not be issued to adopted children if the employee has children of his own prior to adoption.

Dependent relatives mother and stepmother of widow unmarried or widow sister, provided the father is not alive.

Brothers or step brothers under 21 years of age provided father is not alive, married daughter/step daughter and whose husband is missing for a period of at least seven years (on production of an affidavit provided they reside with and age wholly dependent on the employee. (Passes/PTOs may also be issued to dependent relatives when living with the family of the Railway servant but away from the Railway servant himself.

Attendants-each first class 'A' Pass/Metal Pass or First class pass covers one attendant in II class. The term attendant means a person employed on a salary

in the personal service of the employee on a whole time basis and not part time servant.

Note: Passes & PTOs are admissible to families & dependent relatives whether accompanied by the employees or not but such passes and PTOs may not include more than two dependent relatives + the total number of persons allowable on such a pass or a PTO is limited to five individuals exclusive of attendants.

Periodically declaratives of family composition and dependent relatives be invariably obtained from each employee..

Q.6. What are the rules for service of Post Retirement Complementary passes?

Ans. 6 Gazetted officers + self and family:

- a. With service of 20 years and more-2 sets per annum
- b. With service of 25 years and over –3 sets per annum

Group 'C' staff for self and family:

- a. With service of 20 years but less than 25 years one set per annum
- b. With service of 25 years and over 2 sets per annum.

Group 'D' staff for self and family:

- a. With 25 years of service and over 1 set per annum irrespective of the date of retirement for self and family. Unmarried daughter even if earning is eligible for inclusion in post retirement complimentary passes issued to retired employees. (Widowed mother of retired railway employee may also be included in the post retirement complimentary passes as any other family member of the retired railway employee.

17. MINOR AND MAJOR PENALTIES

Q.7. What are minor and major penalties?

Ans.7. Minor Penalties:

- i. Censure
- ii. Withholding of his promotion for specified period.
- iii. Recovery from his pay of the whole or part of any pecuniary loss caused by him to the government or Railway Administration by negligence or breach of orders.
(c) withholding of privilege passes or PTOs or both.
(b) Reduction to lower stage, in the time scale of pay for a period not exceeding three years without cumulative effect and not adversely affecting pension.
- iv. Withholding of increments of pay for a specified period with further directions as to whether on the expiry of such period this will or will not have the effect of postponing the future increments of his pay.

Major Penalties:

- i. Reduction to a lower stage in the time scale of pay for a specified period, with further directions as to whether on the expiry of such period this will nor will not have the effect of postponing the future increments of his pay.
- ii. Reduction to a lower time scale of pay, grade post or service, with or without further directions regarding conditions of restoration to the grade or post or service from which the Railway servant was reduced and his seniority and pay on such restoration to that grade, post or service.
- iii. Compulsory retirement.
- iv. Removal from service, which shall not be disqualification for future employment under the Government or Railway Administration.
- v. Dismissal from service, which shall ordinarily be a disqualification for future employment under the Government or Railway Administration. Provided that in case of persons found guilty of any act or omission which resulted or would have ordinarily resulted in collisions of Railway trains, one of the penalties, specified in clauses (viii) and (ix) shall ordinarily be imposed and in case of passing Railway signals at danger, one of the penalties specified in clauses (v) to (ix) shall ordinarily be imposed and where such penalty is not imposed the reasons thereof shall be recorded in writing.

18. RAILWAY BRIDGES

Q 8 (a) What is the inspection schedule of distressed bridges by various ranks of officials?
What is category I & category II distressed bridges?

Ans.8 Special inspection of distressed bridges shall be carried out as under:-

Category	Inspected by	Periodicity
I	<ul style="list-style-type: none"> • Inspector (Concerned) • Asstt.Engineer /Asstt.Bridge Engineer • Divisional Engineer / Sr. Divisional Engineer 	Once in a month. Once in two months. Once in three months
II	<ul style="list-style-type: none"> • Inspector (Concerned) • Asstt.Engineer/Asstt.Bridge Engineer • Divisional Engineer / Sr. Divisional Engineer 	Once in three months. Once in six months. Once in a year.

Category I Distressed Bridges: Those requiring rehabilitation to be done immediately, say within a year times.

Category II Distressed Bridges: Those requiring to be kept under observation and to be taken up for rehabilitation on a programmed basis.

Q8(b). What are the different points examined during the course of technical inspection of bridges by a BRI?

Ans: The following points are thoroughly examined during the course of technical inspection:

1. Creep of a girder.
2. Camber.
3. Distortion.
4. Seating of Bearings.
5. Lubrication of Bearings.
6. Condition of Bed Block & H.D. Bolts.
7. Loose Rivets.
8. Lateral Bracings.
9. Position and level of track.
10. Corrosion and painting.
11. Drain Holes.
12. Any serious defect requiring immediate attention.
13. Structural condition of different members.

Q9. What are the various methods for strengthening of distressed arch bridges?

Ans9: One of the following methods can be used for strengthening of distressed arch bridges, depending upon the site conditions.

1. In case of cracks in arches, pressure grouting with cement mortar at a pressure 4 to 6 Kg/cm² is generally quite effective.
2. If pressure grouting is not effective, one of the following alternative methods may be adopted.
 - a) Construction of a suitably designed box culvert under the arch and filling the intermediate space between arch and the box with lean cement concrete.
 - b) Construction of a box culvert abutting one of the abutments, dismantling the other abutment, when the HFL is high or the waterway is inadequate.
 - c) Closed ring jacketing, where a slight reduction in waterway is permissible. Specially designed folded plate design can be successfully adopted in the above case. In all these cases, necessary precautions for jacketing should be followed.
 - d) Where the HFL is high, it may be advantageous to convert the arch bridge into a slab top by suitably raising and strengthening the masonry of piers/abutments and using precast reinforced cement concrete / prestressed concrete slabs over them. Alternatively, arch-relieving girders may be used. The arches can be retrained where there is adequate cushion above them. In other cases, the arch may be dismantled, either during a line block or under temporary relieving arrangement but before placing the slab/girder.
 - e) In some special cases, external (external) jacketing of the arch is resorted to, after relieving the arch by temporary girders.

Q10. What is the difference between limit state method & 'working state method of design of RCC Structures?

Ans10:

Limit State Method	Working State Method.
The object of the design based on limit state concept is to achieve an acceptable probability that a structure will not become unserviceable in its life time for the use for which it is intended.	<ul style="list-style-type: none"> • The basis of this method is that the permissible stress for concrete & steel are not exceeded any where in the structure when it is subjected to the worst combination of works loads.
<ul style="list-style-type: none"> • It is based on plastic design theory 	<ul style="list-style-type: none"> • It is based on elastic design theory
<ul style="list-style-type: none"> • It is referred as non deterministic as the parameters of design are based on prediction. 	<ul style="list-style-type: none"> • It is referred as deterministic because it is presumed that loads permissible stresses and factor of safety are known accurately.

<ul style="list-style-type: none"> • In this method stresses in an element are obtained from the design loads (including load factors) and compared with design strengths (including safety factors). 	<ul style="list-style-type: none"> • In this method, the stresses in an element are obtained from working loads and compared with permissible stresses.
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Q11. What are Indian Railway Bridge Rules? Enumerate various types of loads mentioned in these rules?

Ans 11: Bridge rules are the rules, specifying the loads for designing the superstructure and sub-structures of bridges and for assessing the strength of existing bridges. The various types of loads mentioned in these rules are given as under:-

- Dead Load.
- Live load.
- Dynamic effect.
- Forces due to curvature & Eccentricity of the Track.
- Temperature effect.
- Frictional Resistance of expansion Bearings.
- Longitudinal Force.
- Racking Force.
- Forces on parapets.
- Wind pressure effect.
- Forces & Effects due to Earthquake.
- Erection Forces & Effects.
- Derailment loads.
- Load due to Plassers Quick Relay System (PQRS).

Q12. Enumerate various types of Bearings provided for steel girders? Briefly explain the procedure for greasing of sliding bearings?

Ans 12: Generally, the following types of bearings are provided for steel girders:

- Flat girders.
- Centralized bearings.
- Rocker bearings.
- Roller bearings.
- Oil bath bearings.
- Phosphorous bronze bearings.
- Neoprene bearings.

Procedure for cleaning of sliding bearings is as under:

Greasing of sliding bearings can be under taken under traffic with issue o caution order & line protection for temporary works as per para 806, item (i) of IRPWM. Lifting

is done with the help of jacks of 50 ton capacity. Lifting of girder is only 8 to 10mm ensuring that bearing strip does not lift over locking strip and guide strip, to avoid creep of girder in longitudinal and lateral direction. For lifting, it is not necessary to dismantle the track and requires loosening of fish bolts of track and dog spikes of rails, Steel scrapper is inserted between bearing strip and base plate to remove old grease, dust and dirt. Then clean the contact surface with oil and apply the grease and lower the girder back over base plate. Time required for one end is 15 to 20 minutes. If required, surrounding area of bearing of base plate is cleaned and painted.

Q13. What are the different methods for prevention of corrosion in steel girders? Briefly explain the method of use of protective castings with specification, in areas where there is no severe corrosion?

Ans13: Corrosion can be prevented by any one of the following means:-

- a) Protective coatings by painting.
- b) Metallising – a form of protection by spraying a metal either zinc or aluminum.
- c) Use of epoxy based paints.

Protective Coatings by painting

1. Correct surface preparation of the steel to receive the paint.

This is the most important factor in ensuring good performance, as the presence of rust under the paint film can cause its failure. Removal of rust, oil grease and dirt is also necessary to ensure adequate adhesion of paint films to the surface. The cleaning can be done by any of the following methods.

- i) Manual hand cleaning.
- ii) Cleaning with power driven tools.
- iii) Blast cleaning
- iv) Flame cleaning.

2. Choice of suitable paints.

The following system of paints may be adopted for paintings of bridge girders in areas where there is no severe corrosion.

i) Priming coat:

One heavy coat of ready mixed paint red lead priming to IS: 102

OR

One coat of ready mixed paints zinc chromate priming to IS 104 , followed by one coat of ready mixed paint red oxide chrome priming paint to IS 2074.

OR

Two coats of Zinc Chromate red oxide primer to IS-P-31.

ii) Finishing coat.

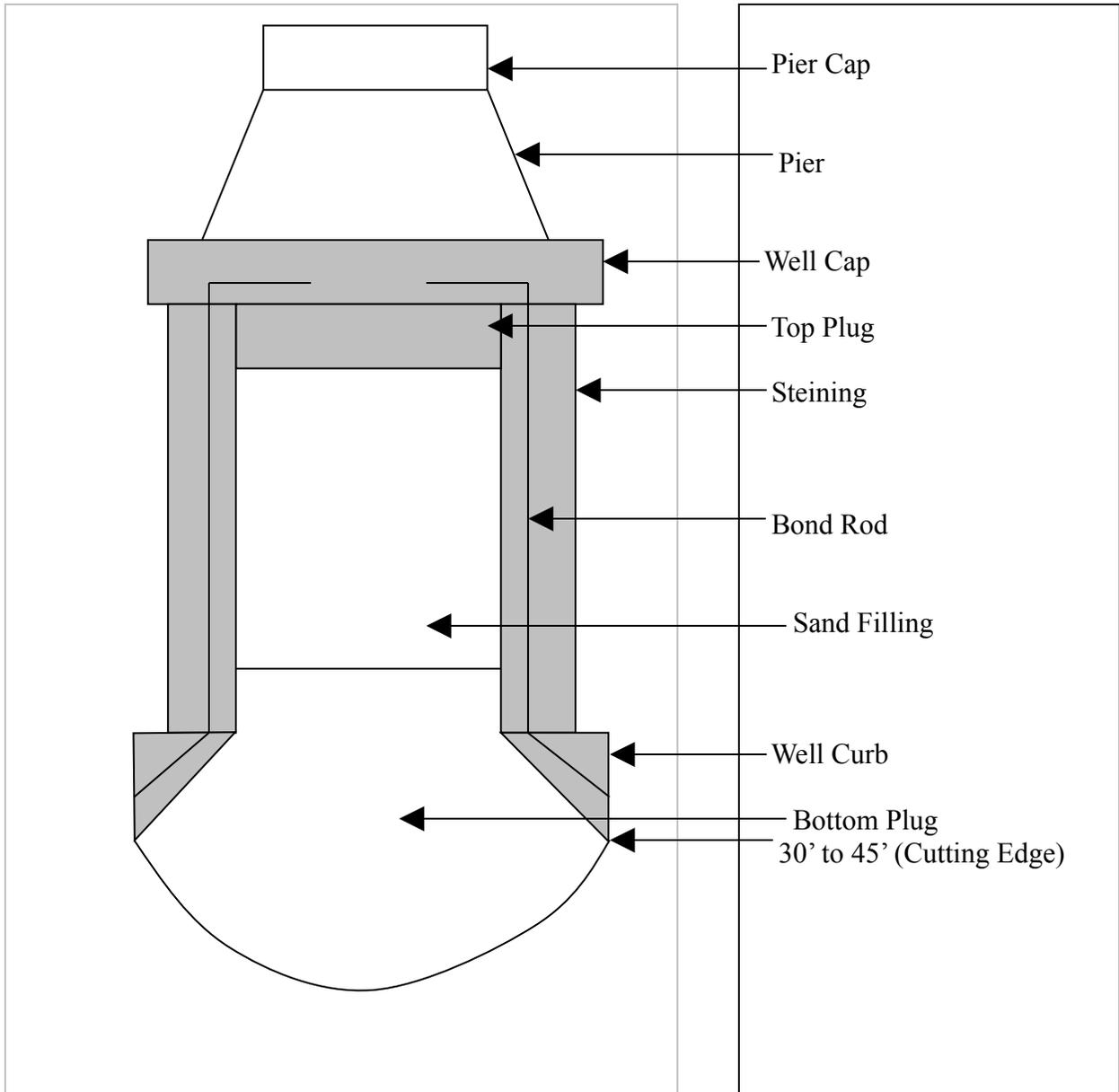
Two cover coats of red oxide paint to IS 123 or any other approved paint applied over the priming coats.

3. Painting procedure:

Prime coat should be applied immediately after surface preparation. Paint should be applied with several vertical / lateral strokes of the brush. Brush should be held at 45° to the surface and frequently turned by 180° subsequent coat of paint should be applied only after allowing adequate drying time for the previous coat.

Q14. Draw standard cross section of a well foundation naming various components?

Ans.14



A TYPICAL CROSS SECTION OF A
WELL FOUNDATION (CIRCULAR)

Q15. What is scour? List various flood records to be maintained for large alluvial rivers?

Ans15: Scour is the erosive action of the running water in loosening and carrying away material for the bed and bank of rivers.

Following are the various flood records to be maintained for large alluvial rivers.

- i) Soundings around piers and abutments during and after high floods.
- ii) Gauge readings of flood level during monsoon.
- iii) Observation of afflux and velocity during monsoon.
- iv) Cross-section of the river during and after floods.
- v) Survey of the river course after monsoon.
- vi) Cross section of guide banks/protection works and their aprons, and
- vii) Annual survey of scours holes.

Q16. What is jacketing? Why it is provided? Explain it briefly.

Ans16: Railways are often required to under take strengthening of existing ridge substructure in connection with works of following nature.

1. Increase in vertical clearance to satisfy codal provision.
2. Regarding of track.
3. Introduction of heavier type of locomotives and other rolling stock with higher longitudinal forces.
4. Increase vertical loads due to replacement of girder with slabs.

With the increase of loadings, due to increased vertical loads, increased earth pressure due to rising of formation levels & increased moments, there is a need to strengthen the substructure by increasing its cross sectional area. It is called jacketing. All cracks should be thoroughly grouted before providing the jacket. For the jacketing to be effective, it has to be taken right up to the foundations and integrated at this level with the existing foundation. The minimum thickness of jacketing should be at least 150 mm.

Q17. What is epoxy grouting? When it is used? Explain the procedure.

Ans17: It is the process of pressure injection of epoxy resins, mixed with hardener in suitable ratio, into the weathered masonry for its repair. Epoxy grouting is used when following properties are required for repairing weathered masonry.

1. Quick setting to allow traffic over newly repaired structures.
2. Low viscosity to fill up hair cracks.
3. Low shrinkage
4. High adhesion to any material
5. Stability at all temperatures.

Procedure:

The surface, over which the epoxy is to be applied, must be strong and sound as well as dry and clean. A "V" groove about 10mm deep is made all along the crack by mechanical or manual means. All loose fragments of concrete are removed by using a jet of air. Nails are driven into the cracks at 15 to 30 cm internals. Holes of 7-10 mm dia should be drilled along the cracks and copper or aluminum pipes or polythene pipes. Pieces 40 to 50mm long and 6 to 9 mm dia are inserted along the nail and allowed to rest on them. All the cracks are now sealed along groove with epoxy Putty. The tubes furnish and unobstructed passage for the epoxy reason into the crack and also forms an outlet for the entrapped air. Epoxy of suitable formulation is injected from the bottom most pipe, keeping an other pipe except the adjacent one blocked by wooden plugs. The injection is done using suitable nozzles connection to air compressors pressure of 3.5 to 7 kg per sq. cm is normally used. As soon as the epoxy comes out from the adjacent open pipe, it is plugged and the pressure increased to the desired level and maintained for 2 to 3 minutes. The injection nozzle is then with drawn and the hole sealed with epoxy mortar. This operation is continued for the other pipes also.

Q18. What is guniting? Explain the procedure.

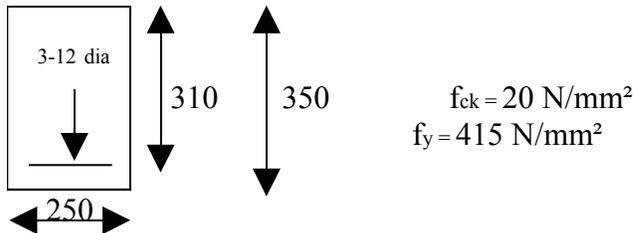
Ans18: It is a process of depositing a dense layer of sand cement mixture for repairing spelled concrete structure or weathered stone or brick masonry. The mortar or concrete is conveyed through a hose and pneumatically projected at high velocity on to the surface short create or gunite is suitable for repairing spelled concrete surface as well as for strengthening weathered stone or brick masonry. For most applications, mortar applied by dry process (guniting) is adequate with concrete (shotcrete), the wet process is adopted. In both the cases, reinforcement in the form of 3 mm dia wire fabric or steel bars up to 16 mm dia may be used as necessary.

Procedure:

All weathered or deteriorated material should be removed until the surface exposed is sound and properly shaped to receive the gunite (Shot Crete) Exposed reinforcement should be cleaned free of rust, scale etc. and given a coat of neat cement or any other anti-corrosive material. The forms, where required, shall be plywood or other suitable material set true to line and dimension. Depending upon on the thickness and nature of the work, reinforcement may consist of either round bars, or welded wire fabric 3mm diameter. The minimum wire mesh spacing should be 50 mm by 50 mm. The cement and sand in specified proportion are premixed and placed in the feeding chamber). The same is then fed into the working chamber through a cone valve controlled from outsider. The mixture, after passing through an agitator is then, carried in suspension by compressed air through the delivery hose to the nozzle. The mixing time shall not be less than 1 minute. As the material passes through the nozzle body, it is hydrated with water introduced in the form of a fine needle spray. The amount of water added is adjusted so that the then in place gunite / shotcrete is adequately compacted and it neither sage nor shown excessive rebound. The mix used generally ranges from 1.3 to 1.4.5 and moisture content of the mixture before placing in the machine should be within 3 to 6%. Uniform air pressure is maintained at the nozzle outlet Up in a number of layers with an internal of about 4 hours. The rebound should not be worked back into the

construction and should be rejected. The surface should be kept continuously wet for at least 7 days.

Q19. What is a Balanced Reinforced beam? Determine the moment of resistance for the section given below using limit state approach.



Ans:19

Balanced reinforced beam:

If the ratio of steel to concrete in a beam is such that the maximum strain in the two materials reaches simultaneously, a sudden failure would occur with less alarming deflection. Such a beam is referred to as a balanced reinforced beam.

Solution:-

$$\begin{aligned} \text{Force of compression} &= 0.36 \cdot f_{ck} \cdot b \cdot x \\ &= 0.36 \cdot 20 \cdot 250 \cdot x = 1800x \text{ N} \end{aligned}$$

$$A_t = 3 \cdot 113 \text{ mm}^2$$

$$\begin{aligned} \text{Force of tension} &= 0.87 \cdot f_y \cdot A_t \\ &= 0.87 \cdot 415 \cdot 3 \cdot 113 = 122400 \text{ N} \end{aligned}$$

$$\text{Force of tension} = \text{Force of compression}$$

$$\text{i.e. } 1800x = 122400$$

$$x = 68 \text{ mm}$$

$$x_m = 0.48 \cdot d = 0.48 \cdot 310 = 148.8 \text{ mm} > 68 \text{ mm.}$$

Therefore, Depth of neutral axis = 68 mm

$$\text{Lever arm 'z'} = 310 - 0.43 \cdot 68 = 281 \text{ mm}$$

Since this is an under-reinforced beam, moment of resistance is governed by steel.

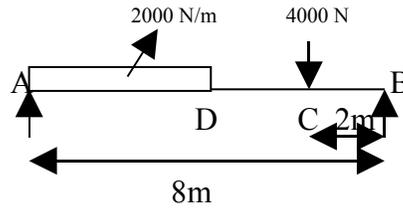
Moment of resistance with respect to steel

$$= \text{Tensile force} \cdot \text{lever arm}$$

$$\begin{aligned} \text{i.e. } M_U &= 0.87 \cdot f_y \cdot A_t \cdot z \\ &= 0.87 \cdot 415 \cdot 3 \cdot 113 \cdot 281 \text{ Nmm} \end{aligned}$$

Or $M_U = 34.4 \text{ KNm}$

Q20 Draw the bending moment & shear force diagram for the simply supported beam with loadings as shown below:



Solution: Taking moments about B,

$$R_A * 8 = 2000 * 4 * 6 + 4000 * 2$$

$$R_A = (48000 + 8000) / 8 = 7000 \text{ N}$$

$$R_B = (8000 + 4000) - 7000 = 5000 \text{ N}$$

Taking a cross section between B&C at x distance from B,

$$M_x = 5000x, \quad F_x = -5000$$

$$F_B = -5000 \text{ N}, \quad F_C = -5000 \text{ N}, \quad M_B = 0$$

$$M_C = 5000 * 2 = 10,000 \text{ Nm}$$

Taking a cross section in CD at a distance x from B

$$F_x = -5000 + 4000 = -1000$$

$$M_x = +5000x - 4000(x-2)$$

$$F_C = -1000 \text{ N}, \quad F_D = -1000 \text{ N}$$

$$M_D = 5000 * 4 - 4000(4-2) = 20,000 - 8000 = 12,000 \text{ Nm}$$

Taking a cross section in AD at x distance from A

$$F_x = 7000 - 2000x$$

$$M_x = 7000x - 2000 \frac{x^2}{2}$$

$$= 7000x - 1000x^2$$

$$F_A = +7000$$

$$F_D = -1000$$

For Max. B.M., $\frac{dm_x}{dx} = 0$

$$7000 - 1000 * 2x = 0$$

$$x = 3.5 \text{ m}$$

$$F_{3.5 \text{ m}} = 7000 - 7000 = 0$$

The maxm. B.M. occurs where shear force is zero

$$\text{Maximum B.M.} = 7000 * 3.5 - 1000(3.5)^2$$

$$= 24,5000 - 12,250 = 12,250 \text{ Nm}$$

B.M. at Centre, i.e. at $x = 4$

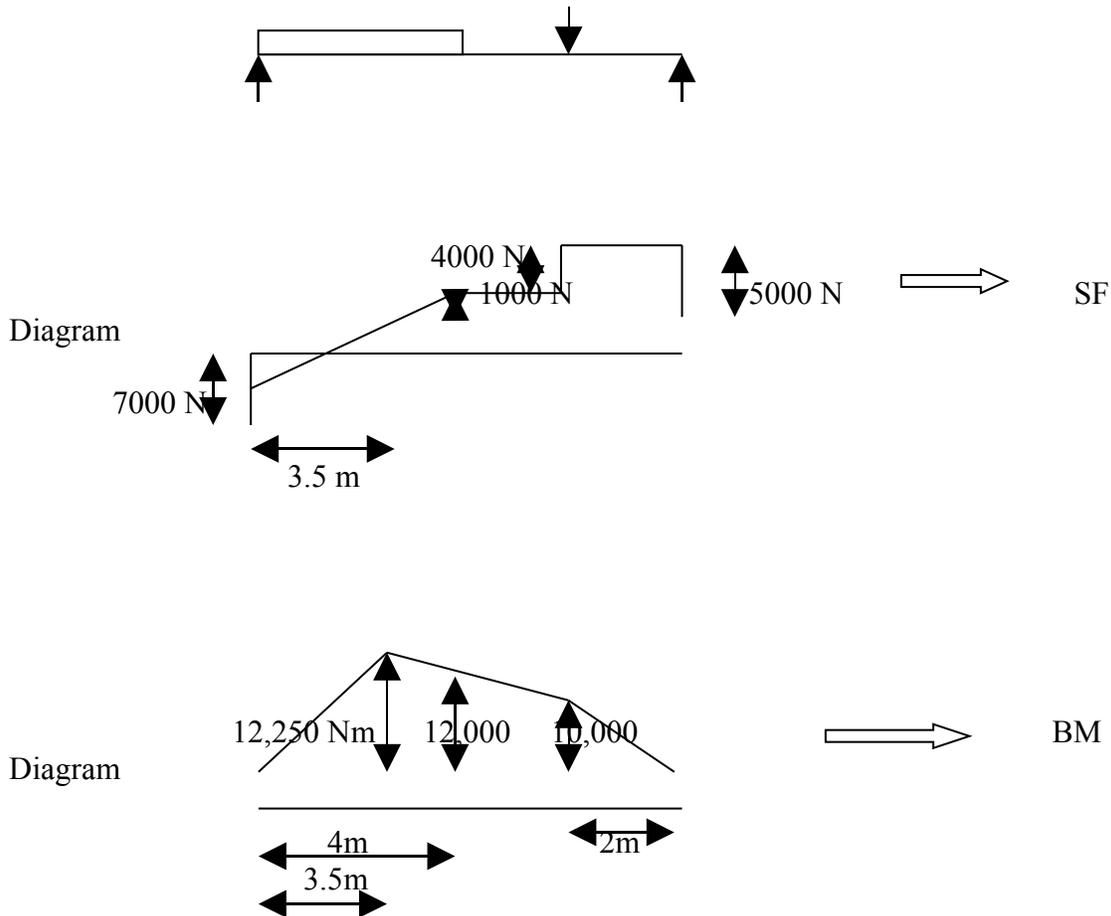
$$M_D = 7000 * 4 - 1000 * 4^2$$

$$= 28,000 - 16,000 = 12,000 \text{ Nm}$$

$$M_{1m} = 7000 \cdot 1 - 1000 \cdot 1^2 = 7000 - 1000 = 6,000 \text{ Nm}$$

$$M_{2m} = 7000 \cdot 2 - 1000 \cdot 2^2 = 14,000 - 4000 = 10,000 \text{ Nm}$$

$$M_{3m} = 7000 \cdot 3 - 1000 \cdot 3^2 = 21,000 - 9000 = 12,000 \text{ Nm}$$

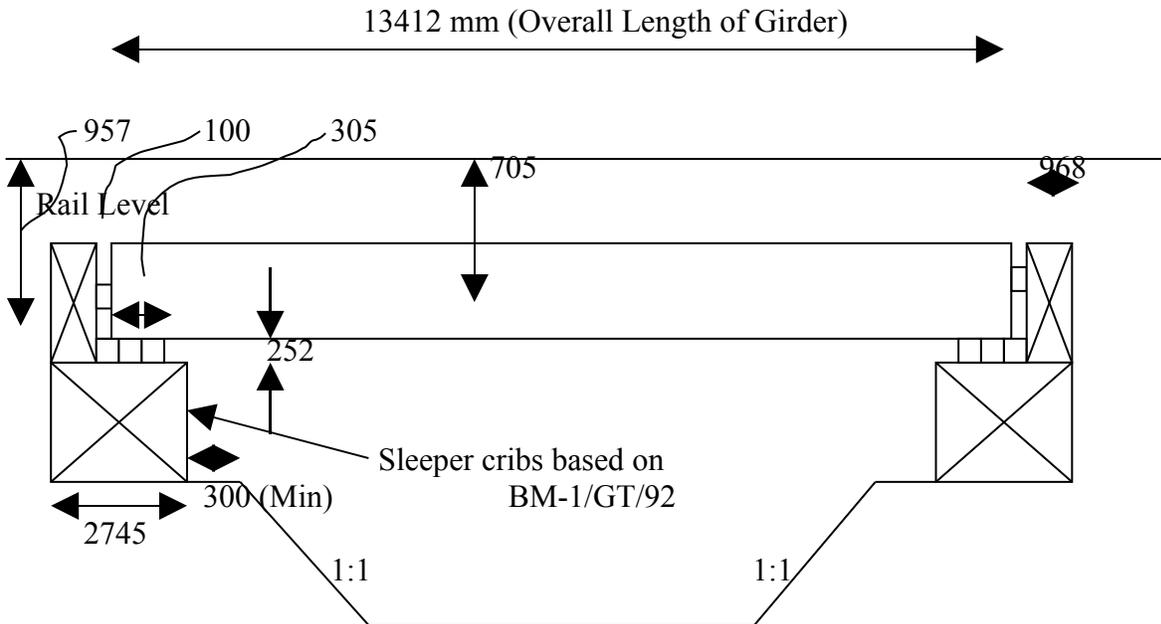


Q21. What are service girders? What are different lengths of service girders available with Northern Railway? Draw a temporary arrangement for a service girder of any length showing its salient features.

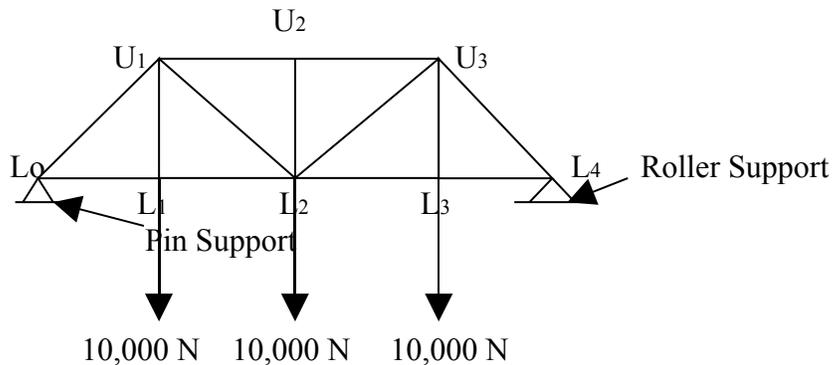
Ans21: These are duplicate girders which are used during temporary arrangement to pass the traffic over them while the repair or construction work goes on. These are made of duplicate RSJ or plate girder sections so that their weight can be kept to a minimum. The service girder come in various lengths, the most common being 45'-0" O.A., 65'-O.A and 87'-4" O.A. lengths . Their corresponding height and weighs are as follows:

S.No.	Lengths	C/C width	Height	Weight in MT
1	45'-0" 0.4	5'-9"	2'-3-1/4	15.67
2	65'-0" O.A.	5'-9"	3-9 3/4	32.5
3	87'-4" O.A	5'-9"	5'-6"	64-0

A Typical temporary arrangement for 45' service girder is shown below:

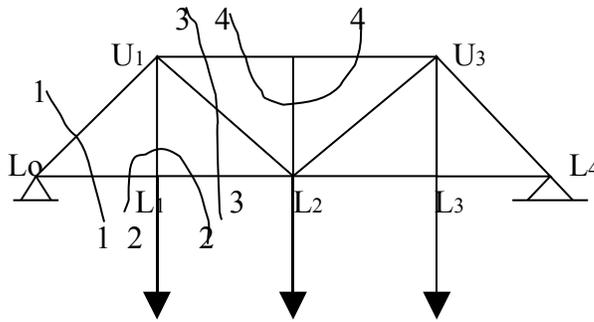


Q22 Find the forces in Pratt –truss loaded as shown below:



Solution:

As the loading is symmetrical, the reactions R_R and R_L will each be 15,000 N. The method of sections will be used & following sections are cut for analysis:



Taking section 1-1 and separating left hand portion

$$L_0U_1 = 15,000 \sqrt{2} \text{ N compressive}$$

$$L_0L_1 = L_0U_1 \cos 45 = 15,000 \sqrt{2} * (1/\sqrt{2}) = 15,000 \text{ N Tensile}$$

Taking section 2-2, round the joint L_1 and separating the portion round the joint from the truss.

$$U_1L_1 = 10,000 \text{ N Tensile}$$

$$L_1L_2 = L_0L_1 = 15,000 \text{ N Tensile}$$

Take section 3-3 and separate the left hand portion to find force in U_1U_2 , take moment about L_2

$$U_1U_2 * 5 = 15,000 * 10 - 10,000 * 5 = 1,00,000$$

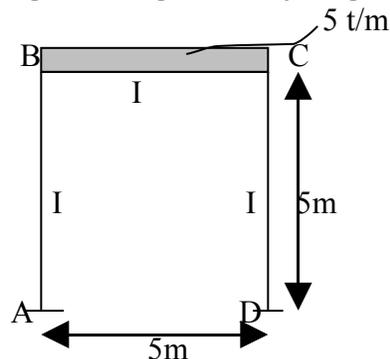
$$U_1U_2 = 20,000 \text{ N Compressive}$$

$$U_1L_2 \sin 45 = R_L - 10,000 = 15,000 - 10,000 = 5,000$$

$$U_1L_2 = 5000 \sqrt{2} \text{ Tensile}$$

Take section 4-4 round the joint U_2 and separate the portion round the joint from the truss
Resolving vertically $U_2L_2 = 0$

Q23 Analyze the following portal frame by 'Moment Distribution Method' & draw BM & SF diagram using free body diagram.



Solution:

Analysis by moment distribution method:

(i) Fixed end moments, $M_{FAB}=0$, $M_{FBA}=0$

$$M_{FBC} = -\frac{5 * 5^2}{2} = -10.42 \text{ t-m}$$

$$M_{FCB} = \frac{12}{12} \times 5 \times 5^2 = 1042 \text{ t-m}$$

$$M_{FCD} = M_{FCD} = 0$$

(ii) Distribution factors:

At joint B, for BA & BC each 0.5 as (I / L) is same
 At joint C, for CB & CD each 0.5

The procedure of moment distribution is tabulated below:

Joint	A		B		C		D
Member	AB	BA	BC	CB	CD	DC	
DF	-	0.5	0.5	0.5	0.5	-	
FEM	0	0	-10.42	10.42	0	0	
Balance	0	5.21	5.21	-5.21	-5.21	0	
Carry over	2.605	0	-2.605	2.605	0	-2.605	
Balance	0	1.303	1.303	-1.303	-1.303	0	
Carry over	0.652	0	-0.652	0.652	0	-0.652	
Balance	0	0.326	0.326	-0.326	-0.326	0	
Carry over	0.163	0	-0.163	0.163	0	-0.163	
Balance	0	0.082	0.082	-0.082	-0.082	0	
End Moments	3.42	6.921	-6.919	6.919	-6.921	-3.42	

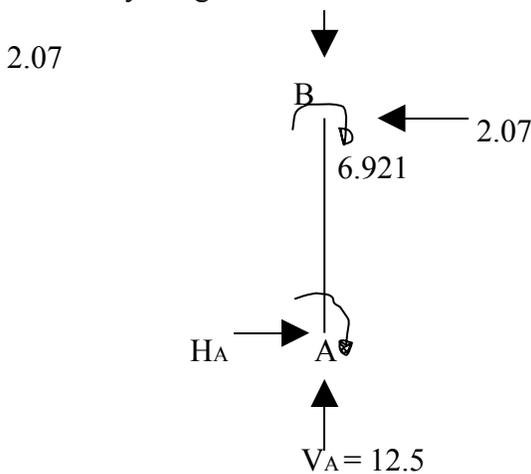
Now vertical reactions can be computed;

$$V_A + V_D = 5 \times 5 = 25$$

Taking moment about A, $V_D \times 5 - 5 \times 5 \times 2.5 - (M_A + M_D) = 0$

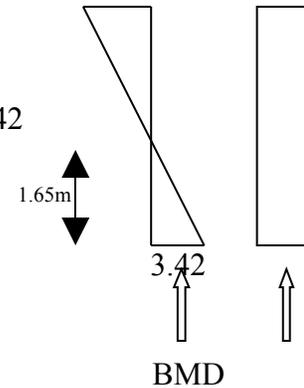
$$V_D = 12.5, V_A = 12.5$$

Free Body Diagrams:



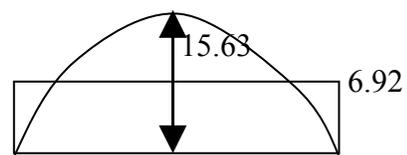
$$H_A \times 5 = 6.921 + 3.42$$

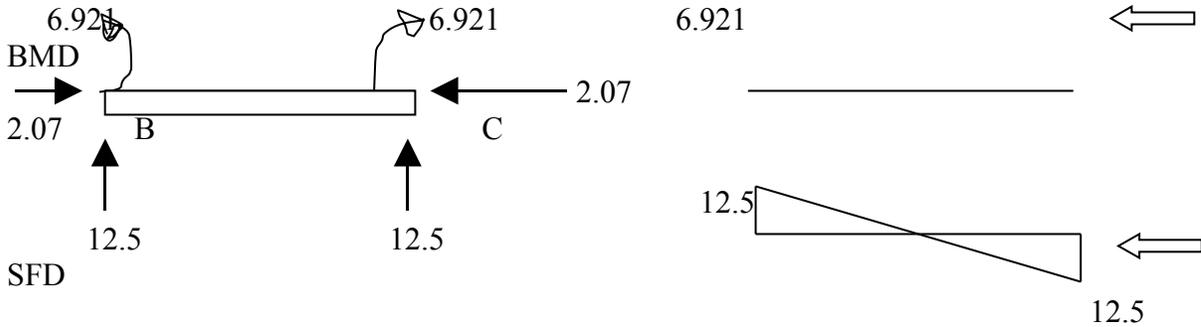
$$H_A = 2.07$$



SFD

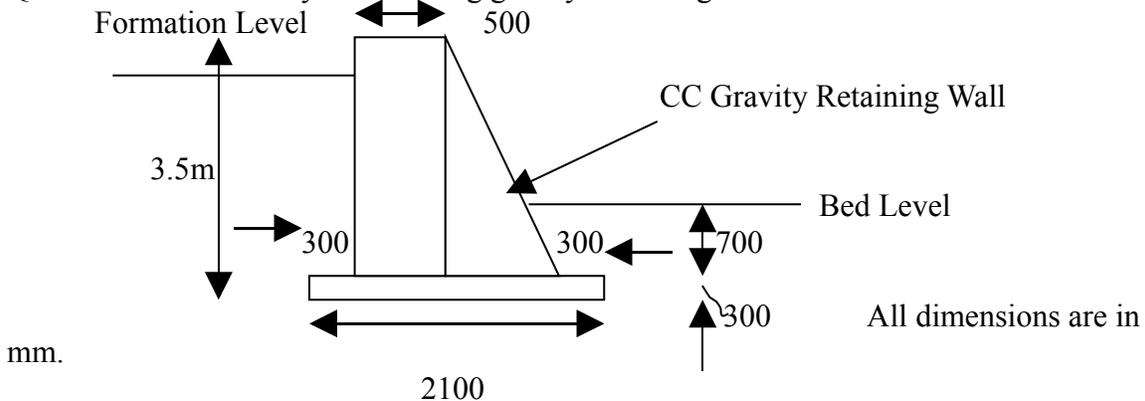
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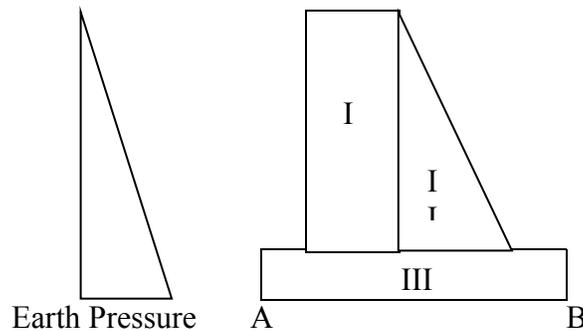
The BMD & SFD for Member CD can be drawn in the same manner as that of Member AB.

Q24. Check the stability of following gravity retaining wall.



Also find out factor of safety against over turning, sliding & base pressures. Take unit wt of concrete = 2.4t/m³ & unit wt of earth retained = 1.9 t/m³. Ignore wt of earth over base footing. Assume active earth pressure co-efficient = 0.3 & water table below the base of the footing. Take co-efficient of friction between soil & concrete= 0.45

Solution:



S.No.	Horizontal force	Vertical Force	Lever arm from B (m)	Overturning Moment (t-m)	Resisting Moment (t-m)
1	Earth pressure = $\frac{1}{2} K_a \rho h^2$ = $\frac{1}{2} * 0.3 * 1.9 * 3.5^2 = 3.49$ t		1.166	4.07	
2		Self wt of I = $0.5 * 3.2 * 2.4 = 3.84$ t II = $\frac{1}{2} * 1.03 * 3.2 * 2.4 = 3.84$ t III = $2.1 * 0.3 * 2.4 = 1.512$ t	1.55 0.966 1.05		5.95 3.71 1.59

Total	3.49 t	9.19 t	4.07t/m	11.25 t-m	11.25 t-m
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$$\text{FOS against overturning} = \frac{\text{resisting moment}}{\text{Overturning moment}} = \frac{11.25}{4.07} = 2.76$$

>1.55 OK

$$\text{FOS against sliding} = (\mu \Sigma V) / \Sigma H = \frac{0.45 * 9.19}{3.49} = 1.18 < 1.55 \text{ Hence not OK}$$

$$\text{Position of Resultant Force from B} = \text{Net moments} / \Sigma V = \frac{11.25 - 4.07}{9.19} = 0.78\text{m}$$

$$\text{: Eccentricity from center} = 1.05 - 0.78 = 0.27\text{m}$$

$$6e = 1.62\text{m} < 2.1\text{m}$$

i.e., Resultant force lies within middle third & hence no tension will occur.

$$\begin{aligned} \text{Base Pressure} &= (\Sigma V/bl) * (1 \pm 6e/b) \\ &= 9.19/2.1(1 \pm 0.771) \\ &= 7.75 \text{ t/m}^2 \text{ at B} \\ &= 1.00 \text{ t/m}^2 \text{ at A} \end{aligned}$$

The wall has inadequate factor of safety against sliding. Hence it is not found stable.

Q25. What are CRN, URN & ORN numbers? Explain in detail the various CRN numbers

Ans:

CRN Numbers

CRN (Condition Rating Number) is recorded for each of the bridge components in the bridge inspection register in the concerned columns/space. The CRNs have numerical values from 0 to 6. The '0' digit indicates that the component was not inspected whereas the numbers from 1 to 6 indicate the severity of deterioration in the physical condition of component in the descending order.

ORN Number

ORN (Overall Rating Number) for the bridge as a whole is proposed from among the various CRN numbers given to the different components of the bridge. It will be lowest, except '0', given to the bridge components.

URN Number

The physical condition of each major bridge is proposed to be represented by a 'Unique Rating number' (URN), consisting of eight digits in which the first digit will represent the URN and each of the subsequent digits will represent the CRN of the different bridge components in the following sequence.

- i) Foundation and flooring.
- ii) Masonry/Concrete in substructure
- iii) Training and protective works
- iv) Bed blocks

- v) Bearings and expansion arrangement
- vi) Super structure – Girder/Arch/Pipe/Slab etc.
- vii) Track structure.
- viii)

The following table gives the CRN and brief description of corresponding condition:

Condition Rating Number 'CRN'	Description
1	A condition which warrants rebuilding, rehabilitation immediately
2	A Condition which requires rebuilding /Rehabilitation on a programmed basis.
3	A condition which requires major/special repairs.
4	A condition which requires routine maintenance
5	Sound Condition
6	Not applicable
0	Not Inspected.

Q26 Enumerate various launching schemes for the erection of steel girders of different spans. Explain any one of them in detail assuming the suitable site conditions.

Ans: Various launching schemes for the erection of steel girders are listed below:

End Launching of Open Web Girder with the help of launching nose	End Launching of Open Web Girder with the help of launching nose	End Launching of Open Web Girder with the help of launching nose
1.	Erection by use of cranes.	Plate girders of spans up to 30.5 m can be placed with the help of two cranes.
2.	Erection with derricks	Used when height of subtraction is less and number of spans are few.
3.	End launching methods. <ul style="list-style-type: none"> a) With rail cluster method. b) By clip lorry method c) Cantilever launching of spans by linking and rolling. <ul style="list-style-type: none"> a) With the help of a BFR. b) With the help of launching pad. 	Used where numbers of spans are few and depth of the bed level below HFL is quite high. It is a safer, more convenient and quicker method for launching of multiple spans up to 18.3m. Avoids provision of staging under the span, front portion of the girder acts as a cantilever. Where access to the new bridges is available by rail; the launching of girders up to 18.3m with this method is ideal. A combination of grillage beams mounted on 4 half sets of clip lorries, used in place of a BFR.
4	Side slewing methods.	The girder is erected over temporary supports & slewed in position.
5.	Launching of triangulated girder on trestles.	The spans of 30.5m and above can be launched by making use of trestles.
6.	Launching of girders by using service span.	A system of pulley blocks is used.
7.	End launching of open web girders with the help of launching nose.	Can be adopted for open web girders where numbers of spans are more and the false work cannot be erected in bed.
8.	Erection by cantilevering method.	Used with the help of an anchor span & derrick crane.
9.	Enveloping method.	Used for replacing of girders of long spans over large rivers where it is difficult to erect any temporary staging on the bed or the piers are very tall.

This method can be adopted for launching of open web girders when the numbers of spans are more and the false work cannot be erected in the bed.

A launching nose fabricated with light sections is connected to the main girder through a suitably designed construction temporary connection. The launching nose can be made of unit construction members and is assembled on rolling arrangements. The girders are temporarily connected one after the other to act as a counter weight. The whole assembly is pulled from the far bank by winches and pulleys and wire ropes. Similar restraining winches are connected at the near of girder assembly to control the movement of the girders. As the launching progresses, and touching the first pier, the deflection can be neutralized by jacking up the nose & providing adequate packing. The launching is continued till the main girders reach their respective supports. The launching nose can then be dismantled and the girders disconnected from each other. The girders are then lowered on to the bearings, already placed on the piers.

19. LAND MANAGEMENT AND USES

Q.1 Describe the category of encroachments?

Ans. There are four categories of encroachments over the Railways. These are A,C,C & D categories. Category 'A' encroachment is of hard type and category 'B', 'C' & 'D' encroachments of soft type.

Category-A: Encroachment by outsiders in the form of cemented structures or other pucca structures. Removal of 'A' category encroachment requires action under PPE Act-1971.

Category-B: Encroachment by outsiders in the form of easements (e.g. temporary occupation of land by hawkers, using railway land for cattle, cowdungs, refuge, opening doors towards railway premises etc.) which do not require action under PPE Act for removal. Such type of encroachments may be removed in consultation and with the assistance RPF, Station Master and Local Civil Authorities.

Category-C: Encroachments by Railway employees in form of huts etc who have not allotted Railway accommodation. D&AR action should be taken to remove such type of encroachments as per Railway Board's letter No. 90/LM(L)/14/34 dated 9.3.1990.

Category-D: Encroachments by Railway employees having railway accommodation and have encroached railway land in the form of extension of structures unauthorized use of land for keeping animals etc. D&AR action should be taken against such encroachers to remove as per Railway Board's letter No. 90/LM(L)/14/34 dated 9.3.1990.

Q.2 Write the short notes on the following terms:

- i) **Lease and License**
- ii) **Security deposit in case of land licensed to outsiders.**
- iii) **Way Leave facilities/Easement Rights**
- iv) **Exchange of Railway land**
- v) **Demarcation of Railway land**

Ans: i) Lease and License:

Railway land is given out on license only. Request of Government Department for lease may considered on merit. Leasing of land is not permitted except in case where it is approved by Railway Board. For Railway land leased/licensed to other Government Departments, the rent should be 6% of market value of land as assessed by Local Revenue Authorities at the time of leasing/licensing.

- ii) Security deposit in case of land licensed to outsiders.

Agreement should provide following details:

- a) Recovery of occupation fees monthly in advance.
- b) Payment of security deposit, equivalent to 12 months occupation fees.
- c) When the duration is one year or more, the 12 months occupation fees should be recovered in advance every year with the grace period of one month.
- d) When the duration is less than one year, full fees for the period should be recovered in advance.
- e) In case of advance occupation fees as per sub para (C) above is not paid by the party within the stipulated period of one month.
- f) In case payment of occupation fees is not made within a further period of three months, the Government shall forfeit the security deposit.

- iii) Way Leave Facility/Easement Rights:

Way leave facility/Easement rights from railway land involve occasional or limited use of land by a party for a specified purpose i.e. passage etc without conferring upon the party any right of possession or occupation of land without in any way affecting the Railways title, possession, control and use of land.

Requests are often received for provision of way leave/easement rights on railway land in the form of passage/access to private houses and establishments of underground pipe lines for water supply and sewerage, electric & telecommunication lines. In many cases these are unavoidable in view of the very nature and extent of railway alignment.

- iv) Exchange of Railway land:

A Railway Administration may at its discretion effect an equitable exchange of land in its occupation for other land equally suited to their requirements with or without a monetary adjustment, the method of transfer following with necessary changes, that prescribed for disposal of land.

- v) Demarcation of Railway land

- a) All land permanently occupied for the purpose of Railway land shall have its boundaries defined on ground.
- b) For this purpose boundary of Railway land may be defined by a continuous wall, fence, posts or pillars.
- c) Where the boundary mark is continuous, boundary of Railway land will be on the outer edge of wall, fence, posts etc.

- d) Where detached marks, such as isolated posts are used boundary of Railway land will pass along outside of such posts, between the marks, the boundary will in each case be taken in a straight line from outside of one mark to outsider of other mark.
- e) Detachment marks should in no case be at a greater distance apart (center to center) than one fifth of Km (200m). They should be of a substantial character not easily destroyed or removed.
- f) Each detached boundary mark should bear a number.
- g) Where a fence, wall or ditch is situated at some distance within the boundary and does not mark the actual limit of railway land, it will be necessary to have actual boundary of Railway land properly marked and defined in accordance with these rules.

Q.3 Describe the position of land under constitution of India under Article 294?

A. General position under Article 294 of constitution of India is that as from commencement of constitution.

- i) All property and assets which immediately before such commencement were vested in his majesty for the purpose of Government Dominion of India and all property and assets which immediate before such commencement were vested in His Majesty for the purpose of Government of each Governor's province shall vest respectively in Union and the corresponding State and
- ii) All rights, liabilities and obligations of Government of the Domino of India and of the Government of each Governor's province whether arising out of any contract or otherwise, shall be the rights, liabilities and obligations respectively of Government of India and the Government of each corresponding State, subject to any adjustment made or to be made by reason of creation before the commencement of Constitution of Dominion of the Pakistan or of the province of West Bengal, East Bengal, West Punjab and & East Punjab.

Article-294 as is evident, relates to succession to property, assets, rights, liabilities in certain cases only.

Q.4 What is the procedure for acquisition of land, describe in detail?

Ans. Following procedure will be adopted for land acquisition.

Application: Whenever land is required for Railway purposes an application should first me bade direct to Revenue Officer In charge of District in which the land is situated for statement of value of land and a draft declaration for acquiring it. Application should set forth clearly the purpose for which land is

required and should have the complete set of land plans prepared in accordance.

When the work of acquisition extends to more than one district lies within the one division application should be made to Commissioner when in more than one division to the Chief Revenue Authority of State.

For better identification of land in cases where the areas to be taken up are expensive, following details should be given to State Government:

- i) Name of the Railway
- ii) Copy of Order of Government when necessary
- iii) Brief description of route to be followed by Railway
- iv) A list of Civil districts in which the land will be required for the purpose

Revenue Officers' estimate of cost of land:

On receipt of application from Railway Administration a responsible Revenue Officer will forward to Railway Administration a statement showing the nearest approximate cost of land also a draft declaration under section '6' of Land Acquisition Act on which it should be recorded there is no objection to acquisition of land.

When the estimated value of land exceeds Rs 25,000 in any one district or one lac in any division, it is necessary that the data should be countersigned by the Commissioner in which land is situated or Chief Revenue Authority of State respectively.

Statement of data received from Revenue Authority should be taken as representing the value of land, exclusive of tenants rights but exclusive of value of houses, trees, standing crops etc on the land the approximate cost of which should be separately furnished by Revenue Authority.

With the information in land the Railway Administration should proceed to frame an estimate (it should be specially mentioned whether or not the land estimate have been prepared from data furnished by Revenue Authority) of total cost of acquisition in detail the additional 15% laid down in section 23(2) of land Acquisition Act on market value of land under section 23 (1) Clause-1 of that Act.

Railway Administration Land Estimates: It should have the following information:

- a) Value of Land:
 - (i) Waste
 - (ii) Arable
 - (iii) Homestead
 - (iv) Bazar

- (b) Value of:
- | | |
|----------------------|---------------------|
| (i) Masonry House | (ii) Trees |
| (iii) Thatched House | (iv) Standing Crops |

Add additional 15% compensation under section 23(2) on the market value of land including houses, trees and crops.

Add market value of Government land taken up
 Add damage under clauses 2 to 6 of Section 23(1)
 Add capitalized value of land revenue (when necessary).
 Add cost of establishment (when necessary)
 Add contingencies

Sanction to land Estimates: General Manager or any other officer duly empowered to sanction the estimate will then accord sanction and allot necessary funds and forward the estimate duly signed Accounts Office together with the draft declaration and duly signed plans and schedules to the State Government for taking necessary steps for acquisition of land. If the sanction of Railway Board is necessary to estimated cost of land Railway Administration should apply for and obtain that sanction before applying to State Government for acquisition of land.

Work bonafide Railway Purpose: As a general rule land may not be acquired except in connection with a duly sanctioned work but this rule does not debar the acquisition of land for bonafide Railway purposes.

In case of urgency Railway Administration are empowered to depart from ordinary rule stated in the previous paragraph and sanction the acquisition of land prior to preparation and sanction of estimate either for work or the land, provided the total probable cost of work is within the power of Railway Administration to sanction.

Q.5 What are the terms and methods for management of land ?

Ans. Terms of Management:

- i) It is the duty of every Railway Administration to preserve unimpaired the title to all land in its occupation and to keep it free from encroachment. This duty will devolve on that authority during the period of such management.
- ii) Utilization to the best advantage of such portions of it as are 'available' and responsibility for all arrangement in connection with their leasing or licensing.
- iii) Justifying, if called upon to do so, its continued retention by Railway or alternately instituting proposals for its disposal.

Method of Management:

To enable management to be conducted on commercial lines Railway Administration are permitted to grant to outsiders or other Departments under lease or license rights and facilities in respect of 'available' land for such purposes.

- i) The leasing or licensing of 'available' land agreeably to their rules for purpose connected with the working of Railway and does not require a reference to a State Government or other authority. State Government or other authority concerned should be consulted whenever the contingent circumstances are such as to render it relevant or advisable, particularly if the alienation is of a quasi permanent nature.
- ii) When Railway land is leased or licensed for a purpose not connected with the working of the Railway no permanent structure should be allowed to be constructed on such land.
- iii) Land in surplus to Railway requirement may be licensed on nominal rent to Railway men's' Co-operative Credit Societies and Consumer Co-operative Societies for the purpose of construction of their own building. The building constructed by these societies should be accordingly to the specifications approved by the Railway Administration concerned so that such buildings may be utilized for staff quarters later.
- iv) Leasing or licensing of Railway land for religious or education purposes for the granting of permission for the erection on Railway land of praying platforms or of new structures to be used for religious purposes or the modification or extension of existing structures will require the sanction of the Railway Board.
- v) In addition to lease/license of land itself, rights pertaining thereto such as grass cutting, grazing, fruits, fishing, mooring etc may be let out by Railway Administration.
- vi) The method by which land is managed by a State Government will be decided by that authority subject only to the conditions on which such management is undertaken.

Q.6 Write the short notes on the following:

- i) Short term licensing
- ii) Safety Zone
- iii) Digitization of land plan
- iv) Reporting responsibilities within Railway premises;

(i) Short Term Licensing:

Temporary licensing of land for conducting exhibitions, melas, carnivals, circus shows and such other cultural activities including temporary shops

on such festive occasions should be permitted subject to maximum of three months with the personal approval of General Manager. The power is not to be delegated to other lower authority.

Rate of license fee should be fixed at 20% of market value of land for shopping etc However, when more than one party is involved, open auction may be done to fetch better value.

(ii) Safety Zone:

Land within the 15 meters on either side of the center line of extreme future track called safety zone. Safety Zone should be free from any encroachment. However, in area coming under Mumbai Urban Transport Project (MUTP) it is the land within 10 m on either side of center line of extreme future track.

(iii) Digitization of Land Plans:

Digitization is the method of converting manually drawn plans drawings, etc in electronic form with the help of Auto CAD and/or scanner so that it is easy for storage updating of plans/drawings. Development of vision LIS (Land Information System) 2000 is very useful for computerization of land plans certified and updated map of Railway land/boundary are available. Digitization will stand security in court of law and helps in easy identification of funds, calculating area and other land management needs.

(iv) Reporting responsibilities within Railway premises:

Responsibility for reporting of new encroachments will be as follows:

- (i) Within station premises including goods sides
 - (a) Station Manager/Station Master In charge he will advise such cases through numbered control message to MTS/Engineering Control through SCNL.
 - (b) Goods Supervisor, wherever posted for Goods shed area.
 - (c) SSE/Works will provide approved plan/diagrams of Station premises indicating clearly Railway boundaries to SM/GS
- (ii) Within the Colony premises:
 - (a) At the HQ of (Sr.) Section Engineer/Works
 - (b) At the non headquarters station of (Sr.) Section Engineer/Works, wherever RPF Inspector is available: RPF Inspector.
 - (c) At other colonies: (Sr.) Section Engineer/Works In charge
- (iii) In between stations: Sr. Section Engineer(P.Way) In charge
- (iv) In areas other than (i) (ii) & (iii): Sr. Section Engineer/Works

Q. 7 Describe Development of properties under GM's power?

Ans; Railway Board has delegated the power for property development. Following procedures should be adopted:

As the floor area is less than 1000 sqm no model agency/PSU need be normally engaged to execute the scheme in terms of Railway Board's extant policy instructions, Railway may directly execute such proposal in respect of selected sites at places other than 4 Metros by adopting a totally transparent procedure of selection for property developer. Following detailed instructions are issued in this regard.

- (i) Preferred arrangement will be to allow the private developer to bid for long terms lease rights over the land/air space in exchange for payment of capitalized lease value to the Railway upfront along with a portion of constructed accommodation for Railways own use. No investment shall be done by Railway and it shall be ensured that the "ownership of title" for the land continues to vest with Railways.
- (ii) In the divisions, the proposals regarding choice of sites and various options available for its exploitation commercially (Including development of shopping complex where the need for them is felt by Railway staff or their dependants), should be processed by a three member committee consisting of DSE/C, Sr. DAO/DAO & Sr. DCM. Divisions proposal duly recommended by DRM should be sent to Headquarters.
- (iii) Division's proposal should be processed by Chief Engineer for FA&CAO's proposal concurrence on file before obtaining the personal administrative approval of GM to the proposal and for calling of members.

Procedure for Tender Finalization:

- (i) Property developer should be selected in a most transparent manner through open tender with two packets system.
- (ii) In this packet system the bidder will submit the conceptual plan, architectural details, credentials and other special terms and conditions as in technical bid. This Technical bid will be finalized in division by three member committee consisting of DSE/C, Sr.DAO/DAO & DCM. Technical bid should be approved by DRM.
- (iii) After the finalization of Technical bid financial bid of eligible bidder should be opened by the division. It should be sent to HQ along with vetted brief. In HQ financial bid should be processed by the Tender Committee as follows.

Value	Constitution of Tender	Accepting Authority
Upto Rs 8 crores	CE/G, FA&CAO/B&E and CCM/G	GM
Above Rs 8 crores	Case will be forwarded to Board for approval with GM's appreciation	

This issues with the concurrence of FA&CAO and approval of GM/Northern Railway.

Q. 8 Define the validation 32 of 1958?

Ans Notwithstanding any judgment decree of order of any court, anything done or any action taken (including rules for orders made notices issued, evictions ordered or effected, damages assessed, rents or damages or cost recovered and proceeding initiated) or purported to have been done or taken under the public premises (Eviction unauthorized occupants) Act 1958 (32 of 1958) shall be deemed to be as valid and effective as if such things or action was done or taken under the corresponding provision of this Act which under such section (i) of Section-1 shall be deemed to have come into force on the 16th day of Sept. 1958 and accordingly –

(a) No suit or other legal proceeding shall be maintained or continued in any court for the refund of any rent or damages or costs recovered under the 1958 Act where such refund has been claimed merely on the ground that the said Act has been declared to be unconstitutional and void and

(b) No court shall enforce a decree or order directing the refund of any rent or damages or costs recovered under the 1958 Act merely on the ground that the said Act has been declared to unconstitutional and void.

Q.9 Define Bar of jurisdiction ?

Ans No court shall have jurisdiction to entertain any suit or proceeding in respect of eviction of any person who is in unauthorized occupation of any public premises or the recovery of arrears of rent payable under sub section (1) of Section-7 or the damage payable under sub section (2) of that section or costs awarded to the Central government or the corporate authority under sub section (5) of Section-9 or any portion of such rent, damage or costs.

Q.10 Describe removal of encroachment from Railway land in Delhi area under Rehabilitation and Resettlement Policy: ?

Ans In terms of Board's letter number 2000/LML/13/31 dated 22/10/01. Northern Railway was permitted to bear part cost of resettlement and rehabilitation (R&R) of encroachment on Railway and required for execution of sanctioned projects in the National Capital Territory of Delhi as per the policy of State Government which has been approved by the Ministry of Urban Development. The cost of R&R in such cases is chargeable to the project.

It has now been decided that Northern Railway may bear part cost of R&R as per policy of Government of NCT of Delhi for removal or encroachment falling within the safety zone also within the jurisdiction of NCT of Delhi subject to observance of the following conditions:

- (i) Genuineness of encroachments should be decided on joint survey carried out by representative of Commissioner (Slums) and Northern Railway as per procedure laid down in R&R Policy of Delhi State.
- (ii) Participation in R&R Scheme will be applicable only for the area notified as safety zone. A Committee constituted by GM will visit the areas, recognized the safety hazards and identify the length to be cleared. Thereafter the genuineness of encroachments should be established through a joint survey with Commissioner (Slums) and only those who are pre 1998 encroachers should be included for benefits as per their R&R Policy.
- (iii) Appropriate records in regard to identification of persons who have been rehabilitated should be maintained to avoid any fresh and duplicate claims.
- (iv) Since the allotment of land is subject to the out come of the SLP suitable under taking should be obtained from the persons to be evicted to this effect making them liable to refund the compensation in case the final verdict of the Supreme Court so demands.
- (v) Proper fencing and appropriate plantation should simultaneously be done to guard against repeated encroachments

Q. 11 What are the duties described for maintenance of Land record in Divl. & HQ Office ?

Ans Land Records in Divisional/Executive Engineers' Office

- a. Divl. Executive Engineer shall be responsible to ensure that the records of title and carefully preserved and kept up to date. All

- land plans should show complete dimensions preferably with boundary stone and their numbers.
- b. Land Record Register in prescribed format should be entered and duly initialed Divl. Executive Engineer as and when transaction taken place
 - c. After land acquisition proceedings are completed the original papers viz. the notifications, awards, certificates of handing over and taking over of land and final land plan and schedule signed by Collector should be separately bound together and carefully preserved.
 - d. Mutation entries should be completed as early as possible in a sustained follow through of land acquisition process.
 - e. Final land plans, after mutation entries should be sent to CE's office for safe custody.
 - f. In case of construction projects involving land agreement, it will be the responsibility of construction Engineer to hand over the land acquired free of all encroachments and along with all records to open line Engineers.

Details of HQ Level

- i) A complete series of land plans for entire railway should be maintained in Executive Engineer's office. Original tracing duly certified by State Government should be kept as permanent record in CE's Office. No noting should be made on certified plans
- ii) Land record rights should be maintained in CE's office as per the permissible format in which all details of transactions acquisition should be noted.
- iii) Land Registers, Engineering Register, Land plans should be maintained by divisional officials. should be checked by HQ Officers.
- iv) All certified land plans digitized by division should be sent to HQ for safe and proper record.

Q.12 Describe the licensing of Railway land to Welfare Organization, Private School etc.

- Ans.
- (a) For Railway land to license to temple committee, Railway co-operative stores, co-operative societies, handicrafts centers and other welfare organizations a nominal fee as per extant rules should be recovered.
 - (b) the license of Railway land for education purpose will require the sanction of Railway Board for privately owned school, Kendriya vidyalas setc. nominal fee should be charged. The nominal fee should be levied as per extant rules. The period of

lease for railway land required by the State Government for opening of new schools for children of railway employees should not exceed 30 years. In case of Railway land leased to Kendriya Vidyalaya the lease period will be 99 years.

Q.13 Describe the procedure for disposal of surplus land ?

Ans When it has been decided that a certain or surplus area of the land is no longer required by any department of railway and that it is therefore eligible for disposal the following procedure should be adopted.

1. If the land adjoins or in near vicinity belonging to any other Railway or Deptt. of Central Government it should first be offered. If one of these desires to acquire it a formal record of transfer should be made.
2. The State in which the surplus land is situated will be given the option of assuming possession of the whole portion. There of subject to following conditions.
 - a) Central Government themselves shall be the judge of whether they require to retain any particular land or not.
 - b) State Government desires to assume possession of land the option to do shall be exercised within 6 months.
 - c) Amount payable for land will be market value at the date of transfer.
 - d) If the State Government do not desire to assume possession of any land Central Government will be free to dispose it of to a third party. Government will consult the State Government as to the levy of ground rent and conditions if any subject to which it should be sold and they will, as far as possible dispose of the land.
3. If State Government is unwilling to ensure possession the land should be disposed of to the best advantage.
4. If no any department desires to acquire the land then the Railway men's Co-operative Society requested for the same land can be relinquished after obtaining necessary clearance from the respective State Government.
5. If neither Railway nor a department of Central Government nor the State Government desire to acquire the land, the land should be retained by the Railway Administration.

Q.14 Define in detail regarding extension of plot of land, change of ownership etc?

Ans. Following steps to be considered in case of extension of plot of land and change of ownership.

1. In case where plot holders are running their business on behalf of original licensees on power of attorney, the present plot holder may be asked to apply a fresh for allotment of the same in their name. The rate of license fee should be fixed at 20% of market value of land as provided in Board's letter No. 83/W2/LM/18/87 dated 29.8.1995, subject to realization of all outstanding dues with 7% interest before entering into fresh agreement as one time exception with the condition that plot/shop should not be transferred or sold on power of attorney to any one. Any violation in this regard would be viewed seriously.
2. In cases where original licensees are originally unfit to perform their functions, the ownership may be transferred to the legal heir subject to the verification of the unfitness from a Government Hospital and furnishing of legal heir certificate. The transfer however, will be as per the latest terms and conditions whenever the identity of legal heir is not established, the license should be cancelled.
3. Regarding extension of area of existing plot/stall it is clarified that in view of the ban on licensing of land for the purpose not connected with Railway working no further extension can be allowed.

Q.No. 15 : Describe the terms and condition for utilization of railway line for
Grow more food

Ans.:- Railway Land can also be allotted to Group 'C' & 'D' railway employee with the following terms and conditions.

1. Railway land in urban area under threat of encroachment should be licensed for cultivation.
2. Preference should be given to SC, ST, OBC and economically weaker section of society.
3. Before allotment it should be ensured that land would not be required for railway in nears future.
4. Land should not be licensed to outsider or State Govt. or State Undertakings.
5. Size of plot should be from 1 to 3 acres. On specific request upto 5 acres may be allotted.
6. Suitable agreement should be signed by Rly. and allot tee and that plot should not be transferred to other employee or outsider.
7. An undertaking should be taken from employee that the official duties should not be suffered on account of such activity for cultivation.
8. An NOC from the Engg. Department should be obligatory before payment of settlement dues.
9. No licensed should be issued to employee who have less than 5 years of service left and license must be taken back at least 3 years before the due date of retirement.

10. Period of licensing should not exceed 5 years at the stretch to any particular employee.
11. The initial licensing for 2 years shall be issued by division and subsequent extension after recovery of license fee can be done by AEN upto total maximum period of 5 years.
12. Water arrangement shall be made by licensee on his cost.
13. Rly. Administration shall have every right to inspect the premises at any point of time.
14. License fee may be fixed according to the needs and merit of each case. License fee may be revised by DRM in consultation with Sr.DAO every year.
15. License fee for every year should be recovered in full in advance along with a security deposit before renewal of license.
16. Details of plots licensed under this scheme should be maintained by IOW/AEN for his jurisdiction, also in divisional Headquarters.
17. The registers in the office of IOW, AEN should clearly indicate the location area, allotted the authority letter for initial license, the approval of extension of license granted and details of monies paid as license fee. Authority for extension being with the AEN. The AEN shall personally ensure that the register be maintained upto date.

Q.No.16: Describe the procedure to taken up the action under PPE Act. 1971.

Ans.:- A hard type encroachment in the form of cement structure falling under category 'A' of encroachment should be removed under PPE Act 1971.

Section 10A:- Appointment of Estate Officer.

A Gazetted officer of Rly. Administration may be appointed as Estate Officer & should be notified in gazette by Central Govt. for purpose of PPE Act proceedings.

Section 10B :- Eviction from Railway Land.

- (i) If the force have a prima facie reason to believe that the person have occupied Rly. land within a period of 6 months. It shall file an application before Estate Officer as the case may be seeking an order to enter such Rly. land & to remove such person.
- (ii) If the State Officer after making such inquiry as he deems expedient in the circumstances of the case, is satisfied that any person who were allowed occupation of any Rly. land, temporarily or on contract basis or by virtue of its appointment are in unauthorized occupation of said Rly. land. It may for the reason to be recorded in writing make an order for eviction of such person forth with and there upon if such persons refuse or fail to comply with said order of eviction he may evict them from the premises and take possession there of and may for that purpose take the help of RPF as may be necessary.
- (iii) When the force intends to enter the Rly. land to remove the encroachment it shall make an application to the State Officer for seeking permission to enter

the such Rly. land and Estate Officer after satisfying himself may grant such permission to the officer of force not below the rank of Sub inspector.

Section 10C :- Power to remove unauthorized construction.

- (i) No person shall erect or place any building on Rly. land except in accordance with authority under which he was allowed to occupy Rly. land.
- (ii) If the building or immovable structure have been place Estate Officer should serve a notice asking the encroacher to remove the structure within 7 days of notice. On refusal of such person to remove the encroachment Estate Officer shall direct the force to remove the encroachment.
- (iii) When erection of Building or execution of work have been started or is being carried on or has been completed Estate Officer may in addition to any other action that may be taken under this act. Make an order for reason to be recorded and directing that such a erection shall be demolished by the person at whose instance the erection has been started or carried on or has been completed.
- (iv) It will be lawful for the Estate Officer at any time before or after making an order of demolition under the aforesaid sub-section to make an order directing the sealing of such a erection.
- (v) No person shall remove such seal except under an order of Estate Officer or under an order of appellate officer.

APPEAL: An appeal shall lie from any order of Estate Officer made in respect of railway line to railway claims tribunal having territorial jurisdiction over the area in which railway land is situated within a period of 30 days from such order provided that tribunal may entertain the appeal after the expiry of said period. If it is satisfy that the appellant was prevented by sufficient cause from filing the appeal in time.

Passing of order: EO may pass the order to give such direction as may be necessary to give effect to its order to remove the encroachment.

Execution of order: When the EO passes the order to remove the encroachment the person shall comply immediately with such direction and handed over the possession to railway administration otherwise EO shall direct the RPF to take the possession and delivered the same to railway administration.

Question-17: Define Estate Officer what are its powers.

E.O.: Central Govt. may by notification in Gazette appoint such person being gazetted officer of Rly. Administration to be Estate Officer to deal with the cases & shall define the local limits within which or the categories of Railway land in respect of which to EO shall exercise the power conferred and perform the duties imposed

Power of E.O.:

1. Where any person is in a arrear of rent payable in respect of Railway land. EO may by order or require that person to pay the same.
2. When any person has unauthorized occupation of Railway land EO may remove such encroachment by order or with the help of force.
3. He is empowered to recover the damages made by any unauthorized person.
4. Summoning and enforcing the attendance of any person or examining him on oath.
5. He may require the recovery and production of documents.
6. Execution of order passed by him or by appellate authority.

Question-18: Procedure order for detection. Prevention and removal of encroachments?

Answer: Following action will be taken for prevention detection and removal of encroachment.

1. Encroachment over railways land cause hindrance to railway working and put consideration pressure of civil amenities for passenger and railway staff. So in order to prevent the encroachment railway land and premises should be demarcated in visible and intelligible manner
2. Types of encroachments:
 - a. Category 'A': Encroachment of hard type by the outsiders in the form of cemented structures may be temporary or permanent for commercial. Housing or other purposes.
 - b. Category 'B': Encroachment of soft type by the outsiders e.g. unauthorized way leave facility such as door opening into railway area drainage into railway area throwing refusal and use of railway land for cattle etc.
 - c. Category 'C': Encroachment by Railway staff in the form of temporary constructions etc.
 - d. Category 'D': Encroachment by railway staff who have been allotted railway accommodation, by way of addition/alteration to the structures, unauthorized cultivation of land etc.

3 Reporting responsibilities of encroachment

3.1 Within station premises including goods sheds

Station Master/Station Master In charge of station.
Goods Supervisors, wherever posted for goods shed area.
SSE/Works will provide approved plans/drawings.

3.2 Within the colonies premises.

At the Headquarters of SSE/Works –SSE In charge.
At non-Headquarters Stations of SSE/Works –RPF Inspector.
At other colonies –SSE /Works In charge.

3.3 In between stations
SSE/P.Way In charge

3.4 Areas other than 3.1, 3.2 and 3.3
SSE/Works

4. REMOVAL OF ENCROACHMENT

4.1 NEW ENCROACHMENT AND TRESSPASSING.

4.1.1 Immediate action should be taken to stop the encroachment by SSF (Works)/SSE(P.Way)/Station Manager/Station Master/Chief Goods Supervisor/RPF Inspector where encroachment is incipient and is in the process. It is easier to prevent encroachment at this stage by awareness, persuasion, watch and ward, show of force etc.

4.1.2 Wherever persuasion by the Railway authorities does not yield any result the concerned railway officials as per 3 would make all efforts to stop the construction even by use of Police force as per law, if necessary. He will report the matter to concerned (Sr.) Section Engineer. (Works) In charges through control message/special messenger.

4.1.3 On receipt of intimation for new encroachment, Section Engineer (Works) shall remove the encroachments under section 147 of Indian Railway Act 1989 within seven days time. He shall be assisted by the concerned SM, Goods Supervisor (Goods shed and station premises), RPF Inspector, and other staff available at the station.

The RPF Inspector/Official in charge of the areas will provide full assistance to the SSE(Works) SSE(P.Way). He shall arrange for extra force, if necessary, from the Divisional Security Commissioner or the local Officer-in-charge of the Police station and provide augmented police assistance. In station and Goods sheds premises, SM/GS shall also provide full assistance to the SSE(Works)/SSE(P.Way).

4.2 OLD ENCROACHMENTS.

4.2.1 Old encroachments (Category 'A') shall be removed as per procedure laid down under PPE Act, 1971. As soon as the decision is given by the court of Estate Officer, the SSE(Works) shall take suitable steps in removing the encroachments as per the order of the court. He shall be assisted by the concerned SM (Goods shed and Station premises) and RPF Inspector. The DSC/ASC/RPF Inspectors in charge of post will coordinate with local police officers for assistance.

4.2.2 Soft encroachments and trespassing (Category 'B') shall be removed without recourse to the PPE Act, 1971. These encroachments shall be removed under Section 147 Indian Railway Act, 1989.

- 4.2.3 In case of any encroachments by the railway employees (Category 'C; & 'D'), D&AR action shall be taken by the Controlling Officers. Simultaneously, SSE (Works) shall remove such encroachment and cost of removal shall be advised to the Controlling Officer for recovery through salary of the employee.

.Q.No. 19: Describe the guidelines/Instructions regarding tree plantation in Railway Land by State Forest Department..

Ans.:- General Guide Lines for Tree Plantation in Railway Land by State Forest Department.

1. The row of trees should be planted as close to the land boundary as possible on each side of track. Existing boundary pillars should not be disturbed.
2. The distance between the rows and between the individual trees may be kept such that maximum numbers of trees are planted.
3. No tree should be planted within 6 m (20') of the Center line of track. There should be no tree plantation between outer signal/sighting boards or either side of the station on the side on which signals and signal overhead alignments are provided. Similarly no tree should be planted within 3 m (10') under any A.C.S.R./Signal/Telegraph alignments. Only flowering shrubs can be planted at these locations.
4. No tree shall be planted inside of curves to avoid obstructions in visibility.
5. The Forest Departments will notify concerned Railway Officials before planting trees so that they may consider all safety aspects before taking up plantation.
6. Along railway line on approaches to Railway shrubs should be planted.
 - (a) Within 6 m (20') track, only ornamental shrubs should be planted.
 - (b) Beyond 6 m to 9 m (20' to 30') ornamental trees like amaltas, gulmohar, pride of India etc.
 - (c) Beyond 9 m (30') up to boundary post. Euclyptus, Babul, Mango, Sheesham, Teack etc.

Q.No. 20: Describe the procedure for const. of houses for public sector undertaking under ministry of Railways.

Ans.:- Following conditions for const. of houses for public sector undertaking under ministry of Railways to be considered.

There is general shortage of houses for officers and it has been decided that Railway PSUs may be allowed to construct houses on Railway land to overcome the shortage of houses on terms and conditions as mentioned below: -

1. Of the total number of flats constructed by Railway PSU, 50% will be for use by the Railway Administration and the remaining 50% will be licensed to the Railway PSU at normal license fee of Rs. 1000/- per annum per house, which may be paid annually.
2. The Railway PSU concerned will bear full cost of construction on Railway land. The developments of surroundings and provision of services like road, water/electric connections, telecom and drainage and lifts etc. Would also be provided by the PSU constructing the quarters.
3. Ownership of the land and structure thereon will continue to be with the railways and Railway will only license out 50% houses to the PSU. PSU at no stage will sell/Sublet for transfer these flats or any of the services to any other individual/authority.
4. Maintenance of the flats licensed to the PSU will be done by the concerned PSU. It should be ensured that proper maintenance to be done by PSUs so that at the time of handing over these houses to the Railways, they are in safe condition as at the time of aging over except the natural aging. All the taxes payable on these flats to the concerned civil authority will also be paid by PSU. The electric and water charges should be recovered as per rules from the officers of PSUs and remitted to Railways.
5. No structural change whatsoever will be made by the PSUs in the flats.
6. These flats will be licensed for a period of 30 years from the date of handing over of the flats to the PSU or till such time it exists or remains attached to the Ministry of Railways, whichever date falls earlier. After this period, the flats allotted to the PSU will be taken over by the Railways without any compensation/payment whatsoever to the PSU.
7. Railway will have unrestricted and unconditional authority to enter the premises by its authorized representative for inspection or for safety of for any other purpose as and when required.
8. These houses will be allotted only to railway officers on deputation to the concerned PSUs or who have come on absorption. The allotment and retention of these houses will be governed by the Railway rules and consultants/Advisers to PSUs will not be eligible.

20. SUBJECTIVE QUESTIONS ON PLANNING & DESIGN

Q.No.1. What are various plan heads for preparing works programme? Describe in short?

Ans: Various plan-heads for preparing the works programme are described below.

- 1) TRAFFIC FACILITIES-PLAN HEAD NO.16: This plan head concerns to: -
 - i) Line capacity works.
 - ii) Terminal facilities.
 - iii) Overhead tanks.
 - iv) Drainage in the yard
 - v) Guards and Driver's Running Rooms.
 - vi) Water coolers
 - vii) Goods platforms and
 - viii) Goods shed.
 - ix) New Station Buildings.
 - x) First Foot Over Bridge.
- 2) BRIDGE WOKS-PLAN HEAD NO.32: This plan head concerns to -
 - (1) Road Over Bridges/Road Under Bridges
 - (2) Rebuilding of Bridges and
 - (3) Training school for Bridges.
- 3) OTHER ELECTRICAL WORKS-PLAN HEAD NO.36: This plan head concerns to establishment of power houses, provision of Traction Sub-Station, improvement to power supply etc.
- 4) SIGNALING & TELECOMMUNICATION WORKS: PLAN HEAD NO.33: This plan head concerns to-
 - i) Provision of track circuiting
 - ii) Provision of lifting barriers.
 - iii) Provision of telephone.
 - iv) Interlocking of Level crossing and
 - v) Manning of un-manned level crossing.
- 5) WORKSHOPS INCLUDING PRODUCTION UNITS PLAN HEAD NO.42: This plan head concerns to-
 - (1) Modernization of sick lines.
 - (2) New Diesel shed for BG Main Line.
 - (3) Trip schedule facilities for Diesel Locos.
 - (4) Improvement of wagon sick line.

- (5) Provision of POH facilities.
 - (6) Extension of electric Loco shed.
 - (7) Power supply arrangement.
 - (8) Provision of facilities for POH of A.C. coaches and power cars.
 - (9) Setting up of concrete sleeper plant.
 - (10) Augmentation of Training facilities.
 - (11) Store depot
 - (12) Printing press etc.
- 6) STAFF QUARTERS PLAN HEAD NO.51: This plan head concerns to Staff Quarter facilities.
- 7) AMENITIES FOR STAFF PLAN HEAD NO.52: This works concerns to
- (1) Improvement to quarters.
 - (2) Electrification of Quarters.
 - (3) Provision of bio-latrines and
 - (4) Provision of Barat Ghar, Schools etc.
 - (5) Medical facilities viz. Hospital, Health unit etc.
 - (6) Staff Recreational facilities viz. club, swimming pool, play ground etc.
- 8) PASSENGER AMENITIES PLAN HEAD NO.53: This plan head concerns to
- (i) Waiting Hall.
 - (ii) Retiring Room.
 - (iii) Electrification of Railway Station & Halt station.
 - (iv) Raising, lengthening, widening and surfacing of platforms.
 - (v) Catering units like Refreshment Rooms, Tea stalls etc.
 - (vi) Washable apron.
 - (vii) Addl. F.O.B.
 - (viii) Foot Over Bridges
 - (ix) Platform and Platforms shelters.
- 9) OTHER SPECIFIED WORKS PLAN HEAD NO.64: This plan head concerns to
- i) Stores, Barracks for GRP Staff,
 - ii) Office Administrative Building,
 - iii) Conversion of Halt station to Flag Station,
 - iv) Training school for ZTS/CH School only,
 - v) Train indicator Boards at Stations,
 - vi) Architectural face lifting of stations,
 - vii) Yatri Niwas.
- 10) ROAD SAFETY WORKS PLAN HEAD NO.29: This plan head pertains to L-Xing works.
- 11) ROAD SAFETY WORKS -PLAN HEAD NO.30: This plan head concerns to RUBs/ROBs Repl. of L-Xing by RUBs or ROB, Provision of ROB/RUB.

Q.No.2: Describe various Type of Estimates?

Ans: Various types of Estimates are as follows:–

1. Abstract Estimate.
2. Detailed Estimate.
3. Supplementary Estimate,
4. Revised Estimate.
5. Project Abstract Estimate.
6. Construction Estimate.
7. Completion Estimate.

a) **Abstract Estimate:** An abstract estimate is prepared in order to enable the authority competent to give administrative approval; to the expenditure of the nature and the magnitude contemplated to form a reasonably accurate idea of the probable expenditure and such other data sufficient to enable that authority to gauge adequately the financial prospects of the proposal. Abstract estimates avoid the expense and delay of preparing estimates for works in detail at stage when the necessity or the general desirability of the works proposed has not been decided upon by competent authority. An abstract estimate should contain a brief report and justification for the work, specifications, and should mention whether funds are required in the current year and to what extent. It should also show the cost subdivided under main heads and sub-heads or specific items, the purpose being to present a correct idea of the work and to indicate the nature of the expenditure involved. The allocation of each item as between capital Development Fund, Open Line works-Revenue, Depreciation Reserve Fund and Revenue should be indicated.

(b) **Detailed Estimate:** On receipt of administrative approval to a project or scheme other than that for which construction estimate in Form E-533 is prepared and, conveyed through the sanction to the abstract estimate relating thereto detailed estimates for various works should be prepared and submitted for technical sanction of the competent authority. It should be prepared in sufficient detail to enable the competent authority to make sure that the abstract estimate sanctioned by a higher authority is not likely to be exceeded. No work included in an abstract estimate should be commenced till a detailed estimate for same prepared and sanctioned and adequate funds are allotted by the competent authority. The detailed estimate of an open line work will comprise (i) statements showing details of estimated cost and (ii) an outer sheet giving the abstract of cost of work, the report, the financial justification and the allocation.

(c) **Supplementary estimate:** Supplementary estimate should be prepared for any item of work, which ought to have been included in the first instance in an estimate already sanctioned but has not been so included or which is found later, should be considered as being a part or a phase of an estimate already prepared and sanctioned, it cannot be met out of contingencies. Such a supplementary estimate should be prepared

in the same form and the same degree of detail as the main estimate and for all purposes be treated as a part of the main estimate.

(d) Revised Estimate: As soon as it becomes apparent that the expenditure on a work or Project is likely to exceed the amount provided in the detailed estimate or construction estimate a revised estimate should be prepared and submitted for the sanction of the competent authority. It should, unless otherwise ordered by the sanctioning authority, be prepared in the same form and the same degree of detail as the original estimate, it should be accompanied by a comparative statement showing the excess of saving under each sub-head of account against the latest sanction. In cases where a supplementary estimate or a previous revised estimate has been sanctioned by the Railway Board, it should be made clear, how the original sanction has been modified by such further sanctions.

(e) Project Abstract Estimate: The abstract estimate of a construction project should be submitted for the approval of the Railway Board on Form E.554 "Abstract cost of Railway" accompanied by (i) An abstract estimate of junction arrangements, (ii) Narrative report explaining the salient features and major items of expenditure (iii) Detailed estimates on Form E.553 prescribed for a construction estimate.

(f) Construction Estimate: When it is decided to undertake the execution of a new line gauge conversion, or doubling of lines a final location survey should be made; and based on the information collected in the survey detailed estimates of all the works included in the project as a whole should be prepared. These detailed estimates are collectively called the "Construction Estimate" of the project. It should be prepared after a careful examination of the various details of construction involved in the project. It should be in such detail as to render it possible to dispense with working estimates or any other further estimating after the construction Estimate has been sanctioned (except when supplementary or revised estimates and necessary). It should provide for the buildings and equipment of the railway up to a standard that will be sufficient for working such traffic as may be expected during the first year or two after opening of the line. It is the basis on which technical sanction to the various works included in the construction of a project is accorded works both as regards estimate and expenditure. In forwarding, therefore, estimates for sanction the work in connection with new lines opened, it should be clearly indicated whether the cost of the work is chargeable to Capital construction of Open line Capital.

(g) Completion estimate: A completion estimate should show following particulars in respect to all the works included in the construction estimate.

Amount of the sanctioned estimate,

1. Actual expenditure on all works up to the date of construction estimate,
2. Commitment on that date,
3. Anticipated further outlay,
4. Total estimated cost and, difference between the sanctioned estimate and the estimated cost.

Q. No.3. Write short notes on-

- Completion report
- Material modification
- Urgency certificate
- Abstract estimate

Ans: (1) Completion Report:- The object of a completion Report is to compare the cost of work actually constructed with those provided in the last sanctioned estimate. The completion report of a project duly verified by the Accounts Officer should be submitted to the Railway Board within 18 months after the end of the financial half-year in which the completion estimate is submitted. It should state the expenditure in the same details as the abstract estimate sanctioned by the Railway Board and should indicate any material modifications thereto. In addition it may contain such other information as would in the opinion of the Railway Administration be of interest to the Railway Board.

The completion report should be prepared in the following form and brief explanations should be furnished for:-

Excess of not less than 10 percent or Rs.25, 000 whichever is less over the estimated provision under each sub-work.

Saving of not less than 20per cent or Rs.1 lakh whichever is less, occurring under any sub-work.

(2) Material Modification:- In the case of estimates sanctioned by the Railway Board or higher authority, instances of what will be considered to be material modifications of a sanctioned project or work are given below. The following may be taken as material modifications on lines under construction and open line works estimated to cost rupees one crore and over:-

Any change in the alignment likely to affect the facilities offered to the public in the neighborhood or likely to increase or decrease the length of the line by over one kilometer.

Introduction of any new station or omissions of any station.

Any alteration in the type or number of engines or vehicles provided in an estimate for rolling stock.

A change in the layout of a yard affecting the general method of working or increasing or reducing the number of trains that can be dealt with.

Any departure from the standards of construction as prescribed in Chapter II or as accepted by the Railway Board in the Abstract Estimate or use of any second hand material, if it affects the speed of trains or the number of trains to be dealt with than contemplated originally.

The introduction or omissions of any work or facility involving a sum of Rs.5 lakhs and over.

Any modification of a sub-work provided for in the estimate of a sanctioned work involving an additional outlay on that sub-work of more than Rs.5 lakhs.

The introduction of the new sub-work not provided for in the estimate of a sanctioned work involving an outlay of more than Rs.5 lakhs.
Any alteration in the standards of interlocking.

(3) Urgency Certificates: - Expenditure or liability may be incurred prior to the receipt of sanction of the authority competent to sanction the estimates under the ordinary rules:-

Works, which are considered to be urgently necessary to safeguard life or property or to repair damage to the line caused by flood, accident or other unforeseen contingency, so as to restore or maintain through communication.

Works considered urgent but not falling within (i) above, as for instance, works, required to meet the immediate needs to traffic, which are considered by the General Managers so urgent that they must be started before the earliest date by which detailed estimates could be prepared.

Divisional Engineer may authorise the commencement of the work, but should send a report to the authority competent to give administrative approval to the work and to allot the required funds. This report may be called an “urgency Certificate”.

(4) Abstract estimate: Abstract estimate prepared in order to enable the authority competent to give administrative approval to the expenditure of the nature and the magnitude contemplated, to form a reasonably accurate idea of the probable expenditure and such other data sufficient to enable that authority to gauge adequately the financial prospects of the proposal. Abstract estimate avoid the expense and delay of preparing estimates for works in detail at a stage when the necessity or the general desirability of the works proposed has not been decided upon by competent authority. An abstract estimate should contain a brief report and justifications for the work, specifications and should mention whether funds are required in the current year and to what extent. It should also show the cost subdivided under main heads and sub-heads or specific items, the purpose being to present a correct idea of the work and to indicate the nature of the expenditure involved. The allocation of each item as between Capital Development Fund, Open Line works-Revenue, Depreciation Reserve Fund and Revenue should be indicated.

Q.No.4: What are the methods of exercising control over expenditure? What are the means of controlling expenditure? Explain?

Ans: Methods of exercising control over expenditure are:-

The preparation in advance of estimates of the expenditure:

- (ii) The allotment of funds through budget grants for the year on the basis of these estimates.
- (iii) The continuous and concurrent review of the expenditure as incurred against the details of the estimates and the sanctioned grants, so that revisions of estimates or re-appropriation of funds are arranged for at the earliest possible point of time.

The means of controlling expenditure are:

Use of works Register:- The Works Register maintained in each division serve as an important management tool in providing information which enables a comparison of the expenditure incurred against a work with the provisions made in the estimate. The executive officer should examine the information recorded in the Works Registers monthly or at more frequent intervals and watch the progress of expenditure on each work so that any tendency towards excess over sanctioned estimate may be investigated and curbed or fresh administrative and technical sanction obtained time to cover the anticipated excess.

Progress Report-cum-Financial Review: For effective financial control of works a system which will monitor the relation between achievement and expenditure is essential. Financial Reviews assist in such a monitoring process and also serves as a management reporting system linking the progress of work with the expenditure incurred. Financial review provides a means of assessing probable variations from sanctioned estimate at the earliest possible date.

The monthly Financial Reviews provide two projections viz (i) actual expenditure compared to the proportionate allotment to the end of the month under review, and (ii) actual expenditure of the end of the month under review compared to the expenditure to the end of the corresponding month of the proceeding year. The financial reporting system provided by the monthly Financial Reviews offers a means of exercising control over expenditure under Revenue Demands.

Budgetary Control over expenditure on Acquisition, Construction and Replacement of Railway Assets: In the case of works chargeable to capital, Deprivation Reserve Funds, Development fund, Accident Compensation Safety and Passenger Amenities Funds and Open Line Works Revenue, Railway Administrations are required to exercise budgetary control not only under each sub-head of grant, but also against the allotment sanctioned for the year for each work costing over Rs, 50,000 each. For this purpose the financial reporting system provides for the preparation of two review statement by the Accounts officer every month (i) by sub-head of grant in Form 525F and (ii) by individual work in Form 526-F. These reviews are furnished to the authorities concerned by the Accounts officer by such dates as may be affixed in consultation with them.

Budgetary Reviews:- During the Financial year three budgetary reviews are made during August, December and February to review the requirements of funds. These reviews provide a means of reassessing the requirements of funds and they should commence at the "grassroots level " i.e. Division, workshop as the case may be. Since the responsibility for framing the requirements devolves upon the spending authorities concerned, care should be taken to see that the data on which the forecast is based is adequate and reliable and that the conclusions arrived at form the data can be sustained by past experience and future expectations of likely events to make the assessment as accurate as possible.

Exchequer control- Exchequer Control is an important tool for budgetary control, and functions as a mechanism for concurrent regulation of cash outgo by each disbursing officer against the cash content of the budget allotment. The regulation of cash disbursements will be made by the disbursing officer separately under each grant and executive officers should assist the disbursing officer framing the data.

Q.No.5: What are the various categories of stations for provision of passenger amenities? Explain the criteria for categorisation of stations.

Ans : Categories of stations for provision of passenger amenities

Sr. No.	Category	Criteria
1.	A	Non-Suburban stations with an annual passenger earnings of Rs.6 crores and above.
2.	B	Non-suburban stations with an annual passenger earnings between Rs.3 crores to Rs.6 crores. Stations of tourist importance, or an important junction station (to be decided by G.M)
3.	C	All suburban stations.
4.	D	Non suburban stations with passenger earnings between Rs.1 and Rs.3 crores.
5.	E	Non suburban stations with passenger earnings less than 1 crore.
6.	F	Halts

Q.No.6. Enumerate various Minimum Essential amenities required at each category of station as per the latest Rly. Bd's guidelines?

Ans: Minimum essential amenities required at each category of station are as follows.

Sr. No.	Amenities	Categories of stations					
		A	B	C	D	E	F
1.	Booking Facility	Yes	Yes	Yes	Yes	Yes	Yes
2.	Drinking water Piped/Hand Pump	Yes	Yes	Yes	Yes	Yes	Yes
3.	Waiting Hall/Shed	Yes	Yes	Yes	Yes	Yes	Yes
4.	Seating arrangement	Yes	Yes	Yes	Yes	Yes	-
5.	Platform shelter Shady trees	Yes -	Yes -	Yes -	Yes -	- Yes	- Yes
6.	Urinals	Yes	Yes	Yes	Yes	Yes	-
7.	Latrine	Yes	Yes	Yes	Yes	Yes	-
8.	Platform's –High Level – Medium - Rail	Yes - -	- Yes -	Yes - -	- Yes -	- - Yes	- - Yes
9.	Lighting	Yes	Yes	Yes	Yes	Yes	-
10.	Fans	Yes	Yes	Yes	Yes	Yes	Yes
11.	Foot over bridge	Yes	Yes	Yes	-	-	-

12.	Time Table Display	Yes	Yes	Yes	Yes	Yes	Yes
13.	Clock	Yes	Yes	Yes	Yes	Yes	Yes
14.	Water Cooler	Yes	Yes	Yes	-	-	-

Q.No.7. Differentiate between desirable amenities and recommended amenities. What are the desirable amenities required at the stations?

Ans: DESIRABLE AMENITIES:- Desirable amenities are those amenities which are considered desirable to improve customer satisfaction and interface process at the station. The quantum of these amenities would depend upon the category of the station.

RECOMMENDED AMENITIES:

The availability of amenities at station as per norms of Minimum essential Amenities may not be commensurate with the actual passenger traffic dealt at the station. Hence, the requirement of actual amenities based on traffic as per the norms should be worked out and any augmentation based on this, will be known as Recommended Amenities. Further, Recommended Amenities also include few additional amenities, viz. Bathrooms, Water coolers, SPTMs and IVRS.

A comprehensive list of the desirable amenities is given below.

DESIRABLE AMENITIES

Sr. No.	Amenities	Station category					
		A	B	C	D	E	F
1.	Retiring room	Yes	Yes	-	Yes	-	-
2.	Waiting room with bathing facilities:						
	Common	Yes	Yes	-	Yes	-	-
	Separate for upper & 2 nd class	Yes	-	-	-	-	-
	Separate for ladies & gents.	Yes	-	-	-	-	-
3.	Clock room	Yes	Yes	-	-	-	-
4.	Enquiry & computer based announcement	Yes	Yes	Yes	Yes	-	-
5.	NTES	Yes	-	-	-	-	-
6.	IVRS	Yes	Yes	-	-	-	-
7.	Public Address system	Yes	Yes	Yes	-	-	-
8.	Booking stall/other-stalls of essential goods.	Yes	Yes	Yes	-	-	-
9.	Refreshment room	Yes	Yes	-	-	-	-
10.	Parking/circulatory area	Yes	Yes	Yes	Yes	-	-
11.	Washable apron with jet cleaning	Yes	Yes	-	-	-	-
12.	Train indicator board	Yes	Yes	Yes	-	-	-
13.	Public phones; &	Yes	Yes	Yes	Yes	Yes	-

	Internet	Yes	Yes	Yes	-	-	-
14.	Touch Screen NTES	Yes	-	-	-	-	-
15	Watering vending machines	Yes	Yes	-	-	-	-
16	Water coolers	Yes	Yes	Yes	Yes	-	-
17	Signages (standardized)	Yes	Yes	Yes	Yes	-	-
18	Modular Catering stalls	Yes	Yes	Yes	Yes		
19	Automatic Vending Machines	Yes	Yes	Yes	-	-	-
20	Pay & use Toilets	Yes	Yes	Yes	Yes	Yes	-
21	SPTMs/UTS	Yes	Yes	Yes	-	-	-
22	Computerization of complaints	Yes	-	-	-	-	-
23	Circulating area lights	Yes	Yes	Yes	-	-	-

Q.No.8. What are the various planning aspects for planning Railway Staff Colonies?

Ans : For Planning of railway staff colonies, following factors should be considered:

Orientation of buildings: - The chief aim of orientation of buildings is to provide physically and psychologically comfortable living inside the building by creating conditions which suitably and successfully ward off undesirable effects of severe weather to the best possible extent.

Prevailing Winds and Relative humidity

In the coastal areas, because of less diurnal variation of temperatures along with high humidity, the emphasis should be on prevailing winds.

In other areas, the emphasis should be on protection from solar radiation.

The best orientation from solar point of view requires that the building as a whole should receive the maximum solar radiation in winter and the minimum in summer.

(c) Water supply, drainage and sewerage system:- Adequate water supply and sullage and storm water drains should be provided. The water supply system should be designed on the basis of at least 200 litres/person/day (which includes 45 litres for flushing requirements) due allowance being made for gardens. Where common hydrants are provided, these may be equipped with suitable anti-waste water taps. For multi-storied buildings, necessary static tanks may be provided for fire fighting arrangements in accordance with the regulations laid down.

Where water borne sewerage/exists in the vicinity, open drains and soak-pits should be dispensed with and an adequate underground system provided. For colonies provided with adequate piped water supply with overhead storage facilities and where no sewerage system exists in the vicinity, an under ground sewerage system with one or two septic tanks according to the layout of the ground should be provided.

Guidelines for the selection of an appropriate sanitation system are given.

Groups of latrines or urinals should not be located within 15 metres of living quarters, 30 metres of any cook house or foodstall, 45 metres of any well supplying drinking water and should be located away from public buildings adjoining railway colonies.

(d) DUST BINS - These should be conveniently located with respect to the quarters and regularly cleared by the conservancy staff. In the case of multi storied buildings garbage chutes may be provided with opening in each floor with arrangements for closing the openings.

(e) SHADY TREES - Shady trees like Gulmohur, Neem, should be provided along service roads at close intervals. Such trees should be provided along the periphery of parking areas and in the circulating areas in railway stations. Some ornamental trees like Alstonia, Kachnar, Bottlebrush, Cassia, Silver Oak, Mulsari, Plumeria, Ashoka and shrubs like Chandani, Gardinia, Chinese Orange and Jatruca may also be planted. For beautification of circulating areas of stations, service of the Gardens may be maintained in circulating areas through voluntary agencies or business houses on terms and conditions to safeguard the interest and rights of the railways.

(f) PLAY GOURNDS FOR CHILDREN -An open space at an appropriate place in the colony maybe left for entertainment and sports of the employees and their wards.

Q.No.9. What are the General Design requirements of Buildings as per Indian Railway Works Manual?

Ans: General Design Requirement of Buildings as per IRWM are as follows:

The plinth level of the building should be carefully fixed based on the level of the land and general drainage features. Plinth level should be adequately higher than road level. Buildings at the time of their construction should be adequately protected against dampness, treatment being governed by the particulars type of he construction, location, soil and rain-fall.

Where considered necessary, antitermite treatment should be done at the time of construction.

Floor level of bathrooms should be suitably designed keeping in view the type of sanitary fittings to be accommodated.

Location of sanitary fittings, inspection holes, plumbing and other sanitary installations should be predetermined to avoid disfiguring and subsequent patching of the walls and floors. Floor level should be suitably lowered to prevent water finding its way into the living area.

Mosquito proof shutters should be provided in Type-IV and higher type quarters and in the kitchen and toilets of all types of quarters.

The position of conduits for concealed wiring and other service installations should be determined in the initial stage in consultation with Electrical and Signaling and Telecommunication Departments.

Designs of important buildings, like hospitals, offices, station buildings etc. should be finalized in consultation with a Architect.

The layout of the kitchen in canteens and the serving counters therein, should be such as to make the canteen functional.

No addition/alterations in an existing structure should be carried out without the approval of drawings and designs by the Hqrs. Office. Particular care should be exercised to check the adequacy of the existing structure to withstand the loads further proposed to be imposed. No building drawing (including that for additions/alterations) should be approved without the relevant designs being put up to the concerned Engineer along with the Drawings. The designs should invariable include design of foundations.

The General Arrangement drawing should have the prior approval of officers in Hqrs. not lower than the rank of SAG in the Office of the Chief Engineer (Open line). Further, in Station Buildings and other important structures, no additions/alterations should be carried out without the prior approval of the general arrangement plan by the concerned SAG officer in the office of Chief Engineer (Open Line).

It should be ensured that cross reference of the drawing and the design calculations are endorsed on both of them and record should be maintained with equal care both for the design calculations as well as drawings.

While checking the design, adequate details of physical condition of the existing structure, details of any signs of distress, settlement, etc. as well as any relevant feature having bearing on the integrity and stability of the structure including type of soil should be intimated to the Hqrs.

Q.No.10. Write short Notes on-
Building Register
Petty repair Book
Basic Amenities required in Staff Quarter.

Ans: (i) Building Register: Building registers in Chief Engineer's Office and Divisional Engineer's Offices should be maintained upto-date and show complete details of each structure of the Indian Railway Code for Engg. Deptt. Replicas of these registers will be maintained in the Accounts Offices. The Senior Divisional Engineers should advise the Accounts Officers of the Construction of new structures and alterations or additions to existing structures and the costs thereof as and when carried out.

(ii) Petty Repair books: At each station, a "Petty repair book" should be maintained. In this, the station Master will enter repairs required to service buildings and staff quarters

as brought to his notice. The section Engineer (Works) should inspect the books frequently and attend to the repairs. Action taken on the Station Master's notes should be briefly recorded in the book itself. Items of day-to-day maintenance only should be recorded by the staff in the petty repair books. Any request for major additions or alterations in the buildings should be addressed to Divisional/Asst. Engineer. The Divisional Engineer and Assistant Engineer should examine and initial the registers during their inspection and issue such instructions as considered necessary.

(iii) Basic Amenities in Staff Quarters: - All staff quarters should be provided with the following basic amenities:-

Kitchen

Individual bath room

Individual sanitized latrines. wherever individual latrines are not feasible due to space constraints as in the case of back to back quarters, sanitized community latrines should be provided.

Basic ventilation arrangements.

Q.No.11: Describe various schedule of Dimensions & what Schedule of dimensions is used for New Lines?

Ans: There are three schedules of dimensions -

Schedule I: The dimensions given in the schedule are essential for safe working and are applicable to all new railways, new works, alterations and renewals on existing railways. Any deviation from these dimensions require prior sanction of Commissioner of Railway Safety.

Schedule II: The dimensions, given in this schedule are recommended dimensions which are generally considered good practices and adoptions of which will lead to very desirable uniformity over the Indian Railways. The deviation from these dimensions do not, however, require the sanction of Commissioner of Railway Safety.

Schedule-III: This schedule gives the dimensions which are infringement to standard dimensions but may be allowed to continue subject to restriction of speed as considered necessary. This may however be understood that such structures when altered will be rebuilt to comply with standards as laid in schedule I.

Schedule No. I is used for New Lines.

Q.No.12. What are the various documents to be prepared while relinquishment of charge by section Engineer works?

Ans: The following documents are required to be prepared while Relinquishment of Charge;

- ◆ While relinquishing charge, the Section Engineer (works) shall prepare, in triplicate, the specified-Transfer-of-charge-statement which will briefly contain the following.
- ◆ Extent of section.
- ◆ Establishment matters (service and leave record)
- ◆ Works in progress.
- ◆ Water sources that give trouble.
- ◆ Certificate of stores check and correctness of stock.
- ◆ General notes.
- ◆ The statement referred in sub-para (a) above should be signed by both the relieved and relieving Section Engineer (Works) Engineer, and two copies submitted by the relieving subordinate to the Assistant Engineer who will forward one copy to the Divisional/Executive Engineer for record.
- ◆ The relieving Section Engineer will examine all books pertaining to rules and order in vogue and all registers pertaining to the section to see that they are kept upto date and initial them with date.
- ◆ The Section Engineer (Works) handing over and taking over charge should together visit over the whole section, inspect each work in progress, check staff, all tools and plant and materials.
- ◆ Errors and discrepancies, which are noticed, should be recorded in the statement and the Assistant Engineer's special attention invited to them.

Q.No.13: What are the various functions served by foundation & what are the common causes of failure of foundations ?

Ans: FUNCTIONS OF FOUNDATIONS

Foundations serve the following purposes:-

Reduction of load intensity: Foundations distribute the loads of the super-structure, to a larger area so that the intensity of the load at its base(i.e. total load divided by the total area) does not exceed the safe bearing capacity of the sub-soil. In the case of deep foundation's it transmits the super-imposed loads to the sub-soil both through side friction as well as through end bearing.

Even distribution of load: Foundations distribute the non-uniform load of the super-structure evenly to the sub - soil. For example, two columns carrying unequal loads can have a combined footing which may transmit the load to sub-soil evenly with uniform soil pressure. Due to this, unequal of differential settlements are minimized.

Provision of level surface: Foundations provide leveled and hard surface over which the super-structure can be built.

Lateral stability: It anchors the super-structure to the ground, thus imparting lateral stability to the super-structure. The stability of the building, against sliding and overturning, due to horizontal forces (such as wind, earthquake etc.) is increased due to foundations.

Safety against undermining: Special foundation measures prevents or minimizes the distress or cracks in the super-structure, due to expansion or contraction of the sub-soil because of moisture movement in some problematic soils.

CAUSES OF FAILURE OF FOUNDATIONS AND REMEDIAL MEASURES:

The foundations may fail due to the following reasons:

Unequal settlement of sub-soil : Unequal settlement of the sub-soil may lead to cracks in the structural components and rotation thereof. Unequal settlement of sub-soil may be due to (i) non-uniform nature of sub-soil throughout the foundation, (ii) Unequal load distribution of the soil strata, and (iii) eccentric loading.

Unequal settlement of masonry: As stated earlier, foundation includes the portion of the structure which is below ground level. This portion of masonry, situated between the ground level and concrete footing (base) has mortar joints which may either shrink or compress, leading to unequal settlement of masonry.

Sub-soil moisture movement: This is one of the major causes of failures of footings on cohesive soil, where the sub-soil water level fluctuates. When water table drops down, shrinkage of sub-soil takes place.

Lateral pressure on the walls: The walls transmitting the load to the foundation may be subjected to lateral pressure or thrust from a pitched roof or an arch or wind action.

Lateral movement of sub-soil: This is applicable to very soft soils, which are liable to move out or squeeze out laterally under vertical loads, especially at locations.

Weathering of sub-soil due to trees and shrubs: Sometimes, small trees, shrubs or hedge is grown very near to the wall. The roots of these shrubs absorb moisture from the foundation soil, resulting in reduction of their voids and even weathering.

Atmospheric action.: The behavior of foundation may be adversely affected due to atmospheric agents such as sun, wind, and rains. If the depth of foundation is shallow, moisture movements due to rains or drought may cause trouble.

Q.No.14. Design a long column as per following data.

Axial load = 450 kN
 Column Size = 250 X 300 mm
 Effective length of column = $L_{ef} = 5m$
 Material: Concrete M-15 and Grade-I-Steel.

Ans (1) Check for Long column

Ratio (L_{ef}/D) $(5000/250)=20 > 12$

Hence long column

Permissible Stresses

$$\begin{aligned} \text{Reduction coefficient} = C_r &= (1.25 - L_e f / 48b) \\ &= (1.25 - 5000 / 48 \times 250) = 0.834 \end{aligned}$$

(3) Permissible stresses:

$$\begin{aligned} Q_{cc} &= (0.834 \times 4) = 3.336 \text{ N/mm}^2 \\ Q_{sc} &= (0.834 \times 130) = 107.9 \text{ N/mm}^2 \end{aligned}$$

Reinforcement in Column

$$P = Q_{sc} A_{sc} + Q_{cc} (A_c - A_{sc})$$

$$(450 \times 10^3) = [107.9 \times A_{sc} + 3.336 (75 \times 10^3 - A_{sc})]$$

$$A_{sc} = 1910 \text{ mm}^2$$

Provide 4 bars of 25 mm diameter ($A_s = 1963 \text{ mm}^2$)

Ties

$$\text{Least diameter of the ties} = 25/4 = 6.25 \text{ mm}$$

Use 8 mm diameter ties

Pitch of ties shall be the least of

- i. Least lateral dimension = 250 mm
- ii. 16 x longitudinal bar diameter = $(16 \times 25) = 400 \text{ mm}$
- iii. 48 x diameter of lateral reinforcement = $(48 \times 8) = 384 \text{ mm}$

Use 8 mm diameter ties at 250 mm centers.

Q.No.15. What are various classes of bricks? Specify the criteria of size, shape, and water absorption for well burnt bricks?

Ans: Various classification of bricks are:-

(a) Well burnt bricks: Such bricks shall be well burnt without being vitrified and shall have a uniform red, cherry or copper colour. They shall be homogeneous in texture and emit a clear ringing sound when struck.

Jhama or Over Burnt Bricks: Such bricks are over-burnt and as a result are discolored and distorted. These are, therefore, normally unfit for exact work.

Under burnt or Pilla bricks: Such bricks are hard-burnt and have a yellowish color. These are easily broken and their use is, therefore, normally, prohibited.

The term bricks shall mean well burnt bricks. All work shall be done with well burnt bricks except where other wise specifically permitted. Jhama or over burnt bricks may be used for certain items of work where permitted by the Engineer.

Size: Unless otherwise specified the size of bricks shall be 22.9 cm x 11.2cm x 7.0 cm (9'x4-3/8'x2-3/4'). A tolerance of 16 mm in length and 13 mm in width and thickness may be permitted. The bricks shall be provided with a frog 6mm (1/2') in one of the larger sides.

Metric size modular bricks where used shall be 19cm x 9.0cm x 9.0cm in accordance with the Indian Standard Specification No.IS:1077-1976.

Shape: Well burnt bricks shall be rectangular and uniform in shape and size, free from any chipping of edges, surface cracks or flaws, which in the opinion of Engineer will effect the soundness of the bricks.

Water absorption: Well burnt bricks must not absorb water more then 20 percent of its dry weight after 24 hours immersion in cold water. The bricks shall not show any appreciable sign of a florescence either in dry state or subsequent to soaking in water.

Q.No.16. Write short notes on.
Preliminary Works Programme
Final Works Programme
Works Budget
Demand for works grant.

(i) Preliminary Works Programme

Every year the Railway Board conveys to each Railway, in respect of each Plan Head the total outlay within which the Works Programme should be framed by the Railway. On receipt of this financial ceiling the Railway Administrations takes stock of the scheme already formulated and those under consideration and select for inclusion in the Works Programme within the financial ceiling such works as are expected to yield the maximum benefit to the Railway, preference being given to works in progress. Further necessary changes in the investment schedule may be made in order to work within the financial ceiling for the year such modification being taken note of in framing the preliminary Works Programme and revising the financial implications, if necessary.

The preliminary Works Programme for the following year should be submitted by the railways to the Railway Board by Ist week of September or such earlier date as may be laid down by the Board. Proper financial appraisal of each work should be given in the preliminary Works Programme together with the comments of the Financial Advisor and Chief Accounts Officer.

(ii) Final Works Programme

After having examined the individual Railway Programme, and discussions with the General Managers the Railway Board decides the works which should be undertaken during the following year and which should be included in the Final Works Programme. The Railway Administration will then modify their Works Programme as a result of the Board's decision and send their Final Works Programme to the Railway Board by the stipulated date.

(iii) Works Budget :-

The revised and budget estimates for the construction, acquisition and replacement of assets are briefly known as Works Budget. The revised estimate gives an estimate of funds required for the current year and the budget estimate refers to the following year. The budget estimate for the works are based on Works Programme approved by Board. The requirement of funds both for new investments and for Works in progress are submitted in the form of "Demand for Grants", in the Works Machinery and Rolling Stock Programme which forms a part of the Budget papers presented to the Parliament.

(iv) Demand for Works Grants

The proposal of Government in respect of sums required to meet the expenditure from the consolidated fund of India are to be submitted in the form of Demands for Grants to the Parliament. The Demand shall be for gross expenditure, the credits or recoveries being shown in the form of footnotes to Demands.

Q.No.17. Write short notes on?

Water-Cement ratio
Workability of concrete
Fineness modulus
Curing of concrete.

(i) Water-Cement ratio - Water has two functions in a concrete mix.
It enables the chemical reactions, which cure setting and hardening of cement.
It lubricates the dry concrete in order to facilitate placing.

If less quantity of water is added concrete will not be workable whilst excess amount of water if added it may flow by reducing quantity of cement and consequently will reduce the strength of concrete. Dense and strong concrete can be obtained by using specific quantity of water consistent with the degree workability required to give maximum density.

Thus a specific ratio of volume of water to the volume of cement is required. At this ratio concrete is found more strong and durable. This ratio is called water cement ratio and denoted as W/C ratio.

(ii) Workability of Concrete – Workability means ease with which concrete can be placed in the forms and compacted. Water content, size shape and grading of aggregate, affect the workability of concrete. The degree of workability depends upon the required strength of concrete and its purpose. Hence workability must be considered in relation to the method of compaction and the type of construction, in order to avoid the necessity for an excessive amount of work to obtain maximum density.

(iii) Fineness modulus- Fineness modulus of an aggregate is an index number which gives an average size of particles in the aggregate. Fineness modulus is roughly proportional to the average size of particle in the aggregate. Coarser the aggregate higher the fineness modulus and vice versa. It is determined by adding the cumulative percentage of material coarser than each of the following test sieves and dividing the sum by 100.

Test sieves 3.35 mm, 2.36 mm, 1.8 mm, 600 micron, 300 micron, 150 micron and 75 micron.

(iv) Curing of concrete:- Curing of concrete is necessary to prevent rapid loss of moisture from the surface of concrete and to keep the temperature of concrete under control. After the concrete has begun to harden, i.e. about one to two hours after its laying, it shall be protected from quick drying with moist gunny bags, sand or any other material approved by the Engineer. After 24 hours of laying of the concrete the surface shall be cured by flooding with water to a minimum depth of 2.5 cm or by covering with wet absorbent materials. The curing is generally to be done for a minimum period of 14 days. Water used for curing shall be clean, land free from sediments of any sort.

Q.No.18. Describe in brief DRF, DF. What are the various demands for Grant for expenditure on Railways concerning to Engg. department?

Ans. Depreciation Reserve Funds: The Depreciation Reserve Fund bears the following

The full cost of replacement including the improvement and inflationary element of an asset the original cost of which is at debit of Capital.

The full cost of replacement of an asset originally created out of Development Funds, irrespective of cost.

The original cost of an asset (other than land) being debited to capital, replaced at the cost of Open Line Works Revenue.

The cost at debit of Capital or Development Funds of an asset (other than land) which is abandoned or disposed of without being replaced.

The cost of tools and plants specially purchased, and of any posts specially created, for the supervision or construction of a work.

The cost of replacement of ballast involving improved type of ballast.

The entire cost of replacement of asset, the original cost of which is at the debit of Open Line works-Revenue is charged to Depreciation Reserve Fund if the cost of replacement is more than Rs.10 lakhs.

Development Funds:

The cost of all works relating to amenities for passengers and other Railway user including additions to existing or new works relating to those amenities irrespective of any, monetary limit provided that where the original cost of the existing work was charged to Revenue being within the New Minor works limit (i.e. Rs.1,00,000), the whole cost of new work replacing the old one shall be charged to the Development Funds.

The cost of all Labour Welfare Works including additions to existing or new works estimated to cost individually above Rs.1,00,000 each.

The entire cost of works costing more than Rs.10 lakhs each which are necessary but unremunerative (i.e. the return of which does not yield more than 6.75% of cost, for improvement of operational efficiency including additions to existing or new works.

The cost of any tools and plant specifically purchased and of any posts specially created for the supervision of constructions of a work chargeable to Development Funds.

The original cost of debit of capital of an asset failing under the category of D.F., replaced at the cost of D.R.F.

The Demand for Grants for Expenditure on Railways concerning to Engg. Deptt. is given below:-

Demand No.4.-Repairs and Maintenance of permanent Way and Works.

Demand No.7.-Repairs and Maintenance of plants and Equipment.

Demand No.11:-Staff Welfare and Amenities,

Demand No.16:-Assets-Acquisition, Construction & Replacement.

Q.No.19. What is controlled concrete? Differentiate it from ordinary concrete. Generally what type of concrete mix are used for various structures.

Ans. Types of Concrete –

Concretes may be primarily divided into two categories.

Ordinary concrete – The concrete, in which no preliminary tests are performed for designing the mix, is called ordinary concrete.

Controlled concrete – The concrete, in which preliminary tests are performed for designing i.e., the mix, is called controlled concrete. The controlled concrete described as *M10, M15, M20, M30, M35 & M40 etc. depending upon characteristic strength of concrete.*

General Concrete Mix for Various Purposes

S. No.	Grade	Concrete mix (general)	Type of construction
1	M ₁₀	1:3:6	Mass concrete in piers abutments, massive reinforced concrete members.
2	M ₁₅	1:2:4	Normal R.C.C work i.e. slabs, columns, beam, walls, small span arches.
3	M ₂₀	1:1 _{1/2} :3	Water retaining structures i.e. reservoirs columns & piles.
4	M ₂₅	1:1:2	Long span arches, and highly loaded column.
5	M _{30, 35 etc.}	to be designed	Post tensioned pre-stressed concrete & other important works.

Q.No.20. What are the various stages for processing the proposals for inclusion in works programme?

Ans: Various stages of processing the proposal for works programme as follows:-

As per Engineering code Railways are required to submit every year to Railway Board their preliminary works programme (in 15 copies) of works chargeable to Capital, D.R.F., D.F., and O.L.W.R. so as to reach the Railway Board not later than the 7th September of the preceding that to which they relate. These programmes are built up as a continuous process from the District/Divisional office level upwards.

A project should ordinarily commence at District/ Divisional Officer level. The District/ Divisional officer of all persons controlling the Department is in a position to state what works are needed and the reasons therefore. When he is satisfied about the need for a project, he obtains a rough estimate for the work from the Divisional/ District Engineer. At this state no detailed information is required and the estimate is required to be accurate enough to indicate the classification of the work e.g. New Minor Works. If in his opinion the work is essential or justified, he submits the case to the H.O.D.

That officer in turn, if he considers the project necessary and sound, prepares a detailed justification and sends the proposal to the FA&CAO. The FA&CAO then examines the project and returns the case with his comments to the H.O.D. either accepting, rejecting or questioning the justification.

If the project is accepted by the FA & CAO, the H.O.D. then forwards the case to the Chief Engineer or whichever authority consolidates and compiles the programme. The programme is then considered for finalization by the G.M.

The departments work up schemes in this manner and maintain registers of projects justified, accepted and forwarded. Railway Administration takes proper care to see that the cost of each work is worked out as accurate as possible and only those works/projects which have reached maturity or which have been approved by the Railway Board are included in the programme.

Major works, like doubling of lines, rebuilding of big major bridges important yard remodeling and all works estimated to cost more than Rs. 30 lakhs, are not included in the programme unless these have been previously approved by the Railway Board. The proposals for all such works with full technical and financial justification together with the FA & CAO's remarks are submitted to the Railway Board when they get ready and well in advance of the programme.

Each new work included in the programme should be supported by a brief explanation to be furnished below the work showing the necessity and urgency for the work and the essential features of the scheme. The financial implications of all new works costing more than Rs. 10 lakhs each, duly vetted by the FA & CAO is noted below the justification for each item. Fresh justification is given in case of work which although included in some previous year programme have been kept in abeyance and are proposed to be restored.

The programme before submission to the Railway Board is examined by the FA & CAO and his comments on each work are shown under the justification for each item.

Final Works Programme – The programme of individual railways are examined by the Railway Board and discussed with the General Managers. The Railway Board thereafter decide the works which should be undertaken during the following year and Railway Administration then modify their works programmes as a result of the Board's decision and send their final programmes to the Railway Board.

Thus the works programme is given its final shape.

21. QUESTION BANK (SUBJECTIVE TYPE) ON WORKS, CONTRACTS, AND TENDERS ESTIMATES ETC.

Q.No.1: What are different types of contracts? Discuss forms of works contracts in brief.

Ans.1: When two or more persons have a common intention communicated to each other to create some obligation between them there is said to be an agreement. An agreement which is enforceable by law is a “contract”.

WORKS CONTRACTS;- All works and supplies relating to the Engineering Department executed through the agency of contracts may be broadly classed as follows:-

- (i) ZONE WORKS; Such as works of ordinary repairs and maintenance and others of petty nature in a particular zone or area.
- (ii) SPECIAL WORKS:- Such as the construction of bridge, the formation of an embankment etc. other than zone works.
- (iii) SUPPLIES OF BUILDING MATERIALS:-
Such as bricks, tiles, lime, bamboos, fire bricks, Shingle, pitching stone etc. which are not usually stocked or purchased by the stores Department.

FORMS OF WORKS CONTRACTS: - The following forms of contract are primarily intended for application to works contracts:-

1. LUMPSUM CONTRACTS: The lump sum contract is a contract under which the contractor engages to carry out a work or effect supply as specified and within a given period for a fixed total sum, his receipt of this sum being dependent on his completing the work or supply to specification and time, irrespective of the actual quantities and kind of work done or materials supplied in achieving his results.
2. SCHEDULE CONTRACTS:- The schedule contract is a contract under which the contractor engages to carry out a work or effect supply as specified and within a given period, at fixed unit rates or prices for each of the various items comprising such work or supply, the sum, he is to receive depending on the actual quantities and kind of work done or materials supplied in completing the work or supply to specification and time.
3. PIECE WORK CONTRACT:- This means a contract under which only unit rates or prices for various kind of work or materials are agreed upon, without reference either to the total quantity of work to be done or materials supplied,

or to the quantity of work to be done or material supplied within a given period. The zonal contract adopted on the Railways fall under this category.

4. **CONTRACTS FOR ZONE WORKS AND ENGEERING MATERIALS:-** It is offere advantageous to allot all minor works and all works of repairs and maintenance in a particular zone for a definite period to one contractor. It may be likewise advantageous to make this contractor who can be called a zonal contractor responsible for the conveyance or supply of engineering materials as and when required, in a particular zone during a specified period.

The Zonal contracts should be for the period from Ist of July to 30th of June. The contracts for these works or supplies should as a rule, be on a yearly basis. It however, any special advantage, such as more favourable rate is likely to be secured by giving out contracts for longer periods (as in the case of manufacture and supply of bricks). Contracts for more than a year may with the concurrence of the Accounts Officer, be entered into. It should be ensured that as for as possible, no work orders are approved against the old contract after the opening of the new tenders and all works of the old contract are completed by the end of JUNE.

Q.No.2 Name various types of Estimates and discuss there in brief:-

Answer – The various types of Estimates are listed below:-

1. Abstract Estimates.
2. Detailed Estimates.
3. Supplementary Estimates.
4. Revised Estimates.
5. Project Abstract Estimates.
6. Construction Estimates.
7. Completion Estimates.

1. **ABSTRACT ESTIMATES:-** An abstract estimate is prepared in order to enable the authority competent to give administrative approval to the expenditure of the nature and the magnitude contemplated, to form a reasonably accurate idea of the probable expenditure and such other data sufficient to enable that authority to gauge adequately the financial prospects of the proposal.

An abstract estimate should contain a brief report and justification for the work, specifications, and should mention whether funds are required in the current year and to what extent. It should also show the cost subdivided under

main heads and sub-heads or specific items, the purpose being to present a correct idea of the work and to indicate the nature of the expenditure involved.

2. **DETAILED ESTIMATES:-** On receipt of administrative approval to project or scheme other than that for which construction estimate is prepared and conveyed through the sanction to the abstract estimate relating thereto detailed estimates for various works should be prepared and submitted for technical sanction of the competent authority. It should be prepared in sufficient detail to enable the competent authority to make sure that the abstract estimate sanctioned by a higher authority is not likely to be exceeded. No work included in an abstract estimate should be commenced till a detailed estimate for the same is prepared and sanctioned and adequate funds are allotted by the competent authority. The detailed estimate of an open line work will comprise.
 - i) Statements showing details of estimated cost, and
 - ii) an outer sheet giving the abstract of cost of work, the report, the financial justification and the allocation.
3. **SUPPLEMENTARY ESTIMATE:-** A supplementary estimate should be prepared for any item of work, which ought to have been included in the first instance in an estimate already sanctioned but has not been so included, or which it is found later, should be considered as being a part or a phase of an estimate already prepared and sanctioned, if it can't be met out of contingencies. Such a supplementary estimate should be prepared in the same form and the same degree of detail as the main estimate and for all purposes be treated as a part of the main estimate.
4. **REVISED ESTIMATES:-** As soon as it becomes apparent that the expenditure on a work or project is likely to exceed the amount provided therefore in the detailed estimate or construction estimate the sanction of the competent authority. It should be prepared in the same form and the same degree of detail as the original estimate, and should be accompanied by a comparative statement showing the excess or saving under each sub-head of account against the latest sanction.
5. **THE PROJECT ABSTRACT ESTIMATE:-** The abstract estimate of a construction project should be submitted for the approval of the Railway Board on form "Abstract cost of Railway" accompanied by (i) an abstract estimate of junction arrangements (ii) a narrative report explaining the salient features and major items of expenditure (iii) detailed estimates under the various heads.
6. **CONSTRUCTION ESTIMATE:-** When it is decided to undertake the execution of a new line, gauge conversion or doubling of lines, a final location survey should be made and based on the information collected in that survey, detailed estimates of all the works included in the project as a whole should be prepared. These detailed estimates are collectively called the "Construction Estimate" of the project. It should be prepared after a careful examination of the various details of construction involved in the project.

7. COMPLETION ESTIMATES:- A completion estimate is prepared in super session of a construction estimate. It; shows the following particulars in respect of all the works included in the construction estimate:-
- (a) Amount of sanctioned estimate:
 - (b) Actual expenditure on all works up to the date of the construction estimate
 - (c) Commitments on that date.
 - (d) Anticipated further outlay.
 - (e) Total estimated cost, and
 - (f) Difference between the sanctioned estimate and the estimated cost.

Q.No.3:- Discuss different types of tenders in brief.

Answer 3:- There are three methods of obtaining tenders.

1. Open tenders.
 2. Limited tenders.
 3. Single tenders.
- 1 OPEN TENDER:- In case of the open tenders wise publicity is given through the newspapers. Any person on payment of the tender cost can purchase the same. These are resorted to get enough competition and competitive rates for the work. As a general rule all the tenders must be the open tenders, excepting where the situation warrants the invitation of limited and single tenders
- 2 LIMITED TENDER:- When offers are invited form a limted number of tenderers of tenderers from the approved list to save the time, for smaller valve of work or for the specialized nature of work, the tenders are called limited tenders. In case, it is desired to invite offer from the contractors other than on the approved list, finance concurrence and competent authority's approval is to be obtained irrespective of the valve of the work.
- The following conditions should be fulfilled when limited tenders were called without finance concurrence.
- (a) Minimum number of the contractors on the approved list should be 10.
 - (b) The approved list of the contractors should be dynamic and updated list as on date.
 - (c) Not with standing the provisions above, the Railway may invite open tenders in the following circumstances.
 - (i) In the event of the insufficient response to the tender from the contractors borne on the approved list.

- (ii) When ring formation is suspected.
- (iii) When work is of specialized nature and the contractors with requisite experience are not available on the approved list.
- (d) In limited tendering, the tender notice should be sent to all the contractors on the approved list by registered post or UPC and their acknowledgement obtained.
- (e) To check the reasonableness of rates, it is not enough to compare the same with the previously accepted rates, especially, if the previous tender happens to be a limited tender. A check on the current market rate and rate analysis may also be undertaken.
- (f) To test the market rate periodically open tenders may be called for in place of the limited tender.

SPECIAL LIMITED TENDERS:- For important works, special limited tenders can be invited. In this system few contractors are picked up who are considered to be capable of doing that work. Their credentials are verified. These can be other than those on the approved list. But care should be taken to include the contractors in the approved list, in that area capable of doing that work. The calling of the special limited tender and selection of the limited contractors needs finance concurrence and approval of CAO/OM.

3. **SINGAL TENDER:-** When under special circumstance, the offer is taken from only a single agency, it is called single tender. The single tender is not to be called for routine works. In case of single tenders, the tender committee and the accepting authority should be one step higher than that in the case of open/Limited tenders excepting in the case where GM is the accepting authority.

The single tenders may be invited in the following emergent and other conditions:-

- (1) Accidents, breaches, involving dislocation to the traffic.
- (2) Work of specialized nature or some very inescapable situation as decided by GM/CAO(C) with poor concurrence of FA&CAO
- (3) Annual maintenance contracts for the equipment may be placed on single tender basis on the authorized dealers with the approval of GM.

Q.No.4 Define Earnest Money and Security Deposit. In which form Earnest Money and security deposit should be submitted?

Ans:4:- **EARNEST MONEY:-** EMD is asked for in token of the genuine interest in the work on the part of the tenderer. On acceptance of the offer, total EMD becomes part of

the security deposit for the performance of the contract. The EMD of unsuccessful tenderer is returned immediately on finalization of the tenders. In case of withdrawal of the offer after opening of the tender but before finalization of the tender within validity period . EM is forfeited. The cost of work, on which EM is calculated should be realistically assessed considering the prevalent market rates. The scale of EM is given as below:-

- 1) For works costing upto Rs,5 Lakhs – 2 ½% advalorem subject to maximum of Rs. 10,000.
- 2) For works costing more than Rs.5 lakhs but upto Rs.,20 lakhs 2% ad valorem subject to maximum of Rs.20,000.
- 3) For works above Rs.20 lakhs but upto Rs.50 lakhs – 1% ad valorem subject to a maximum of Rs.35,000.
- 4) For works above Rs.50 lakhs ¾% advalorem subject to maximum of Rs.50,000.

Earnest money in the form of guarantee Bonds should not be accepted.

SECURITY DEPOOSIT:- It is the amount to be deposited by the successful tenderer as a token of the guarantee for the due and faithful fulfillment of a contract. The scale of SD is as given below:-

1.	For contracts upto Rs.1 lakh in value	10% of the value of contract.
2.	For contracts costing more than Rs. 1 lakh upto Rs.2 lakh in value.	10% of the first Rs. 1 lakh and 7-1/2 % of the balance.
3.	For contracts more than Rs.2 lakhs upto Rs.2 crores	10% of the first 1 lakh,7-1/2% of next Rs.1lakh and 5% of the balance subject to the Max of Rs 3 lakhs.
4.	For contracts above Rs.2 Crores.	5% of the contract value. The amount over and above Rs. 3 lakhs to be recovered from the progressive of the contractors @ 10% till it reaches 5% of the contract value.

The security deposit may be collected by deduction from running bills of the contractor at the rates mentioned above.

FORMS IN WHICH EARNEST MONEY AND SECURITY DEPOSIT IS ACCEPTABLE:-

The earnest money should be in cash or in the form of deposit receipts, pay orders, demand drafts or guarantee bonds executed by State Bank of India or any of the nationalized bank or by a scheduled bank. Government Securities (Stock Certificates, Bearer Bonds, Promissory Notes, Cash Certificates etc) should not be accepted as earnest money. The provision regarding earnest money does not apply to other railways or departments of Government.

The security deposit may be in the following forms.

1. A deposit of cash.
2. Govt. Securities including State Loan Bonds at 5% below the market value.
3. deposit receipt pay orders, demand drafts and guarantee bonds.. The forms of security deposit could be either of the State Bank Of India or of any of the Nationalized Bank.
4. Guarantee bonds executed or deposits receipts tendered by all scheduled banks.
5. A deposit in the post office Savings Bank.
6. A deposit in the National Savings Certificates.
7. Twelve years National Defence Certificates.
8. Ten years defence Deposits.
9. National Defence Bonds, and
10. Unit trust Certificates at 5% below market value or at the face value which ever is less.

Q.No.5. How many class of contractors are registered in Railways? Discuss each with their monetary limits.

Answer:- In Government departments many times the works to be executed are of repetitive nature. So to reduce the time of finalization of the tenders and to eliminate incapable bidders a system of preparing “ Approved List of contractors” is followed in the tendering process.

A separate list of the approved contractors is to be maintained for the following five slabs of estimated value of the contract according to their capacity to take up such works.

- 1) Class “A” for the works over Rs.50 lakhs.
- 2) Class ”B” for the works upto Rs.50 lakhs.

- 3) Class “C” for the works upto Rs.20 lakhs.
 - 4) Class “D” for the works upto 5 Lakhs.
 - 5) Class “E” for the works upto 1 Lakhs.
1. Class “A”-(a) they should have an Engineering Organization with at least a graduate Engineer having 10 years experience plus an Engineering Diploma holder having 5 years experience and should maintain in minimum complement of the transport equipment and the construction tools and plants required for the works.
(b) At the time of the enlistment, they should have satisfactorily executed at least two works, each individually costing not less than Rs.25 lakhs.
 2. Class “B”:- (a) They should have an Engineering organization with at least a graduate Engineering having 5 years experience and should maintain a minimum complement of the transport equipment and the construction tools and plants required for the works.
(b) At the time of enlistment, they should have satisfactorily executed at least two works, each individually costing not less than Rs.10 Lakhs.
 3. CLASS “C”:- (a) They should have an Engineering Organisation with an Engineering Diploma holder having at least 3 years experience.
(b) At the time of enlistment, they should have satisfactorily executed at least two works, each individually costing not less than Rs.3 lakhs.
 4. CLASS “D”:- At the time of enlistment, they should have satisfactory executed at least two works, each individually costing not less than Rs.,50,000/-
 5. CLASS “E”:- No specific minimum requirement need be insisted upon.

Once a year wide publicity should be made through the advertisement, notices inviting the contractors/firms to get themselves registered in various categories,. Working contractors, who have executed satisfactorily in the past may be included in consultation with associate finance based on their field of specialization and credentials. Prior to the enlistment, the capacity of the intending contractors/firms to execute the work satisfactorily as an independent and competent agency, their financial capability, the field of specialization to supervise the works and other aspects should be examined and investigated. The list of approved contractors should keep confidential without disclosing the names to each other. It is valid for 3 years. Thereafter, the contractors have to apply for the renewal. The; names of the contractors can be added or deleted even; after finalization of the approve list.

Q. No.6 Discuss process of invitation of Tenders in brief mentioning minimum period of time for floating a tender.

Answer: In open tenders, the “Notice Inviting Tender” is given to various important newspapers for the publication for wide publicity. Notice inviting tender covers the nature and scope of work, site, location, approximate cost, completion time, EMD, office from where the tender form can be obtained and submitted, any special requirement or criteria for the tenderers etc. Notice Inviting Tender should also mention the date of closing of issue of the tenders and the date, time, place of opening of tenders. Notice Inviting Tender in case of open tenders may be published in the local newspaper, sent to the various Government departments and offices for wide publicity. In addition Notice Inviting Tender is sent by Regd. post to the contractors borne on the approved list of the contractor and may also be placed on the notice boards.

The tender documents should also be ready in the Executive Office on the nominated date for issue to the tenderer. A minimum of 15 days should be ensured between the availability of the tender form for sale and the date of submitting tenders. In tenders involving the foreign exchange component of more than Rs.50,000/- Railway Board’s prior approval should be obtained before inviting the tenders. Normally, a period of “30 days” should be kept between the date of publication of Notice Inviting Tenders and the date of opening of tenders.

While preparing the tender documents, following precautions should be taken –

1. In respect of the General Conditions of Contract, specifications and standard schedule of rates, a reference to last correction slip/amendment should always be made.
2. All blanks in the tender forms should be filled up properly such as place of work, name and description of work, latest correction slip no. In printed documents, drawing numbers, amount of earnest money, completion period, delivery schedule, maintenance period, validity period etc.
3. Tender forms to be initiated by a Gazetted Officer or at least by a responsible Senior Supervisor, nominated for this purpose.
4. Actual sales of tender documents should be recorded in a register.

Q.No.7 What you understand from Price variation clause? Describe it in brief.

Answer For long duration contracts, the price quoted at one point of time becomes unworkable after sometime due to the price escalation. Once, the rates become unworkable, the failure of contract becomes imminent. Hence, Railway Board has decided to introduce the "Price Variation Clause". The brief stipulations of PVC are :-

1. PVC is to be applied to works costing more than Rs.10 lakhs. The Chief Engineer, however, has the discretion not to provide PVC for works costing between Rs.10 lakhs to Rs.25 lakhs, on account of some special considerations redeems fit.
2. PVC is applicable for the works having completion period more than 12 months. Accordingly, it is not applicable to the zonal contracts since their completion period is one year.
3. Price variation will be calculated once every quarter for the on account payments made in that quarter. If, more than one on account bill is paid in one quarter, calculations for payment towards the price variation will be made in each bill.
4. Calculation of the payment on account of price variation should be based on the average price index of the three months of the quarter.
5. The price variation in respect of various components viz. labour, material, fuels etc. will be carried out as per formula given in tender document. The formula takes into account the increase in the price index with respect to the base period.
6. The fixed component will include payment to the consultants as specified in the accepted offer, if any, and cost of cement, steel and the other items supplied free by the Railway.
7. The fixed cost of the contract value on which no price variation would be permissible may be pegged at 15% on the value of contract.
8. Price variation upto 15% is to be absorbed by the contractor.
9. Maximum amount of the price variation will be 15% for the contractors with a completion period of upto 2 years and 20% for the contractors with a completion period of more than 2 years.
10. Before calling of tenders where PVC is proposed to be introduced, Senior Officers should look into the reasonableness of the period provided for the completion of work.
11. If the rate quoted in the negotiated tender are accepted, it is logical that the base month for PVC should be the month in which negotiations are held.
12. The contract should be awarded taking into account the possibility of the mobilization and the availability of materials in case of the materials supplied by the Railway, where the completion period is less than one year to avoid losses accruing due to PVC.

Q.No.8. Define Arbitration. Mention different types of common disputes and contractor's claims.

Answer: ARBITRATION:

Arbitration has been defined as the reference of the dispute or difference for determination after hearing both sides in a judicial manner, by a person or persons other than a court.

The person or persons here could be a Sole-Arbitrator or an arbitrator tribunal depending on the amount of claims.

COMMON TYPES OF DISPUTES:

Following types of disputes are possible in the contracts:-

1. Claims for extra items of the work, quantum, rate of the payment etc.
2. Claims for the variation in the scheduled quantities.
3. Delay in completion of the works.
4. Compensation for prolonged duration of the works.
5. Delay in the payment of the bills.
6. Delay in giving decisions on the matters referred.
7. Dispute regarding non-scheduled items.
8. Dispute regarding termination of the contract at Contractor's risk and cost.
9. Disputes regarding certain aspects of the measurements, specifications, drawings, defective workmanship etc.
10. Hire charges for the plant and machinery.
11. Lacunae in contract conditions.
12. Dispute regarding classification of a matter as "Excepted Matter".
13. Dispute regarding interpretation of any clause of the contract.
14. Operation of +30% clause of quantity variation after specified time limit given in contract.

CONTRACTOR'S CLAIM:

Normally, the contractor's claims are of following types:-

1. Claims based on breach of the contract such as Railway's failure to supply the drawings, materials, decisions, access to the site, clear site, and providing any infrastructural item (if agreed in contract) in time.
2. Claims arising out of the variations in the contract conditions and extra items, during course of the work.
3. Wrongful termination of the contract and withholding of the security.
4. Claims based on the refusal to pay due consideration such as on account or the final payments, release of the SD etc.

Q.No.9

Write short notes on the following:-

- (a) Standing Earnest Money.

- (b) Railway's claims.
- (c) Liquidated damages.
- (d) Deposit works.

Answer (a) STANDING EARNEST MONEY:-

A Standing Earnest Money of the values indicated below can be accepted from a contractor borne on the Railway list of approved contractors to cover tendering against any number of works costing upto the limit indicated against each amount on the Zonal Railway Civil Engg. Department:-

- | | | | |
|----|-------------------------------------------------|---|---------------|
| 1. | Upto Rs.5 lakhs | - | Rs.10,000/- |
| 2. | More than Rs.5 lakhs but less than Rs.20 lakhs | - | Rs.20,000/- |
| 3. | More than Rs.20 lakhs but less than Rs.50 lakhs | - | Rs.50,000/- |
| 4. | More than Rs.50 lakhs | - | Rs.1,00,000/- |

This amount would not be adjusted towards the security deposit of individual contracts obtained by a contractor.

(b) RAILWAY'S CLAIMS:

These could may be defined/arise as follows:-

1. Claims for the defective work, unacceptable quantity, the delay in completion of work, insolvency of contractor, offering of illegal gratification etc. related to the "Breach of Contract".
2. Failure to render satisfactory account of the materials issued, misuse or theft of the material etc.
3. Claims related to the advances given to the contractor.
4. Claims relating to the hiding of information such as employment of a Government Officers without the permission or false credentials etc.

(c) LIQUIDATED DAMAGES:

Commonly speaking, liquidated damages are a genuine estimate of damages in case of non fulfillment of obligations by one party. The penalty is considered to be an amount "in terrorem" against breach.

Liquidated damages are to be assessed properly as the loss suffered by one party due to non-completion or delaying of the work.

The liquidated damages are restricted with respect to cost of work.

It would be necessary for the Railway to serve on the contractor a notice of the intention to recover liquidated damages are required under the Contract Act even though the contractor has been apprised of this liability earlier. The decision for recovery of liquidated damages should not be taken at a level lower than the authority who signed the contract.

(d) DEPOSIT WORKS:

A Railway Administration is occasionally required to execute works for and at the cost of other Govt. Depts., local bodies, private persons. Such works are known as “Deposit Works”.

The term “Deposit Works” is applied to works of construction or repair, the cost of which is met, not out of Railway funds, but out of funds from non-railway sources.

To meet the cost of plans and estimates of such works as also those to be carried out for other Departments out of railway funds, which are subsequently not carried out, charges at the following sliding scale shall be levied on the total of the estimate inclusive of departmental charges:-

- | | | |
|----|--------------------------------------------------------------------------|---|
| 1. | For works costing over Rs.1,00,000/- | = |
| | 2% | |
| 2. | For works costing over Rs.60,000/- but not more than Rs.1,00,000 | = |
| | 2½% | |
| 3. | For works costing over Rs.30,000/- but not more than Rs.60,000 | = |
| | 3% | |
| 4. | For works costing over Rs.20,000/- but not more than Rs.30,000 | = |
| | 3½% | |
| 5. | For works costing over Rs.10,000/- but not more than Rs.20,000 | = |
| | 4% | |
| 6. | For works costing over Rs.1,000/- but not more than Rs.10,000 | = |
| | 4½ % | |
| 7. | For works costing over Rs.1,000 and below 5% subject to a min. of Rs.25. | |

Q.No.10

Write short notes on:

- (a) Counter offer.
- (b) Delayed & late tenders.
- (c) Two Packet System of tendering.
- (d) Mobilization Advance.

Answer: (a) COUNTER OFFER:-

Sometimes after opening of the tender, the Railway may give a counter offer to the contractor on the reduced rates or without accepting some of

the contractor's conditions. This offer is known as counter offer. After contractor's unconditional acceptance of the counter offer further processing of entering into contract may be done. Such situation may come in case of award of similar works to different parties at the same time.

(b) DELAYED & LATE TENDERS:

The "Delayed" tenders i.e. tenders received before the time of opening but after the due date and time at receipt of the tenders should also be opened and dealt with in the same manner as the tenders received before the due date and time.

The "Late" tenders i.e. tenders received after the specified time of opening should be opened by the concerned Branch Officer and marked distinctly preferably in the red ink, prominently on the envelope as well as on the tender papers.

The late & delayed tenders shall normally be not considered and rejected summarily.

(c) TWO PACKET SYSTEM OF TENDERING:

In some important jobs, the tenders are called in two parts – two sealed covers. This system facilitates taking the decision in two steps or two parts. This system can be used to pre-quality the contractors or bring the special conditions of contractors at one level as explained below:-

In this system the tenderers are asked to submit their tenders in two parts. The first part, in a sealed cover, contains the tenderer's special conditions and all other technical and commercial particulars, except the prices. The second part is in another sealed cover and contains the prices only. In this method the first set of covers are first opened and the conditions read out. The employer then deliberate in private over the conditions and also discuss with the tenderers and decide which of the conditions are acceptable and which are totally unacceptable. By this method, a common minimum set of the conditions emerges. The tenderers are then again called and asked to agree to these conditions and stipulate a % increase or reduction in their priced offers. The offer of tenderers who refuse to accept the min. set of conditions are rejected. The second set of cover (the priced offer) is then opened and the new percentages already stipulated by the tenderers applied to their prices & new prices obtained. The evaluation and settlement of the tenders is done on these new prices.

(d) MOBILISATION ADVANCE:

In tenders for the works which are capital intensive and of a specialized nature, if the estimated value of a tender exceeds Rs.1 Crore and if the work warrants grant of advance, suitable provisions may be included in the special conditions of tenderers for grant of mobilization advance immediately on signing of the contract.

The Mobilization advance should be limited to 10% of the contract value and is given in two stages as follows:

Stage – I 5% of the contract value against irrevocable bank guarantee from a Nationalized bank in India or the SBI on signing of the contract documents.

Stage – II 5% on mobilization at the site of establishment etc and the actual commencement of work. The advance shall carry rate of interest of 18% per annum. This may be recovered through on account bills in installments, the recovery commencing when the value of the work executed and paid for reaches 15% of the provisional value of the contract and shall be completed when the value of the work executed reaches 85% of the original value of contract. The installments on each on account bills will be on pro-data basis.

22. Water Supply & Hydraulics

-

Q1:- Write short note on following

- (a) Static water level
- (b) Pumping water level
- (c) Draw down
- (d) Specific yield
- (e) Well yield
- (f) Specific capacity_

Ans.1 :-

(a) **Static water level** : It is level at which water stands in a well either penetrating an unconfined or confined aquifer is called static water level. It is measured from the ground surface.

(b) **Pumping water level** : It is the level at which water stands in a well when the well is pumped. It is also called working water level.

(c) **Draw down** : Draw down is the vertical distance by which water table is lowered when pumping is on. It is the difference between static water level and working water level.

(d) **Specific yield** : Rate of water percolation in the well or yield of a well under a head of one meter is called specific yield of a well. It depends on following aspects:

- (i) Position of water table
- (ii) Permeability and porosity of the soil
- (i) Rate of water withdrawal from the well
- (ii) Quantity of water stored in a well.

It is also called yield of the tube well per unit draw down. It is the measure of effectiveness of the well and varies with the discharge and time of pumping of the well.

(e) **Well yield** : Also called safe yield. Yield of the well is the rate at which water percolates into the well under the safe maximum working head or critical depression head. “When water is drafted from a well, the water level in the well falls more quickly

than the ground level water and it forms a cone of depression. Under this head water percolates in the well through soil pores. More the depression head, more will be discharge or yield. There may come up a stage when soil pores may be disturbed due to drafting of water from the well. This is known as critical velocity. It is desirable that critical depression head should not be allowed to reach as it may create unstable condition to sub-soil strata.

(f) Specific capacity : Specific capacity of a well is its yield per unit of draw down measured in GPH or LPM.

$$\text{Specific capacity} = \text{Yield} / \text{Draw down}$$

Specific capacity is a measure of efficiency of a well. Hence if value of a well is decreasing, it points out decreasing of its specific capacity. Decrease in its capacity could be due to a number of factors such as choking of screen due to incrustation and blockage of screen openings due to rushing of sand and silt.

Q2. What do you understand by the following terms in case of open wells or tube wells?

1. Cone of depression
2. Depression head
3. Shrouding
4. Recuperative test.

Ans.2 :-

- (i) **Cone of depression** :- It is the curve which joins the water level in the well to the static water table line. The portion of soil mass below the cone of depression is saturated strata while the soil above or in the cone is unsaturated. It connects static and working water levels in the well.
- (ii) **Depression head** :- It is also called the vertical difference between static water level and pumping water level is called depression head.
- (iii) **Shrouding** :- The process of pouring gravel in the vicinity of a tubewell is called shrouding. The tubewell is gravel packed in the annular space around the well which has following advantages:-
 - (a) To prevent silt and clay coming in to the well.
 - (b) To create higher permeability zone.
 - (c) To minimize the entrance velocity in the zone.

Generally 2 to 4 mm gravel is used which should be clean, well graded and having smooth grains. Over size gravel may promote sand pumpage while undersize gravel may chock the openings of slotted screen.

- (iv) **Recuperative test** :- The method is used to determine the yield of a well. In this method water level in the well is depressed by pumping to any level below the normal level. Then the pumping is stopped and time taken by percolating water to refill the water to any particular level is noted. Total quantity of water coming out of well is calculated by knowing its x-sectional area and rise in water level after stoppage of pumping.

Q3. Describe the sequential operations involved in boring a tube well by Reverse Rotary Rig with neat sketch.

Ans.3 :- Following sequences of operation evolves for drilling a bore by RR Rig:-

- (i) Demarcation of site.
- (ii) Excavation of 6m x 6m x 1.5m (2 pits) settling pit and storage pit for formation cutting settlement and for water storage. Pits should cement plastered.
- (iii) Placement of rotary rig and its leveling.
- (iv) Excavation of pilot/dry bore by 15 feet by auger bit.
- (v) Conventional drilling is switched on.
- (vi) On completion of drilling, entire drilling rod alongwith bit are taken out from bore hole. Bore is washed with clear water.
- (vii) Preparation of well assembly in accordance with strata prevailed.
- (viii) Lowering of tubewell assembly in to the bore hole.
- (ix) Pouring/ shrouding of gravel up to reducer into the bore hole.
- (x) Removal of rig from the site.
- (xi) Verticality of tubewell.
- (xii) Shrouding of Pea gravel up to the ground level and packing of gravel.
- (xiii) Holding of tubewell with clamp and covering of top with steel cover.
- (xiv) Making of temporary brick platform in the proximity of the tubewell.

Sketch showing drilling of Bore by Reverse Rotary Rig

Q4. Describe following:

- (i) **Development of a tubewell with scheme sketch.**
- (ii) **Verticality test of a tubewell with scheme sketch.**

Ans.4 :-

- (i) **Development of a tubewell with scheme sketch.**

Development of is an essential operation in the completion of a well to get maximum discharge free of sand, silt and clay. This operation creates larger passages in the formation through which water can flow more freely increasing permeability and porosity of a well to bring maximum yield. Well development grades the material in the aquifer around the screen and stabilizes formation. There are four methods for development of a tubewell but the air compressor is mainly used for the purpose:-

- (a) Development with pump
- (b) Development with surge plunger
- (c) Development with air compressor
- (d) Development with high velocity jetting tool.

Development with air compressor :-

The water wells are effectively developed by means of compressed air. It helps in breaking the mud cake and opening of aquifers. Education line and air line are dropped into the tubewell. Submergence of air line in the well is made by 60% minimum. Air pressure is applied through air line which creates turbulence in the aquifer and resets its grain and formation. Pumping is stopped when there is no sand/clay coming out of well and water is clear.

- (ii) **Verticality test of a tubewell with scheme sketch.**

Verticality of a tubewell should be true to the line for better yield and better life of a turbine pump. A tubewell out of plumb can cause severe wear on pump shaft, bearings, discharge casing. Recommended deviation of a well is 100 mm per 30 mts which should be one plane only. In case of gravel shrouded tubewell if pipe assembly is found in slanted position before pouring of gravel, the assembly should be pulled in desired direction to make it perfect vertical. The verticality of a tubewell is tested by using a plumb line and disc 10 mm lesser in

diameter as of casing pipe diameter. It is tied with a tripod pulley 3 m above the tubewell top. Two planes N-S and W-E indicating direction are created with steel wire and inserting datum point is made concentric with the pulley centre. Knots are made at every 3 m on plumb line which indicate the depth of a well. Plumb line and disc is then lowered and deviations are noted on the top of the tubewell which are tabulated on standard Performa for final derivations.

Sketch showing Verticality test of a tubewell

Performa for Verticality test of a tubewell:

1. Size of Tubewell =
2. Location of Tubewell.....
3. Internal Diameter of Tubewell.....
4. Outer dia of Disc.....(10 mm less than Internal dia of tubewell)
5. Point of suspension above top of well.....3 m above.
6. Static Water Level.....
7. Working water level.....
8. Depth of housing pipe.....
9. Discharge.....
10. Standard permissible deviation from top of tubewell.....10 mm per 3 m depth.

Depth in m below top of tubewell	Reading from arbitrary datum		Deviation from vertical at top of tubewell				Calculated Deviation from vertical at respective depth				Calculated Deviation from vertical at respective depth adding Disc correction				Remarks
	X	Y	N	S	E	W	N	S	E	W	N	S	E	W	

- Q5. (i) How will you differentiate between shallow, deep and artesian well ?**
(ii) What factors are taken into account while selecting site for a well ?

Ans.5 :-

(Sketch-----)

- (i) Shallow, deep and artesian well :-**

Shallow Well :- It is that well which goes below the water table without meeting mota formation. Shallow well derives water from the underground pervious rock or soil formation through the bottom or side of a well.

Deep Well :- It is the well which goes below the water table and finally finds its foundation in the mota formation. It is clear that mota formation is impervious. Cutting formation and getting way in another aquifer below mota formation for getting more yield comprises deep tubewell.

Artesian Well :- The water which enters through bore of mota formation with high velocity and pressure is called artesian well. Hollow space is formed progressively under the bore and increase in pressure creates fountains or jets.

It is seen from above that Shallow well does not mean of lesser depth tubewell and deep tubewell of greater depth. It depends upon the presence of mota formation available in the sub-soil formation.

- (ii) Factors to be taken into account while selecting site for a well:-**

- i) While selecting the site of new tube well, a number of factors must be known of assumed either by close examination nearby wells or a knowledge of the area gained through earlier exploration of testing of ground water system. Most of the factors, such as total available thickness of aquifer static water level, water table fluctuation and trend, the average yield and specific capacity transmissibility and or permeability are at best “averaged” from tests conducted in the vicinity of the new tube well.
- ii) Central ground water Board, Geological department, drilling contractors who have operated in the area should whenever possible be consulted, and a plan

of the area indicating tube and open wells, etc. with depth location of water bearing attrite yield static water level and quality of water tapped be obtained.

- iii) Where availability of good underground potable water source is not already proved by virtue of existing successful tube wells, say in Rajasthan or Hilly areas, specialized agencies like Central Ground Water Board, Rajasthan Arid Zone Research Institute Rajasthan underground water Board should be consulted before deciding location of a tube well. Test drilling to determine the strata water level, aquifer and quality of water could also be thought of before deciding on the location of tube wells.
- iv) There should be no kutchha sullage water drains septic tank, chemical factories or sugar mills in the vicinity, causing contamination of sub soil water . There can be no arbitrary rule governing the distance necessary for ensuring safety between a ground water well and a source of contamination. Many factors such as slope and level of ground water and soil permeability effect the removal of bacteria in ground water. As a rule, however, the distance should be the maximum that economics, land owner-ship, geology and topography will permit.

Table given below gives the recommended minimum distance between ground water well and various sources of contamination. The distances given are suggested values to be used only as a guide. The under certain conditions, these distances may be inadequate and have to modified. Where local health regulations are in force, these should be met Table 1. Recommended minimum distances between ground water wells and various sources of contamination.

	<u>Contamination sources</u>	<u>Recommended distance (in metres)</u>
	Building sewer	15
	Septic Tank	15
	Disposal field	30
	Seepage pit	50
	Cess-pool	45

	14
Dry well	

- v) A careful investigation should be made while locating wells in areas containing coarse gravel, fissured rocks or lime-stone formations, since pollution may be carried directly to the ground water supply through solution channels and without natural filtration.
- vi) Distance between the proposed and old well if any should not be less than 150 mts. so that yield from the new source does not affect the yield of the old source.
- vii) There should be no high building, main line track or overhead tank within radius of 30M. In each case there is a danger of well collapsing during drilling.
- viii) There should be no overhead wiring within radius of 15M.
- ix) There should be no cavity within a radius of 45M. In such case sometime the cavity starts absorbing the water fed into the hole collapses.
- x) There should be equal distribution of water to the adjacent areas, and pipe layout required should be economical.
- xi) A well should be located on the highest ground practicable.
- xii) The well should be so located as to facilitate access for pump repair, cleaning, treatment, inspection and power connection should be available nearby, availability of load may also be checked up and site plan got approved by Elect. Branch.
- xiii) Near the site of tube well clear space of at least 30mX30M and continuous water supply from a 3" dia pipeline should be available at the proposed site in case drilling is to be done by Reverse Rotary Rig.

Q. 6:- A tubewell is 0.46 metre in diameter. The unconfined aquifer is of 18 metres depth. After draw-down, working water level is at 12 metres. Permeability of soil is 24.50 metres/day. Radius of influence is 275 metres. Calculate the discharge of the tubewell?

Ans.6 :-

Sketch.....

$$Q = \frac{\pi \cdot P (H_1^2 - H_2^2)}{2.303 \log_{10} R/r}$$

Where Q = Discharge in cubic metre per day

P = Permeability of soil = 24.50 m/day

 H_1 = Static water level above impervious aquifer = 18 m H_2 = Working water level above impervious aquifer after depression = 12 m

R = Radius of influence = 275 m

r = Radius of tubewell = 0.23 m

$$Q = \frac{\pi \cdot P (H_1^2 - H_2^2)}{2.303 \log_{10} R/r} = \frac{\pi (24.5) (18^2 - 12^2)}{2.303 \log_{10} 275/0.23} = \frac{\pi (24.5) (180)}{2.303 \log_{10} 1200}$$

$$= \frac{\pi (24.5) (180)}{2.303 \times 3.079} = 2000 \text{ cubic metre/day}$$

Q. 7:- A tubewell is driven in a confined aquifer of 24 metres thickness. The aquifer is met 25 metres below ground level. The discharge of tubewell is found to be 6000 metres³/day when depression head is 12.25 metres. Permeability is 24.50 metres/day. Find out the diameter of the tubewell.

Ans.7 :-

Sketch.....

$$Q = \frac{2\pi.P.m(H_1 - H_2)}{2.303 \log_{10} R/r}$$

Where P = Permeability of soil = 24.50 m/day
 m = Thickness of confined aquifer through which tubewell is driven = 24 m
 H₁ = Static water level above impervious aquifer
 H₂ = Working water level above impervious aquifer after depression
 Depression head = (H₁ - H₂) = 12.25 m

R = Radius of influence = 300 m

r = Radius of tubewell = ?

Q = Discharge = 6000m³/day

$$Q = \frac{2\pi.P.m(H_1 - H_2)}{2.303 \log_{10} R/r}$$

$$6000 = \frac{2\pi \times 24.5 \times 24 \times 12.25}{2.303 \log_{10} R/r}$$

$$\log_{10} \frac{300}{r} = \frac{2\pi \times 24.5 \times 24 \times 12.25}{2.303 \times 6000}$$

$$\log_{10} 300 - \log_{10} r = \frac{2.4 \pi}{2.303}$$

$$2.4771 - \log_{10} r = 3.275$$

$$\log_{10} r = -0.79788$$

$$r = 0.16 \text{ m}$$

Hence, D = diameter of TW = 0.32 m

Q. 8 :- What are recommended limits of Physical, chemical and bacteriological contents in water ? Numerical values of limits be given?

Ans.8 :-

Impurities in water may be classified as **Physical, chemical and bacteriological**.

Physical characteristics relates to its appearance, colour, taste and odour etc.

Chemical impurities may be organic or inorganic.

Physical and Chemical standards of quality of drinking water are tabulated below.

Bacteriological impurities are the most important from the point of safety of public health. Bacteria are of various kinds. Many of them are either harmless or beneficial to mankind. Bacteria which cause diseases are known as Pathogenic Bacteria. Water should satisfy coliform count in a sample of 100ml which should be **zero**. The pathogenic bacteria are generally inherent in coliform group of bacteria known as Eschcrichio coli (E-Coli). The presence of E-coli indicates the possible existence of pathogenic bacteria such as typhoid-bacillus.

Physical and Chemical standards

S.N.	Characteristics	Requirement (Desirable Limit)	Permissible limit in the absence of alternate source
1.	Turbidity (NTU scale)	5	10
2.	Colour Haten units	5	25
3.	Taste and odour	Unobjectionable	-
4.	Ph- value	6.5-8.5	No relaxation
5.	Total dissolved solids (mg/l) max.	500	2000
6.	Total hardness as CaCO ₃ (mg/l) max	300	600
7.	Chlorides as Cl ₂ (mg/l) max	250	1000
8.	Sulphates as SO ₄ (mg/l) max	200	400
9.	Flourides as F (mg/l) max	1.0	1.5
10.	Nitrates as NO ₃ (mg/l) max	45	100
11.	Calcium as Ca (mg/l) max	75	200
12.	Iron as Fe (mg/l) max	0.3	1.0
13.	Zinc as Zn (mg/l) max	5.0	15

14.	Mineral oil (mg/l) max	0.01	0.03
15.	Copper as Cu (mg/l) max Toxic material	0.05	1.5
16.	Arsenic as As (mg/l) max	0.05	No relaxation
17.	Cadmium as Cd (mg/l) max	0.01	No relaxation
18.	Lead as Pb (mg/l) max	0.05	No relaxation
19.	Residual free chlorine (mg/l) max	0.2*	-

* CMD/NR had pointed out that as per Rly. Bd. Instruction/Medical Manual it should be taken as 0.5 ppm minimum.

Q. 9 :- How will you testify following checks to ascertain water quality:-

- (i) **Physical Test**
- (ii) **Chlorine Test**
- (iii) **TDS test**
- (iv) **Bacteriological Test_**

Ans.9 :-

- (i) **Physical Test :-** The test implies the physical properties of water such as colour, turbidity, taste and odour.

Colour :- If we visualize the water in a glass, it should be free from suspended impurities and should be sparkling in colour. There should not be any sedimentation in pure water.

Turbidity :- Water is turbid when it contains visible material in suspension. It can also be visualized in a glass.

Taste & Odour :- Water when taken in, should be free from odour and should be tasteful.

- (ii) **Chlorine Test :-** At present residual chlorine is testified with the help of a testes known as 'Chloroscope'. It is having standard type of comparable digitted test tubes having chlorinated sealed water displaying different colours in accordance with chlorine content. To start with, water is taken from a running tap in a test tube and 4-5 drops of 'orthotulidine' solution is poured in. If chlorine is

present in water, its colour changes into yellowish which can be compared with standard test tubes. If chlorine is nil in water, colour of water will not change.

- (iii) **TDS test** :-Total dissolved solids are in the water due to suspended dissolved impurities. Its highest desirable limit is 500 and maximum permissible limit is 1500. Due to high content presence of TDS, the water taste is hard and tasteless. The test is conducted with the help of ‘**TDS Meter**’ which gives direct digital reading when dropped in water. In this, water to be tested is taken in a glass and TDS Meter is dipped into it. It gives direct numerical value of water.
- (iv) **Bacteriological Test** :- Water should satisfy coliform count in a sample of 100ml which should be zero. Due to presence of pathogenic bacteria, it makes the water bacteriologically impure which is dangerous for human consumption. The pathogenic bacteria are generally inherent in coliform group of bacteria of which the Bacillus coli formally known as ‘B-Coli’, now known as Escherichio coli (E-Coli). The E-Coli inhabits in intestinal tracts of warm blooded animals. The presence of E-coli indicates the possible existence of pathogenic bacteria such as typhoid-bacillus. So it is important to test water for presence of E-coli before declaring fit for human consumption. The E-coli test in water is carried out by incubating the sample at 30 degree centigrade for 24 to 48 hours. The production of gas and acid in test tube indicate presence of E-coli. Then referring to standard statistical tables (M.P.N.) most probable number of E-coli per 10 ml of water can be found out.

Q. 10:- Describe the methods to check different water levels and draw down of a tubewell.

Ans.10 :-

It is essential to have correct water levels and discharge of a well in view to find out its performance. Following methods are generally used to check water levels and draw down of wells:-

- (i) Wetted Tape Method
- (ii) Electric sounder method
- (iii) Air line method

(i) **Wetted Tape Method** :- Graduated steel tapes are used for measuring the water levels. The float may consist of hollow metallic cylinder tied at the bottom of the tape. The tape is marked with the chalk. Now the tape is lowered into the water and wetted line on the tape can be read to know the static water level. Same is followed to know the pumping water level after pumpage of well. The difference between two is the draw down of the well.

(ii) **Electric Sounder Method** :-

Sketch.....

Electric sounder method is the easiest method for measuring the water level and draw down. It is the device consisting of an electrode, insulated wire, a battery and an ammeter by which electric contact is made when the sounder strikes the water surface in the well.

In this method, a single conductor insulated wire is connected to an electrode at one end and other end is connected with the casing of the pump. As soon as the electrode touches the water surface, the circuit is completed and meter gives a reading. The depth of water can be known by measuring the amount of wire in the well.

(iii) **Air Line Method** :- The device consists of a tube made of copper 6 mm in diameter having sufficient length. The air/copper line is lowered into the annular space between the pump column and tubewell. The device works on the principal that air pressure required to push all the water out of submerged portion of air line is equal to the water pressure of a column

of water of the height. In this method, air line is lowered 3 m below the limit of draw down from the top of tubewell to the lower end of air line is determined. At this stage when no pumping is done, air line is full of water up-to the level of water in the well. Now air is pumped in to the air line until maximum pressure is reached. On pumping, water in the air line is expelled and air line is full of air. From the record of pressure readings, the depth of water can be calculated as below:-

$$d = L - l$$

Where d = Depth of water in mtrs.

L = Depth of bottom of air line in mtrs.

l = Pressure head in mtrs (Submerged length of air line)

Sketch.....

23. Surveying, Building & Construction Materials, Soil Mechanics, Project Reports

Q.No.11 what points require attention while doing survey for the provision of additional lines alongside the existing track?

Ans. In carrying out the survey for the provision of additional lines alongside the track the following points require attention.

The projected line should be laid parallel to the existing line as far as possible on the right-hand side or on the left hand side, depending on:

- (i) Location of telephone and telegraph wires.
- (ii) Location of existing station buildings and other goods facilities.
- (iii) Construction of new bridges with least interference to traffic on the existing line as far as possible.
- (iv) In sections where there are pronounced directional movements of empty and loaded traffic, the possibilities of running heavier train loads with multi engine operations and its effect on the existing bridge structures should be taken into account.

Q.No.12. Define classification of bricks and its merits over stones.

Ans. Bricks are generally classified into following categories:

(i) First class bricks:

These bricks are well burned having smooth and even surface, with perfect rectangular shape and of uniform reddish colour. When struck with other bricks, these give a metallic ringing sound. These should not leave any mark when scratched by fingernail. These should not absorb water more than 20% of its weight when immersed in cold water for 24 hours.

(ii) Second Class Bricks:

These are not perfectly rectangular in shape and are having rough surface but are hard, slightly over burnt and uniform in colour. These give ringing sound when struck with each other. Water absorption should not be more than 22% by weight when immersed in water for 24 hours.

(iii) Third Class Bricks:

These are not burnt properly in the kilns and may be slightly under /over burnt, hence these are soft and can be easily broken. These are light red in colour, with yellowish tinge. On striking these do not give a ringing sound. These should not absorb more than 25% of water by weight when immersed for 24 Hours.

(iv) Jhama or over burnt bricks:

Due to excess fusion and temperature, bricks get over burnt, loose their shape and get twisted. These bricks are dark bluish in colour.

As a construction material, bricks possess the following merits over stones:

- a. These are lighter in weight as compared to stones.
- b. These can be easily manufactured in uniform shape and size everywhere.
- c. These are easily laid to construct the walls of uniform thickness.
- d. These are cheaper than stones excepting in region where stones are available.

Q.No.13 What precautions should be taken in storing cement?

Ans. The following precautions should be taken in storing cement especially when in sacks:

- (i) It should be stored for the shortest period possible but not at all in the rainy season.
- (ii) It should be kept in a weather tight room.
- (iii) Damp godowns and floors should be avoided.
- (iv) It should not be stored against walls but should be 0.6 Mt away from walls.
- (v) It should be stored in close formation and covered over with tarpaulin so as to prevent circulation of air through the stock.
- (vi) Not more than 10 cement bags should be stacked one over another as due to heavy load air setting take place in bags.

Q.No.14 Define workability of concrete:

Ans. Workability is the most elusive property of concrete and is quite difficult to define and measure. In its simplest form a concrete is said to be workable if it can be easily mixed, and handled, transported, placed in position and compacted.

Evidently the requirement of workability varies according to the nature of the job, the obstruction to the full flow of concrete caused by the spacing and nature of the reinforcement. The workability of concrete can be measured by the following three tests:

- (i) Slump test
- (ii) Compaction factor test
- (iii) Vee-bee test.

Q. No. 15 Define density and optimum moisture content of a soil.

Ans. Density:

The density or true weight of a soil is equal to the specific gravity of the solid materials x1000 (weight or density of water per cum.) A soil consists of solids, pores or voids and the moisture. The overall weight of the mass (including solid particles, the effect of voids whether filled with air or water) per unit volume i.e. total weight of soil-divided by total volume of soil, is termed bulk density. Bulk density varies with the type of the soil, moisture content and its composition.

Optimum Moisture Content:

The maximum moisture content in the soil after which the addition of water creates hindrance in bringing the particles closure, is called optimum moisture content.

If the moisture content of the soil is more than the optimum moisture content, the no compaction of the soil is possible because of too wetness.

Q. No. 16 Define various kinds of surveys carried out during investigation of Railway projects.

Ans: The various kinds of Surveys which are carried out as a part of investigation of Railway projects are indicated below:

(i) **Traffic Surveys:**

This is a detailed study to make a forecast of the traffic prospects to facilitate the projection of the most promising route and the category of the line to be constructed in the case of new lines and to assess the quantum of traffic to determine the traffic facilities to be provided on an existing line. These surveys are to under-taken in conjunction with Reconnaissance or Preliminary Engineering surveys so that the technical feasibility of the alternative proposals can be taken into account while formulating the recommendations.

(ii) **Reconnaissance Survey:**

This term should apply to all rough and rapid investigations of an area with a view to determine the technical feasibility and approximate cost of one or more routes for a projected. Railway line from a general examination with the help of contoured survey of India maps and other available material without a more careful investigation of the field and with the use of only those instruments that will rapidly give approximate distance and heights such as prismatic compass, clinometers and similar instruments.

Where suitable aerial photographs are available, field investigations by instruments can be considerably avoided /dispensed with by stereoscopic studies of the photographs and site inspections as may be required.

(iii) Preliminary Survey:

This consists of a detailed instrumental examination of the route or routes selected as a result of "Reconnaissance " in order to obtain a close estimate of the probable cost of the projected line, under this survey. However, staking out of the alignment with a theodolite is not required. Whether a line is to be built or not will usually be decided on the result of the survey considered in conjunction with traffic survey. The Railway Board may, however, require the submission on an estimate based on final location survey before sanctioning the commencement of the construction.

Whether suitable aerial photographs are available, detailed instrumental examinations of the route/routes selected as a result of "Reconnaissance Survey" could be avoided dispensed with by using photogrammetric methods that involves plotting of contoured strip maps.

(iv) Final location survey

A final location survey will generally be a post investment decision investigation to prepare working details and to make accurate costing in certain cases. The principal difference between the work required in a final location survey and that in a preliminary survey is that the alignment finally selected during a survey should be fully staked on the ground with a theodolite and /or Electronic Distance Measuring Instruments, the report should be fuller and detailed plans and sections should be submitted.

Q. No. 17 Define different bearing capacity of soils

Ans The following are the different bearing capacity of soils.

(i) Bearing capacity:

The Bearing capacity may be defined as the ability of the soil to support the load of the structural foundations without failure or deformation.

(ii) Ultimate bearing capacity:

The maximum load intensity transmitted by the base of the footing of a structure to the soil causing the soil mass to fail in shear, is defined as ultimate bearing capacity.

(iii) Safe Bearing Capacity:

The maximum load intensity which the soil can take without any risk of shear failure is called safe bearing capacity of soil. It is generally calculated by dividing the ultimate capacity by a factor of safety.

Q. No. 18 What point should be noted in Traffic Survey report.?

Ans. The following points should be noted in Traffic Survey report:

- (i) History of the proposal and terms of reference.
- (ii) General Description
- (iii) Potentials and prospects.
- (iv) Industrial and economic development and traffic projections.
- (v) Population projection & volume of passenger traffic.
- (vi) Existing rates and rates to be charged.
- (vii) Location of route or routes examined, alternate routes and possible extensions.
- (viii) Station sites and their importance.
- (ix) Train services necessary section capacity and various alternatives to increase capacity.
- (x) Coaching earnings.
- (xi) Goods earnings.
- (xii) Working expenses and net receipts.
- (xiii) Engineering features.
- (xiv) Telecommunication facilities.
- (xv) Financial appraisal.
- (xvi) Conclusions and recommendations.

Q. No. 19 Define gradient and compensation for curves on gradients.

Ans. Gradients

Gradients should be defined by the distance in which a rise or fall of 1 meter occurs per 100 meters length. Thus a rising gradient of 5 meter in 100 meters is to be described "rise 1 in 200 (0.5 %)".

All lines should be graded with due regard to the possibility of additional intermediate stations being constructed later on.

Sharp changes of gradients should be avoided, if possible on curve. All sharp changes of gradient should be eased off by vertical curves.

Compensation of curves on gradients:

All gradients should be compensated for curvature if the ruling gradient would otherwise be exceeded. The compensation to be allowed should ordinarily be .04 % degree of curvature on the 1676 mm gauge, 0.03 % degree on the meter gauge, 0.02 % on the 762 mm gauge and 0.015% on the 610mm gauge. Compensation should be allowed on easy curves as well as on sharp ones.

Q. No. 20 Define Curves and give classification of circular curves in brief.

Ans. Curves are regular bends provided in the lines of communication like roads, Railways etc. to bring about the gradual change of direction. They are also used in the vertical plane at all changes of grade to avoid the abrupt change or grade at the apex. Curves may be horizontal curves or vertical curves. Curves provided in the horizontal plane who have the gradual change in direction are known as horizontal curves and those provided in the vertical plane to obtain the gradual change in grade are known as vertical curves. Curves are made out on the ground along the centre line of the work.

Classification of Circular Curves:

Circular curves are classified as:

(i) **Simple Curve**

A simple curve consists of a single arc of circle connecting to straights. It has radius of the same magnitude through out.

(ii) **Compound Curve**

A compound curve consists of two or more simple curves having different radii bending in the same direction and lying on the same side of the common tangent. Their centers lie on the same side of the curve.

(iii) **Reverse or Serpentine Curve:**

A reverse or serpentine curve is made up of two arcs having equal or different radii bending in opposite directions with a common tangent at their junction. Their centers lie on opposite sides of the curve.

These are commonly used in Railway sidings and some times on Railway track and roads meant for low speeds. They should be avoided as far as possible on main Railway lines where speeds are necessarily high.

(iv) **Deviation Curve:**

A deviation curve is simply a combination of two reverse curves It is used when it becomes necessary to deviate from a given straight path in order to avoid intervening obstructions such as a bend of river, a building etc.

Q. No. 21 Define various kinds of engineering surveys carried out.

Ans. a) **Reconnaissance Survey-** In carrying out a reconnaissance Survey particular attention should be paid to ascertaining the waterway required and the best sites for stations crossings to streams, bridges and roads. The nature of foundation which would be required for large bridges should be investigated and recorded. Materials and labour available in the area covered by the Survey should be taken note of. Ruling gradient and

degree of curvature for the proposed line as indicated in the Terms of Reference are to be considered as broad guide-line and the survey team should examine the question in detail taking into account the topography of the area, the level of traffic, the speeds envisaged the mode of traction and above all the initial cost of construction and the unit cost of service with different alternative and make their own recommendations. Prior approval of the Administration should be obtained before proceeding further with the survey in case a change in the terms of reference is considered desirable.

(b) **Preliminary Survey** – The fieldwork of a preliminary survey should include a compass traverse along one or more routes with such longitudinal and transverse levels as are sufficient to prepare a “Predicted Section” of the route or routes proposed. Where suitable aerial photographs are available for carrying out preliminary survey by photogrammetric techniques the “ predicted section” of the route or routes proposed will be determined by plotting of contoured strip maps on a 1: 10,000 scales from aerial photographs. Geological mapping may be done and soil surveying by photo- interpretation of remotely sensed data. The fieldwork should also cover a soil survey by sampling at suitable intervals, in order to obtain a fair idea of the soil classification and characteristics on the proposed route/routes. Testing of disturbed soil samples is usually adequate but Geophysical survey may be done in rocky terrain.

(c)**Final Location Survey:** A final location Survey should be based on a good theodolite or traverse, which should approximate as closely as possible to the center line to be finally adopted. Unless otherwise specified the survey operations should be sufficiently comprehensive to secure the information necessary for the preparation of the detailed plans and sections required and having regard to all the circumstances of the case to ensure that the alignment selected is the most economical obtainable. The amount of detail in sectioning will to a great extent depend on the nature of the country traversed. Cross sections should be taken wherever the Engineer considers them necessary. The information collected during the course of the survey should be such as will enable the preparation of a fairly accurate estimate of the cost of the line. Investigations should be made of bunds, bunded streams and irrigation works in the vicinity of the projected line, which might affect the future safety of the line. In arriving at decision on the waterways the engineer should pay due regard to these works and consider the alternative of altering or diverting the bunds, irrigation streams etc. even it would mean incurring some expenditure on such alternations, if that would save a large expenditure on the waterways. In the case of passage through hills , the geological characteristics of the country should be investigated by the engineer , particularly in respect of the probable stability of the line , and if the importance of the work requires it , the railway administration should apply for the assistance of an officer of the geological survey of India. As the method of construction of earthwork will be dependent largely on the nature and classification of the soil a systematic soil sampling at suitable intervals and upto sufficient depths depending upon

the nature of terrain should also be done all along the proposed route. Wherever borrow areas are not located along the alignment soil samples should be collected from such places also. These samples shall then be tested for the standard properties , bore logs prepared and the data used for designing the profiles of the embankments and cutting foundations of important structures as well as the method of undertaking the earthwork.

Q.No.22 What important points should be mentioned in Techno-Economic Survey Reports?

Ans. Techno-Economic Survey Reports are compiled based on preliminary Engineering-cum-Traffic Surveys for new lines and traffic facilities. Points to be given are:

- (i) Introduction.
- (ii) Traffic projection.
- (iii) Analysis of alternatives.
- (iv) Characteristics of project area.
- (v) Standards of construction (for new lines, multiple tracking scheme, gauge conversions).
- (vi) Route selection/project description.
- (vii) Project Engineering (for new lines, multiple tracking schemes and gauge conversions).
- (viii) Cost, phasing and investment schedules.
- (ix) Financial Appraisal
- (x) Recommendation.

Q.No. 23. Explain details of Civil Engineering works to be carried out in gauge conversion projects.

Ans. (i) Engineering –cum-traffic survey:

The survey is done to examine technical feasibility of the proposal and the economical aspects of the same.

(ii) Land acquisition:

The land required for converting the track is assessed extra land if necessary is required as per extent procedure laid down in Land Acquisition Act.

(iii) Earth Work:

Earthwork is done on either side of existing formation to increase its width if necessary.

(v) Bridges and culverts:

The existing bridges and culverts are extended to suit the B.G formation and to conform to standards adopted for B.G. Proper

planning is done to extend these bridges, as the work has to be done with minimum dislocation to traffic.

(vi) **Track Linking:**

Unloading of Track Materials: Track materials viz Rails, sleepers and fastenings are taken from the base depot to the site of work and unloaded at the final location. Preliminary works like proper matching of rails, drilling of holes in the rails etc. are planned in advance.

Interlacing of sleepers: Wooden sleepers, if available, are best suited for gauge conversion projects. The wooden sleepers are interlaced in between the existing sleepers of the track and spiked to the existing rails.

Arrangements of men and Materials: Detailed planning of manpower including the supervising staff is with minimum interruption to traffic. Normally about 50 to 100 men per KM are required to do the track work during traffic block. In addition skilled artisan staff like blacksmiths and hammer men are also required for the above work. All the track material including fittings are properly organized and arranged at site. Tools and equipments like augers and drills, Jim crows, crowbars, rail tongs, sleepers tongs, spanners, etc. are also arranged in adequate quantities.

Traffic Blocks: Traffic is suspended on the railway line for a period of about 15 to 30 days depending upon the length of track so that the work of gauge conversion can be carried at one stretch. During the traffic block, traffic is diverted on alternate routes or transshipped and carried by road vehicles.

Linking the new track: During the traffic block, the existing rails are removed and new rails placed in the final position for B.G track. The new sleepers are placed in proper position and the rails spiked to the sleepers as per B.G requirements. The track is properly leveled and aligned and traffic is allowed to pass on the new line at the restricted speed after obtaining the sanction of commissioner of railway safety.

Ballasting and Packing: Adequate quantity of ballasts then put in the track properly packed the speed restrictions are gradually relaxed as the stability of track improves.

Q. No. 24 What will you do for earth work in Construction Projects.

Ans Initial Measurements for earthwork

- (i) Before commencement of earthwork, initial cross sections are required to be taken in cuttings at an interval of 20 mts. and for banks at intervals of 50 meters. However, they may have to be taken at closer intervals in cases where the land has heavy undulations.
- (ii) The cross sections are recorded in the presence of a contractor's representative by means of a Dumpy level, with levels being recorded every 5 meters or wherever change of gradient occurs. For this purpose, the toe of slopes of banks outside limit of cuttings on both sides of the center line are assessed approximately on the basis of the height of embankment/ depth of cuttings at the respective chain ages. The cross section readings are then recorded over a distance of about 10 to 15 meters beyond this point on either side.
- (iii) The reduced levels thus obtained are plotted on graph sheets, using suitable horizontal and vertical scales, to give the ground profile. This forms the basic record of the calculation of earthwork quantities for which payment is to be made to the contractor. The cross sections are also useful in locating the exact toe lines of cutting and embankments, to enable accurate commencement and execution of work. The desired profile of the cutting/embankment along with side slopes etc. are drawn on the ground profile based on which work is executed.

Calculation of Earthwork:

On completion of the work the profile of the executed work i.e. cutting/embankment is again recorded in the cross-section sheets at the same chainages where initial cross section were taken. This enables us to calculate the cross section area of the work executed at the respective chain ages. The average of such areas between them, gives the quantity of earthwork executed between the two chainages. In this manner, the earthwork is calculated for the entire length of cuttings/embankment. Normally, cross-sections are invariably taken at 'null points' i.e. chainages where cutting/embankment end, including locations of abutments of major bridges, beginnings of tunnels etc.

Where embankment is to be executed from borrow-pits in Railway land beyond the toe of embankment, the initial cross-sections are to be recorded similarly, for calculation of earthwork. Usually in such cases the cross-sectional measurement for the particular chain ages in embankment is extended sufficiently beyond the toe to cover the borrow pit area.

Deductions:

While calculating the quantity of earthwork for payment, deductions are made from the gross quantity, of bridge structures, opening and other gaps. For embankments, the gross quantity is reduced by the shrinkage allowance, which is usually specified as follows:

- (a) Where embankment has been compacted by heavy mechanical machinery- 5% of gross quantity
- (b) Where earthwork is executed without heavy mechanical machinery- 10% of gross quantity.

In cases, where an embankment is executed both by means of earthwork from cutting as well as borrow pits, fresh cross sections are to be taken at the level where one category of earthwork is completed before commencement of the other category.

Q.No.25 Write in details about blanket and blanketing material.

Ans. Blanket can be defined as an intervening layer of superior material, which is provided in the body of the bank just underneath the ballast cushion. It is different from sub-ballast, which is provided above the formation. The function of the blanket are two fold:

- (a) To minimize the puncturing of stone ballast into the formation soil.
- (b) To reduce the ingress of rainwater in the formation soil.

The blanket should generally cover the entire width of the formation from shoulder to shoulder except that in case of sand or similar erodable material, it should be confined within berms of width 60 to 70 cm. The depth of the blanket should normally be about 30 cm. in ordinary clay soil. However, in formation soil is particularly weak, a thicker layer upto 60 cm may be necessary depending on the shear properties of the formation soil, blanket material should have the following properties.

(a) For sand, quarry grit, gravel and other non-cohesive materials:

- (i) The blanket material should be coarse and granular.
- (ii) If the material contains plastics fines, the percentage of fines i.e. particulars upto 75 microns should not exceed 5% if fines are non-plastic, these can be allowed upto maximum of 12%.
- (iii) The material should be properly graded and its particle size distribution curve should lie within the standard enveloping curves.

(b) For moorum:

- (i) The liquid limit should not exceed 35 and plasticity index should be below 10.
- (ii) Uniformity coefficient (D60/D10) should be above 4 and preferable above 7. Coefficient of Curvature, which is $D_{60}^3 / (D_{30} \times D_{10}^2)$, should be within 1 and 3.
- (iii) When moorum is used as blanketing material, should be compacted in suitable layers at or near the optimum moisture content, so as to achieve not less than 90% of the maximum dry density as determined using heavy compaction.
- (iv) If erodable material is used as blanket, it should be confined in a trench and sand drains should be provided across the cess to drain the track and blanket. These cross sand drains with adequate slope should be 5 to 10 cm below the bottom of the blanket and spaced 2 to 4 metres apart.

Q.No.26 What is soil exploration and what tests will you do for unstable formations.

Ans. Before widening of formation for Gauge conversion and Doubling projects, it is necessary to ensure that the existing formation is stable and trouble free. Failure of existing formation is generally accompanied by signs of distress or instability. These location should be subjected to examination in the shape of soil exploration and testing as per details given in the table.

Soil exploration and testing for troublesome formations

Type of failure	Symptoms at site	Soil exploration and data collection	Soil testing
1. Base failure	Base settlement; loss of longitudinal profile; Heaving of soil beyond toe; Leaning of telegraph posts trees etc. at the toe.	Recording of bank profile Field tests viz, vane shears DCP/SPT Undisturbed sampling.	Classification tests consolidation tests Natural moisture content and natural dry density test.
2. Slope failure	Flattening of bank/slope Bulging of slope surface Longitudinal cracks on cess / slopes Leaning of OHE masts Oozing of water from slopes	Recording of bank profile Survey and recording of Surface cracks. Undisturbed sampling.	Classification tests Lab. shear tests Swell Tests Natural Moisture content and Natural dry density tests.

3. Sub grade failure (by shear)	Soil heaving on cess and on slopes. Ballast penetration exceeding 30cm below formation Excessive cross level variations. Excessive labour inputs.	Recording of bank profile and ballast penetration inside sub grade collection of data track geometry variations labour inputs. Quantum of ballast recoupments speed restrictions imposed un-disturbed soil samples from below the ballast penetration.	Classification tests. Shear tests. Swell tests. Natural moisture content & natural dry density tests.
4. Sub grade failure by mud pumping	Fouling of ballast with sub-grade fines. Ballast penetration below formation- 30cm or less. Impaired drainage excessive cross level variations in monsoons Excessive labour inputs in monsoons hard running during summer	Recording of bank profile & ballast penetration inside sub-grade. Collection of data track geometry variations natural dry density tests. Labour inputs. Speed restriction imposed. Un-disturbed soil samples below the ballast penetration.	Classification tests. Shear tests. Swell tests Natural moisture content & natural dry density test.

Q.No.27. What is the classification of earth worth in Railway projects?

- Ans.**
- (a) **Soft Soil:** Comprising any of the following:
Vegetable or organic soil, turf, sand, cinder, gravel, loam, clay, mud, peat, black cotton soil or loose moorum etc. or previously dug earth or a mixture of these as can be excavated by spade or shovel.
- (b) **Medium hard Soil:**
Requiring close application of picks only.
- (c) **Hard Soil or Soft rock:**
Comprising any of the following:
- (i) Stiff heavy clay, hard shale, or compact moorum etc. requiring crowbar and /o pick and shovel closely applied.
- (ii) Generally any material which requires close applications of picks and crow bars or scarifies to loosen.
- (d) **Rock:**
Comprising any of the following:

Subjective Questions

- (i) Lime stone, sand stone, laterite, hard conglomerate or other soft or disintegrated rock etc. which can be quarried or split with crowbars or wedges; but not requiring blasting.
- (ii) Rocks above variety, but hard, requiring light blasting.
- (iii) Any rock for the excavation of which the use of mechanical plant for boring holes and blasting is required on an extensive scale.

These are separately listed out in the Schedule of Rates and are usually combined into 2 to 3 categories viz. ordinary soil rock not requiring blasting (NRB) and rock requiring blasting (RRB) etc.

For the purpose of payment, the cutting shall be assumed to be composed of such soil/soils as stand exposed on the side of the finished cutting and the quantities calculated by drawing horizontal lines to the center.