BALASORE SCHOOL OF ENGINEERING

SUBJECT-RAILWAY & BRIDGE ENGINEERING

SUBJECT CODE-CET (TH-03)

BRANCH-CIVIL

SEMESTER-5TH

ER.DEEPALI BARIK

CHAPTER – 1

MEDIUM TYPE,

Q1. What is the advantages of Railways.(2019-1(b))

Ans: A part from transportation of goods and human beings from one corner of the country to another railways also have brought political, social and economic changes in the life of the society.

A. POLITICAL ADVANTAGES:-

i. Due to the adequate network of railways, the central administration has become more effective and easy.

ii. Railways have provided opportunity of meeting people from different parts of the country, developing a sence of national unity.

iii. During war or emergency, droops and material can be transported from one place to another with out loss of time.

B. SOCIAL ADVANTAGES:-

i. Railways provide safe & convenient mode of transport to the people.

ii. Railways have made easier to visit religious place.

C. ECONOMIC ADVANTAGES:-

i. the mobility of masses has contributed to the industrial development.

ii. Railways have provided facilities of transporting raw materials to the factories & finished goods to the areas of consumption at reasonable cost.

CHAPTER:2

Q. Define a permanent way 2016(w) 2013, 7(vi)

Ans: The combination of rails fitted on sleepers and resting on ballast and sub grade is called the railway track or permanent way.

Q. Write down the different types of railway gauge in India with their gauge width. 2010(w)

Ans: In India the following gauges are used.

Types of Gauge	**Gauge width**
Broad Gauge(B.G.)	1.67 m
Metre Gauge (M.G.)	1 m
Narrow Gauge (N.G.	0.762 m
Light Gauge (L.G.)	0.610 m

Q. Define the Gauge in railway Engg. 2006 (w)

Ans: The gauge of a track in India is measure as the minimum distance between the inner running or gauge faces of the two rails.

Q.Define cant.2019 1(a)

ANS:

Q. What do you mean by permanent way Mention the requirements of an Ideal permanent way. 2016, 2(b), 2013, 7(vi)

Ans: The combination of rails, fitted on sleepers & resting on ballast & sub grade is called permanent way.

Requirements of an ideal permanent way

A good track should provide comfortable and safe journey at the maximum permissible speed with minimum maintenance cost. To achieve these objectives the track should met the following requirements .

i. The gauge of the track should be correct and uniform.
ii. The alignment of the track should be correct.
iii. The rails should have perfect cross levels on curves the outer rail should have proper super elevation to take into account the centrifugal Forces.
iv. the gradient should be uniform and as gentle as possible.
v. the drainage system of the track should be perfect, so that the stability of the track is not affected due to water logging.
vi. The friction between the wheels of the railing stock and rails should be minimum.
vii. The track should be designed in such a way that the load of the train should be distributed uniformly over it.

CHAPTER:3

Q.1. Define sleeper density. 2013(s) 3(a) 2014, 1(a)

Ans: Sleep density represents the number of sleeper rail length in meters.

Q.2. What do you mean by Creep rails ? 2010 (w), 1(c)

Ans: Creep is defined as the longitudinal movement of rails with respect to sleepers in a track.

Q.3. Write the types of rail seen used in our country. 2009(w), 1(f)

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

i. Double headed rails
ii. Bull headed rails
iii. Flat footed rails

Q.4. Describe briefly the purpose of providing fish plate. 2012(w), 2014 , 2(a)

Ans: Fish plates are used in rail joints to maintain the continuity of the rail & to allow for any expansion or contraction of the rail caused by temp. variations. They maintain the correct alignment of the line both horizontal and vertically.

Q.5. What is the standard life of concrete sleeper. 2012(s) 1(viii)

Ans: The standard life of concrete sleeper as 40 to 60 yrs.

Q.6. Determine the no. of sleepers for construction a B.G. track 936 m long. Adopt sleeper density as n+7. 2012(s), 1(ix)

Ans: Length of each rail on a B.G. track = 12.8m. Total no. of rails required = 936/12.8 = 73 rails.

Sleeper density is n+7

No. of sleeper each rail 13 + 7 = 20

Total no. of sleeper required = 73 × 20 = 1460.

Q. 7.Define ballast . 2015, 1(a)

Ans: It is material that is used to provide stability to a rail track.

Q.8. What is fish plate ? 2015, 2(a)

Ans: Fish plate resembling is shape of fish are used to provide the continuity between the two rails at the rail joints.

→ they also provide the required gap for expansion and contraction of rails due to temp. variation.

5 mark

Q.1. Write the physical properties of a good ballast. 2010(w), 2(A) 2014, 2(B)

Ans: The physical properties of a good ballast is as follows:

→ It should be able to withstand hard packing without disintegrating.

→ It should not to make the track dusty or muddy.

→ It should be allow for easy drainage.

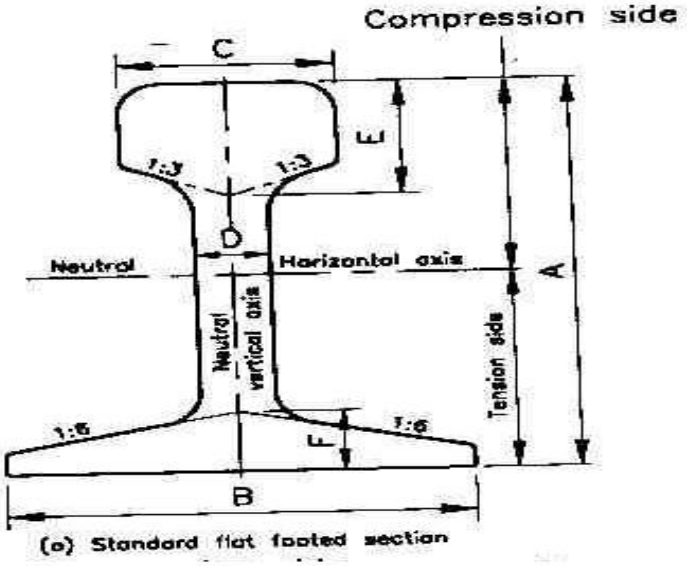
→ It should offers resistance to abrasion and weathering.

→ It should retain its position laterally longitudinally under all conditions of traffic particularly on curves.

→ The size of store ballast should be 5 cm for Wooden sleepers, 4 cm for metal sleepers and 2.5 cm for turnouts and crossovers.

Q.2. Draw a neat sketch of Bull headed rail with proper dimensions. 2013, 5(b)

Ans:



Q.3. Describe briefly about the purpose of providing fish plates with sketch. 2013, 6(b)

Ans: Fish plates are used in rail and follow for any expression or contraction of the rail caused by temperature variations. They maintain the correct alignment of the line with horizontally and vertically.

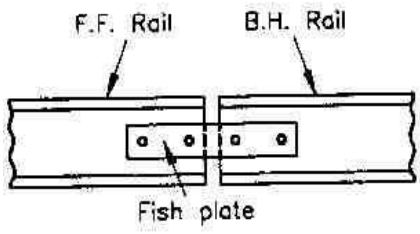


Fig. 7.6. Compromise Joint.

Q.4. Describe the railway boards classification based on importance of route traffic carried and maximum permissible speed. 2016, 1(b)

Ans: Classification of Indian railways

All the B.G. routes in India of Indian Railways have also been classified based on speed criteria. According to this method, the B.G. railway lines can be divided into the following five groups.

1. **Group 'A' Lines:** They consist of those trunk routes on which the trains are running or are meant for running the trains at a speed of 160 km p.h. or more. At present, the following routes come under this category.

i) Central/New Delhi to Howrah by Rajdhani route.

ii) New Delhi to Mumbai Central via Kota by Frontier mail/Rajdhani Route.

iii) New Delhi to Chennai Central by Grand Trunk route.

iv) Howrah to Mumbai V.T via Nagpur.

2. **Group 'B' Lines:** They consist of those routes on which the trains with a maximum sanctioned speed of 130 kmph. are running or are intended to run. At present, nearly 13 routes come under this category e.g., Allahabad to Bhusaval, kalian to Chennai, Kharagpur to Vijayawada, Wadi to Kazipet, Howarh to New Jalpaiguri, Sitarampur to Mughalsarai, Kiul to Barharwa, Delhi to Kalka, Ambala to Pathanokot, Ambla to Mughalsarai, Arkonam to Coimbatore, Vadodara to Ahmedabad and Jalanpet to Bangalore.
3. **Group 'C' Lines:** They consist of all suburban routes of Mumbai, Calcutta and Delhi.
4. **Group 'D' Lines:** All other routes in the country where maximum permissible speed at present is 100 kmph.
5. **Group 'E' Lines:** The other routes and branch lines where the permissible speed limits are less than 100 kmph.

The above classification based on speed criteria has been made for specifying the track standards.

[7 mark]

Q.1. Define Gauge of the railway track. Discuss different gauges used in India with their suitabilities. 2016, 2(c)

Ans: Gauge of the railways track.

i. B.G. $\rightarrow$ 1.676

ii. M.G. $\rightarrow$ 1 m

iii. N.G. $\rightarrow$ 0.762 m

Q.2. Describe the methods of maintenance of railway track. 2015, 2(b)

Ans: MAINTENANCE OF TRACK.

In America and other developed countries mechanical appliances are largely used The maintenance to track can be divided in to two parts:

a) Daily maintenance, and

b) Periodic maintenance.

DAILY MAINTENANCE:

Daily maintenance is carried out by the full time staff maintained through out the year. The use of maintenance gangs, all along the railway track, is made. The railway track is divided in suitable sections of 5 to 6 km length. One gang is attached to section for maintaining that section in good condition.

PERIODIC MAINTENANCE:-

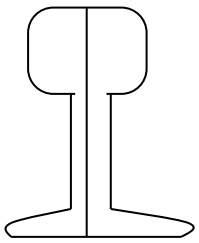
Periodic maintenance is carried out after an interval of 2 to 3 years. During periodic maintenance, the gauge, levels detected, the causes are determined an finally

remedial measures taken. The track is made in perfect condition by removing all its major and minor defects. The subject of maintenance is very wide. The maintenance of track includes the following items of maintenance in good condition.

1. Surface of rails.
2. Track – Alignment.
3. Gauge.
4. Proper Drainage.
5. Track components.
6. Bridges and its Approaches.
7. Rolling Stock.
8. Points and Crossings.
9. Level Crossings.
10. Tunnels

Q.3. Draw the neat diagram of a flat footed rail what are the requirements of an ideal rail section. 2015, 2(c)

Ans: Flat food rail. To remove the above draw backs. Charles vignole developed a inverted T shaped section known as flat footed rail in 1836. Flat footed rail is also known as vignole rail as shown in fig. It has the following advantages over double headed and bull headed rails.



Requirements of an ideal rail section

Following should be the characteristics of an ideal rail section:

1. the rail should posses adequate lateral and vertical stiffness.
2. the shape of the bottom of the head and top of the foot should be such that the fish plate could be fixed easily.
3. The centre of gravity of the rail section should be located very near the centre of the height of the rail so that the maximum compressive and tensile stresses are equal.
4. The depth of the rail head should be sufficient to allow the sufficient margin for the vertical wear.
5. The rail should be shaped suitably.
6. The metal distribution in head, web and foot of the rail should be properly balanced.
7. The surfaces and gauge faces of the rail should be hard and capable to resist wear.

8. The thickness of the web of the rail should be sufficient to withstand the load likely to come on the rail.
9. The width of the foot of the rail should be sufficient to spread the rolling stock load on a large area of sleeper.
10. The contact area between the rail and wheel should be sufficient to minimize the contact stresses.
11. In short, the rail should have most economical section consistent with strength, stiffness and durability.

Q.4. What are the different types of rails ? Explain type of rails with neat sketch?
2016, 1(c),2019 -2(b)

Ans: Types of rails:

Rails can be classified into the following categories.

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

DOUBLE HEADED RAIL:-

Originally the rails used were double headed made of 1 section or Dumb bell section as shown in fig. The idea was that when the head of the rail is worn-out during the service period, the rail could be inverted and reused with out incurring any extra expenditure. Such rails have to be supported on chairs which rest on sleepers. But later it was found that during the service the bottom table of the rail was deneted by the long and continuous contact with the chair to such an extent that it was impossible to reuse it. This led to the development of Bull headed rail.

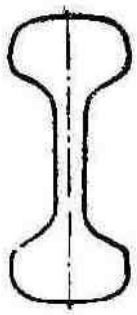


Fig. 4.1. Double Headed rail

BULL HEADED RAIL.

As shown in fig., the Bull head rail is almost similar to double head rail . The only difference between the double headed rail and Bull head rail is that in Bull headed rail more metal is added to the head to allow greater wear and tear. The lower head or table was kept of just sufficient size to be able to withstand the stress to be induced by the moving load. This rail also.

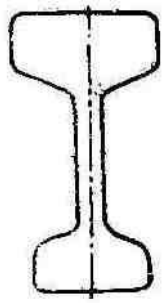


Fig. 4.2. Bull headed

Q.5. Write down the requirements of good ballast. 2013, 6(c)

Ans: i. It should be able to withstand hard packing without disintegrating. In other words is should resist crushing under dynamic loads.

ii. It should not make the track dusty or muddy due to powder under dynamic wheel loads but should be capable of being cleared to provide good drainage.

iii. It should allow for easy drainage with minimum soakage and the voids should be large enough to prevent capillary action.

iv. It should offer resistance to abrasion and weathering.

v. It should not produce any chemical action with rail & metal sleepers.

vi. The material should be easily workable by means of the implements in use.

vii. The ballast should be available in nearly quarries so that it reduces the east of supply.

Q.6. Causes of creep and prevention. 2013, 7(b), 2016, 4(b)

Ans: Causes of Creep in rails are :

i. Wave action or wave theory wave motion is set up by moving loads of wheels.

ii. Percussion theory: This theory states that the creep is due to impact of wheel at the rail end ahead at joints.

Prevention is always better than cure. If creep is not prevented in time, it will result in derailment following are the common methods adopted to prevent creep.

i. Pulling Back the rails

ii. Provisions of Anchors or Anti creepers.

Q.7. What are the requirements of rail Joints ? Discuss the different types of rail joints with the help of neat sketches with relative merits and demerits. 2015, 1(b),2019,4(b)

Ans: An ideal or perfect rail joint is one which provides the same strength and strength and stiffness as the other rail section of the track. The following requirements should be met by an ideal joint:

i. The two rail ends should remain true in line both laterally and vertically when trains move on the track. This is necessary to avoid wheel jumping or changing its correct path of movements.

ii. The rail joint should be as strong and stiff as the rail itself and should be elastic both laterally and horizontally.

iii. The rail joint should provide enough space for free expansion and contraction to account for the effect of temperature variations.

iv. A good joint should be easily disconnectable so that it can be easily taken out without disturbing the whole track for the purposes of changing rail or a fish plat, and lubricating the contact faces.

v. It should not allow the rail ends to get battered in any case.

vi. The joint should fulfill the above requirements with the minimum of initial and maintenance cost (i.e. it should be economical).

Types of Rail Joints:

The following types of Joints are commonly used on Indian and Foreign railways

1. Supported Rail Joints:

When the rail ends rest on a single sleeper called a "joint sleeper", it is termed as "Supported joint". The duplex joint sleeper with other sleepers is an example of the supported joint.

There sleeper support (as shown in fig) with long fish plate, i.e. combined supported and suspended joint is most objectionable. Because in this case when the packing under the outer sleeper gets loose, undue load comes on central sleeper and in turn the loose central sleeper converts this join into a weak suspended joint.

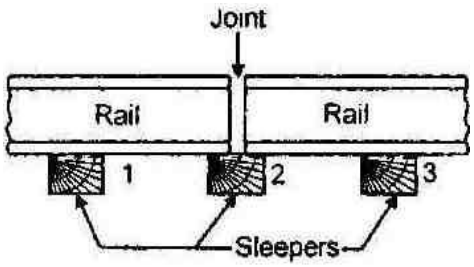


Fig. Supported Rail Joints

2. Suspended Rail Joint:

When rail ends are projected beyond sleepers called "shoulder sleeper" it is termed as suspended joint (as shown in fig.) This type of joint is generally used with timber and steel trough sleepers on Indian and foreign railways.

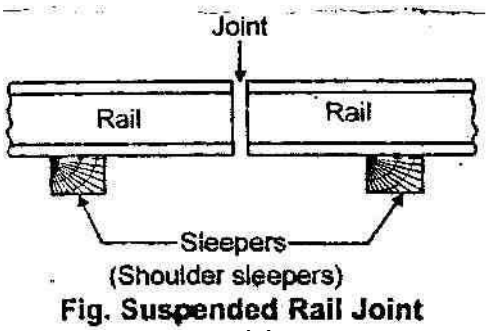


Fig. Suspended Rail Joint

3. Bridge Joint:-

When the rail ends are projected beyond sleepers as in case of suspended joint and they are connected by a flat or corrugated plate called a "bridge plate", it is termed as a bridge joint. This type of joint is not used on Indian Railways.

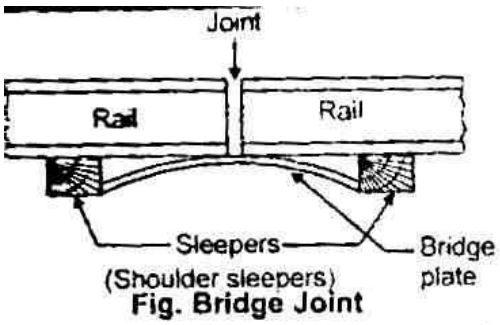


Fig. Bridge Joint

4. Base Joint:-

This is similar to the bridge joint, with the difference that the inner fish plates are of bar type and outer fish plates are of the special angle type, in which the horizontal leg is further extended over the sleeper. Due to complicated design, this is generally used.

5. Welded Rail Joint:-

These are the best joints as they fulfill nearly all the requirements of an ideal or perfect joint. So these are widely used.

6. Staggered or Broken Joint:-

In this position of joints of one rail track are not directly opposite to the joints of the other rail track (fig.). these joints are generally provided on curves, where the length of outer curved track is greater than the length of inner curved track.

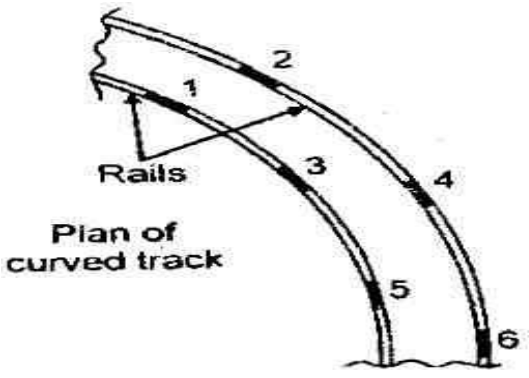


Fig. Staggered Rail Joint

7. Square or even Joint:-

In this also, the position of rail joint is the basis of its nomenclature, the joints of one rail track are directly opposite to this joints of other rail track. This type is generally used on straight tracks (fig).

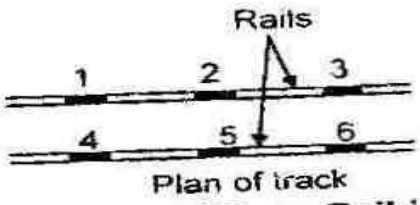


Fig. Square of Even Rail joint

8. Compromise Joint:-

Where two different rail section are required to be jointed together, it is done by means of fishplates which fit both the rails and this is joint termed as compromise joint (fig.)

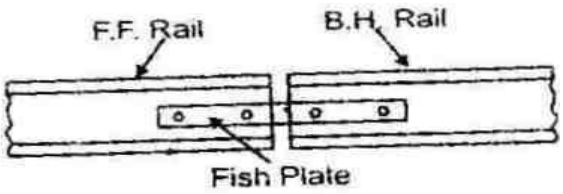


Fig. Compromise Joint

9. Insulated Joint:-

When insulating medium is inserted in a rail joint to stop the flow of current beyond the track-circuited part, it is called insulated joint.

10. Expansion Joint:-

In bridges, provision for expansion and contraction is kept for girders and rails both. This gap is 2.2 cm in case of "metered" joint and 7.2 cm for "Halved Joint".

CHAPTER-4

[7MARK]

Q.1. A 6° curve in reverse direction in the layout of a B.G.. If the speed in branch live is restricted to 65 kmph, determine the restricted speed on the main track. 2014, 5(c)

Ans: i. Equilibrium can't required for 65 kmph sped by equation.

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

$$R = \frac{1720}{6}$$

$$e = \frac{1.676 \times (65)^2}{1.27} \times \frac{6}{1720} = 19.45 \text{ cm}$$

Where G = 1.67 for B.G.

V = 65 kmph.

ii. For B.G., the can't deficiency for main line = 7.6 cm

iii. So the cant for main track = 19.45 – 7.6 = 11.85 cm

iii. There fore the cant to be provided for branch track = –11.85 cm. i.e. Negatie case.

Theoretical super elevation –11.85 + 7.6 = –4.25 cm

Q.2. State advantages of concrete sleepers & functions of ballast. 2015, 1(c)

Ans: Advantages of concrete sleepers:-

→ It is economical

→ It increases durability

→ It reduces corrosion of steel.

→ It allows rapid construction.

Function of ballast

Ans: Ballasts performs the following functions:

i. It transfers the load from the sleeper to the subgrade and then distributes it uniformly over a larger area of the formation.

ii. It holds the sleepers to position and prevents the lateral and longitudinal movement, due to dynamic loads and vibrations of moving trains.

iii. It imparts some degree of elasticity to the track.

iv. It provides easy means of maintaining the correct levels of the two lines of a track (i.,e. elevation on curves) and for correcting tack alignment.

v. It provides good drained foundation immediately below the sleepers and helds to protect the top surface of the formation. Ths is achieved by providing coarse and rough aggregates with plenty of voids.

Q.3. Determine the length transition curve for BG track curve of 4 having a cant of 8 cm. the maximum permissible speed on the curve is 80 kmph.

Ans: The length of curve will be maximum out of the following three values.

$L = 7.20 \times e = 7.20 \times 8 = 57.6$ cm

$= 0.073\ D \times V_{max} = 0.073 \times 7.6 \times 80 = 44.384$ m

Where D is cant deficiency in cm for maximum speed

$= 0.073\ e \times V_{max} = 0.073 \times 8 \times 80 = 46.72$ m

Which is maximum i.e. $L = 57.6 \simeq 60$ m

$Y = x^3/6RL$

$$\text{Again offset at } 15\text{m} = \frac{15^3}{232200} \times 100 = 1.45\text{cm}$$

$$\text{Bec} = C = \frac{1}{6LR} L = 60\text{m}$$

$$C = \frac{1}{232200} R = \frac{1720}{4} = 430\text{m}$$

$$\text{Offset at } 30\text{m} = \frac{30^3}{232200} \times 100 = 11.63\text{cm}$$

$$\text{Offset at } 45\text{m} = \frac{45^3}{232200} \times 100 = 39.24\,\text{m}$$

$$\text{Offset at } 60\text{m} = \frac{60^3}{232200} \times 100 = 93\text{ cm}$$

Thus the offsets at every 15 m are

Chainage(m)	15	30	46	60
Offsets(cm)	1.45	11.63	39.24	93

$$\therefore S = \frac{L^2}{24R} = \frac{60^2}{24 \times 430} = 0.35\text{m}$$

Q.4. If a 8 curve track diverges from main track curve of 5° in an opposite direction in the layout of a B.G. yard. Calculate the super-elevation and the speed on the branch line. If the maximum speed permitted on the main track is 450 kmph. 2016, 6(b) 2015, 4(c)

Ans: i. Equilibrium cant required for 45 kmph speed

By equation

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

$$\text{Where } G = 1.676\text{ mfor B.G. \&} V = 45\text{ kmph}$$

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

$$e = \frac{1.676 \times 45 \times 45}{1.27} \times \frac{5}{1720} = 7.78\text{cm}$$

ii. For B.G. the cant deficiency for main line = 7.6 cm

iii. So the cant for main track = 7.78 – 7.6 = 0.1 cm

iv. There fore the cant to be provided for branch track = -0.18 cm i.e. negative cant.

v. With cant deficiency of 7.6 cm which is permissible the speed of the main will be for a cant of 7.6 + (–0.18) cm = 7.42 cm

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

$$\Rightarrow \quad 7.42 = \frac{1.676 \times v^2}{1.27} \times \frac{8}{1720}$$

$$\Rightarrow \quad v^2 = 1210 \text{ kmph}$$

$$\Rightarrow \quad v = 34.7 \text{ kmph}$$

Q.5. What are the main objectives of providing super elevation ? Mention their limiting values for railway track. 2009(w), 2)(C) 2014, 1(c)

Ans: → To introduce the centrifugal force for counteracting the effect of centrifugal force, this will result in the faster movement of trains on curves. This will also prevent derailments & reduce the side wear and creep of rails.

→ To provide smooth working of the track resulting in safe movement of the goods & comfortable ride of the passengers.

→ So that there is no tendency of track to move out of position due to more load on outer rail.

→ This reduces the wear of rails, equipment Y results in saving in maintenance cost.

$e = gv^2/gR$

G = Gauge of track in mt.

V = Velocity speed of vehicle in kmph.

g = acceleration due to gravity m/se^2

R = Radius of curve in m.

$$e = \frac{G \times (0.2780)^2}{9.81 \times R} = \frac{GV^2}{127R} \text{ in m}$$

In India G for BG $= 1.676$m

M.G. $= 1$m

N.G. $= 0.762$m

for B.G. , $e = \frac{1.676V^2}{1.27R} = 1.315\frac{V^2}{R}$cm

for M.G., $e = \frac{1V^2}{1.27R} = 0.80\frac{V^2}{R}$cm

for N.G. , $e = \frac{0.762V^2}{1.27R} = 0.60\frac{V^2}{R}$cm

CHAPTER-5

7MARK

Q.1. Shows a left hand turnout with its components by providing a neat sketch.
2014, 5(b) 2009(w), 2(C)

Ans:

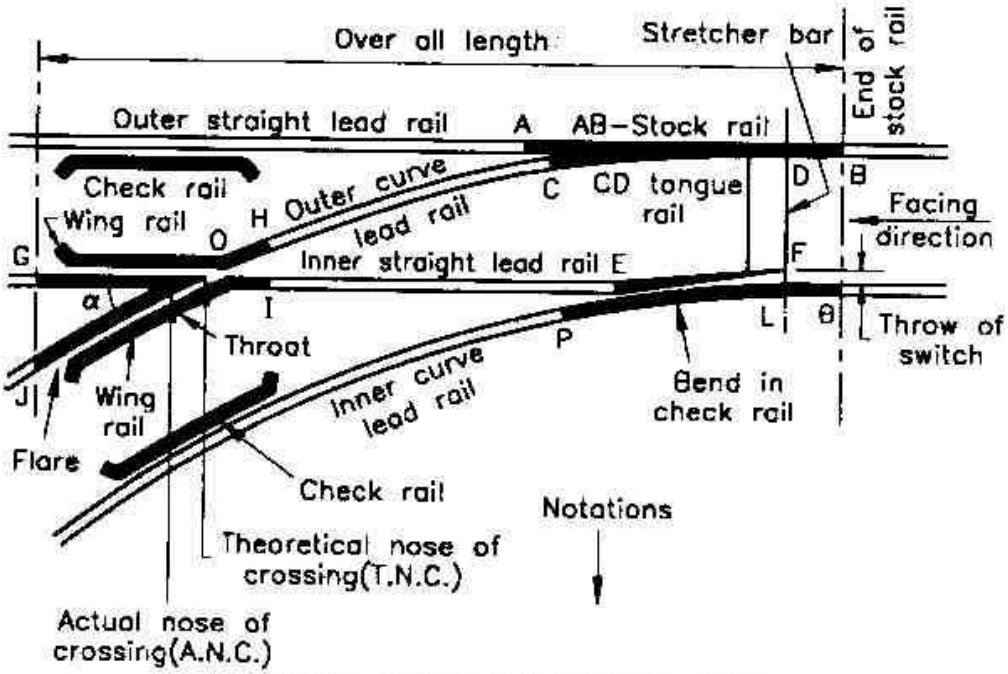


Fig. 16.1. Left hand turnout (Split switch).

Q.2. Describe the necessity of points & crossing and describe briefly the main components. 2010(w) (5),2014, 2(c)

Ans: In case of roads, the facilities for turning of vehicles from one path to another do not require any special arrangement as the wheels have no flanges. The directions of movement of vehicles is controlled by the driver and the steers according to his own speed will. But this is not ture in case of railways because the wheels as provided with flames inside, so the direction of movement and the diversion of the vehicles to another track are controlled automatically by the wheels flange inside, so the direction of movement and the diversion of the vehicles to another track are controlled automatically by the wheels flanges rather than the driver as in case of roads. The problem of diversion of trains from one track to another is solved by special arrangements known as points and crossing. The knowledge of the points and crossing is important in following days for the operating personal.

i) Paints and crossing provide flexibility of movement by connecting one line to another according to requirements.

ii. They also helps for imposing restrictions over turnouts which necessarily roated the movements

iii. From safetch aspect , it is also important as paints and crossing are weak kinks or paints in the track and vehicles are susceptible to derailments at these places.

Facing direction:-

If someone stands at toe of switch and looks towards the crossing, then the direction is called Facing Direction.

Trailing Direction:-

If someone stands at the crossing and looks towards the switches, then the direction is called Trailing Direction.

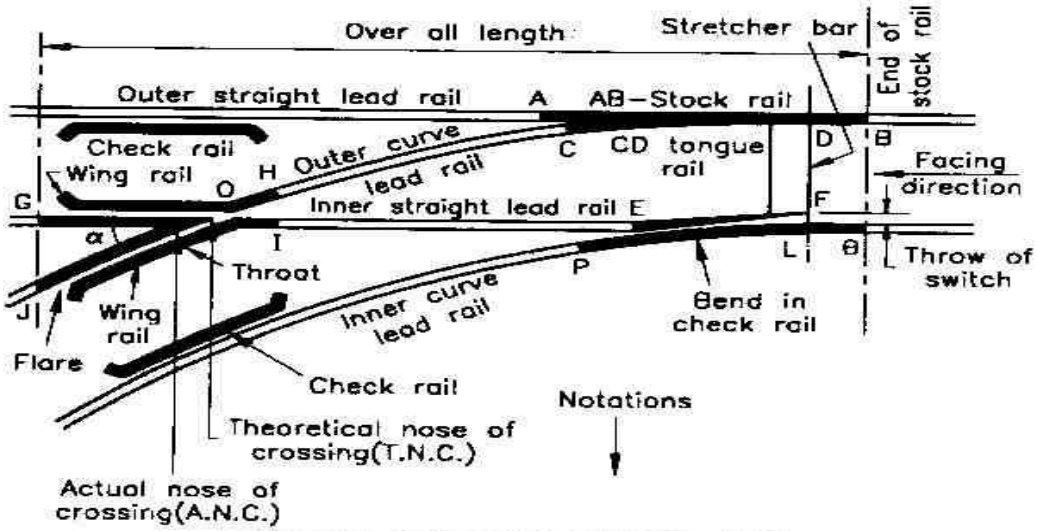


Fig. 16.1. Left hand turnout (Split switch).

Facing Paints of turnouts:-

Facing Paints of Turnouts are those where trains pass over the switches first and then they pass over the crossing. These are important to specify when the direction of movement of trains reserved for facing direction.

Trailing Paints of turnouts:-

Trailing, paints of turnouts are those on the opposite side of facing paints in which the trains pass over the crossing first and then over the switches. These are important to specify when the direction of movement of trains is reserved for trailing direction only.

So every paint may be a "facing or trailing" paints or both depending upon the direction of movement of trains.

Right Hand and Left Hand Turnout:-

If a train from main track is diverted to the right of the main route in the facing direction then this diversion is known as Right hand turnout. If train from main track is directed to the left of the main route in the facing direction then the diversion is known as left hand turnout.

Right Hand and Left Hand Switches:-

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

16.2 and 16.3.

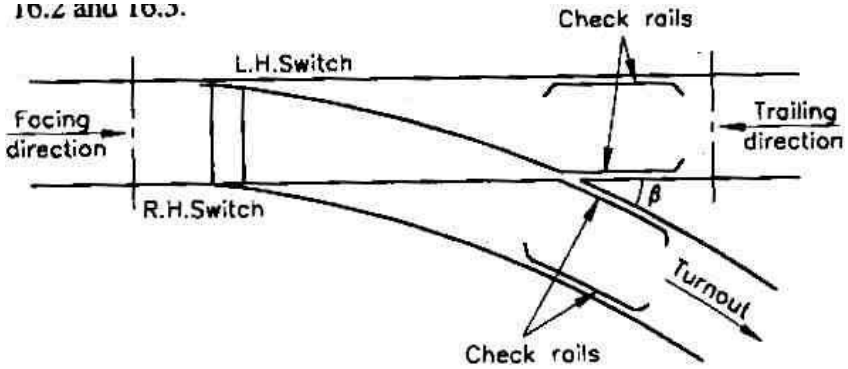


Fig. 16.2. Line Diagram of Right-hand + Turnout.

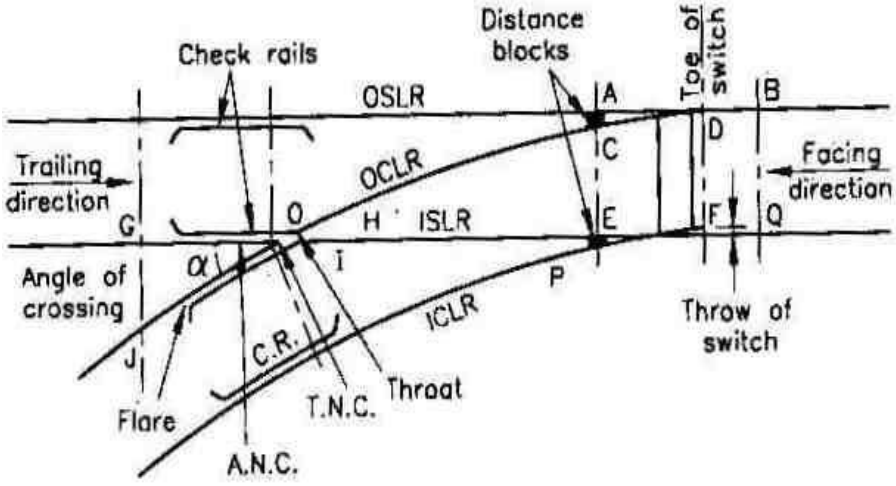


Fig. 16.3. Line Diagram of Left-hand Turnout.

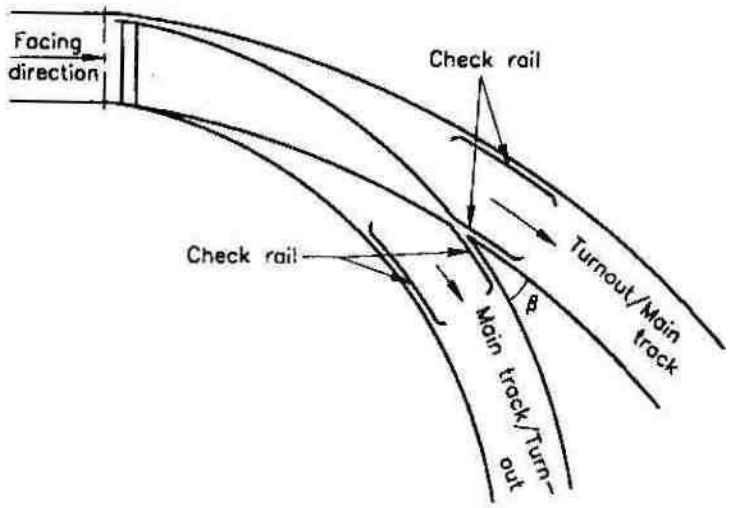


Fig. 16.4. Turnout from Curved Main Track.

CH-7

(5 MARKS)

Q.1. What is Conning of wheels ? Discuss the necessity and effects of it.

2016, 3(b)

Ans: CONNING OF WHEELS AND EFFECTS ON RAILS:

The tread of rim of the wheels of a railway vehicle are not made flat, but sloped at about 1 in 20 to enable these vehicles to move smoothly on curves, as well as on straight track. Generally the wheels remain central on a straight and level surface with uniform gauge and the circumference of the treads of both vehicles

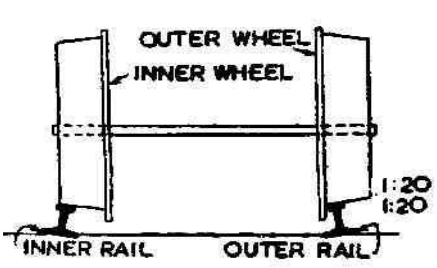


Fig. 4.13.

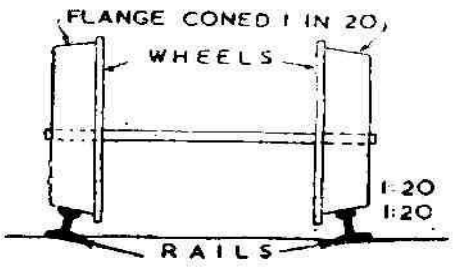


Fig. 4.14.

CONNING OF WHEELS

traverse the same distance, on wheel slides instead of moving. Due to the resistance to sliding, further side movement is stopped. If the coning of wheel was not there, the side movement would have continued till the flange of the wheel would have come in contact with the side of the rails causing jerk and shocks resulting in uncomfortable riding. Thus to avoid the lateral movement of wheels and development of shocks in rails, coning of wheels is done. It has following advantages and disadvantages.

Advantages of coning of wheel:-

It has the following advantages:

i. It gives smooth riding.

ii. It helps a vehicle to negotiate a curve smoothly.

iii. It reduces the wear and tear of wheel flanges.

CHAPTER:8

Q.1. Define water way ? 2009 (w), 1(h) 2015, 3(a)

Ans: the Area through which the water flows under a bridge super structure is known as the water way of the bridge. The linear measurement of this area long the bridge is known as linear water way.

Q.2. How is the linear water way of bridges fixed ? 2015, 3(a)

The linear water way of a bridges shall be the length the available in the bridge between extreme edge of a water surface at the highest flood lever, measured at right angles to GTECH abutment face.

Q.3. Define water way and economic span for a bridge ? 2006(w) 1(g)

Ans: The area through which the water flows under a bridge superstructures is known as water way of the bridge.

The economic span of a bridge is the one which reduces the overall cost of a bridge to a minimum.

Q.4. Classify different type of bridge. 2014

Ans: 1. Permanent bridge:

a. Stone masonary and plane

b. R.C.C. bridge.

c. Iron and steel

d. Culverts

e. Pre stressed bridge.

2. Temporary bridge.

a. Truss

b. Bridges on piles, trestle cribs

c. Raft

d. Pontoon

e. Lift.

Q.5. Define Afflux 2014, 2(a)

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

Q.6. What s break water? 2013, 3(a)

Ans: A breakwater is a structure which reflects & dissipates the force of wind generated waves.

CH-09

Q.1. What is scour depth ? 2009 (w), 1(i) 2013, 2(a)

Ans: Bridge scour is the removal of sediment such as sand and rocks from around bridge abutments or piers. Scour, caused by swiftly moving water, can scoop out *scour holes*, compromising the integrity of a structure

For a safe and sound design of a bridge it is important to estimate the correct scour depth.

Q.2. Mention different types of movable bridge ? 2009 (w), 1(k)

Ans: Different types of moveable bridges are swing bridge, bascule bridge, refractile bridge, left bridge and ferry bridge.

Q.3. Explain tilting of the well foundation. 2016, 7(a)

Ans: Well foundation is a type of deep foundation which is generally provided below the water level for bridges.

Q.4. What is scour depth ? Why is important for bridge design ? 2009 (w)

Ans: When the velocity of stream exceeds the velocity which the erodible particle of bed material can stand the scour occurs. The normal scour depth is the depth of water in the middle of the stream when it is actually carrying the peak flood discharge.

For a safe and sound design of a bridge it is important to estimate the correct scour depth.

5 MARKS

Q.1. What is scour depth ? Discuss the relative merits and demerits of finding scour depth by various methods. 2008(w) , 2(c)

Ans: When the velocity of stream exceeds the limiting velocity which the erodible particle of bed material can stand, the scour occurs. The normal scour depth is the depth of water in the middle of the stream when it is carrying the peak flood discharge. This can be easily ascertained by actual soundings at or near the site proposed for the bridge during or immediately after a flood before the scour holes have had time to silt up appreciably. Due allowance should be made in the observed depth for increase in scour resulting from.

i. The designed discharge being greater than the flood discharge during which the scour was observed.

ii. The increase in velocity due to the obstruction in flow caused by construction of the bridge. The scour pattern at a bridge depends upon factors like flood discharge, bed slope, direction of flow, bed material alignment of pier, pier geometry, i.e. is shape and size etc.

For a safe and sound design of a bridge it is important to estimate the correct scour depth, where the practical method of determining a scour is not possible the following theoretical methods may be used to different types of streams.

Q.2. What are different types of bridge foundation and describe shallow and wel foundation with sketches.2015, 3(c), 2019- 6(c),

Ans: Open foundation or shallow foundation. This is the most common types of foundation above the water table. The bas of the structure is enlarged or spread to provide individual support. Since spread foundation are constructed in open excavations. Therefore they are termed as open foundations. This type of foundation is provided for structures of moderate height built on sufficiently firm dry ground. The various types of spread footings are :

1. Wall footing
2. Isolated footing
3. Combined footing
4. Inverted arch footing
5. continuous footing
6. Cantilever footing
7. Grillage footing
8. Stepped footing

Wall foundations in Bridges:-

Caissons the caisson is a structures used for the purpose of placing a foundation in correct position under water. The term caisson is derived from the French word 'Cause' meaning a box. It is member with hollow portion. Which after installing in place by means is filled with concrete or other material. Caissons are preferred in sandy sails. The caissons can be divided in the following three groups.

1. Box Caissons
2. Open Caissons or wells
3. Pneumatic caissons.

Box caissons:

A box caisson is a strong watertight vessel open at top and else of the bottom. They are generally built of timber, reinforced concrete and steel. This type of caissons suitable where bearing stratum is available at shallow depth and where loads are not very heavy to place the caisson is position, It is launched and floated to pier site where it is sank in position.

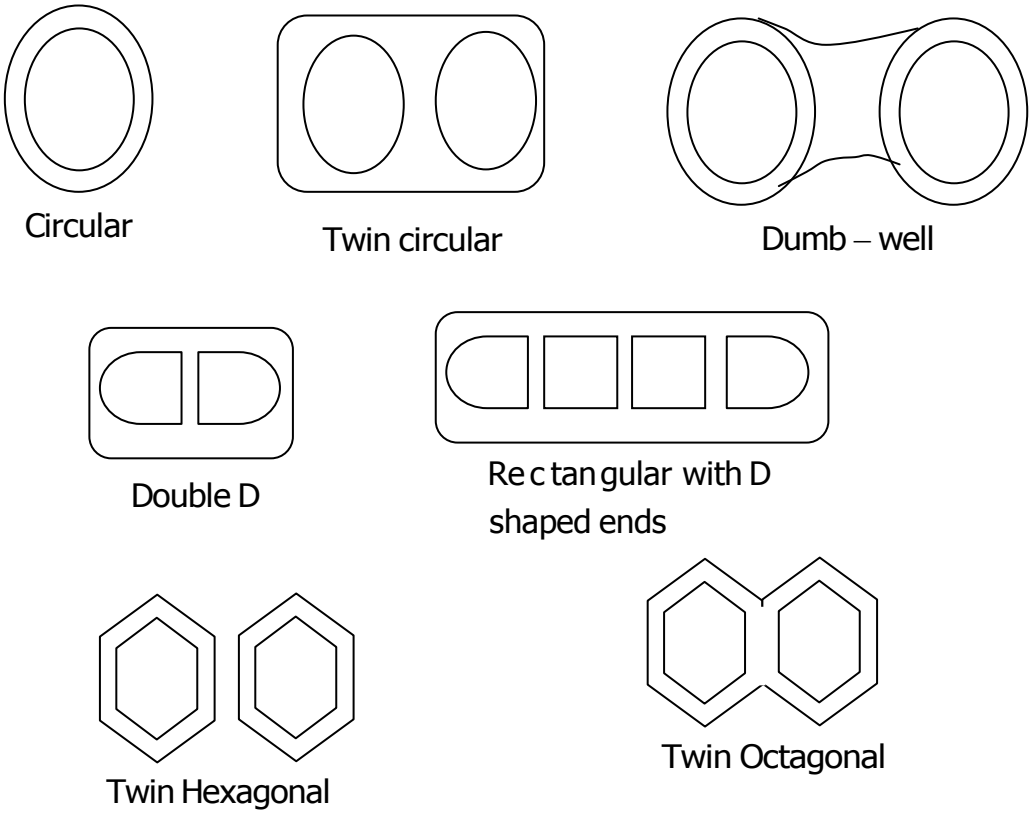
Open Caissons or wells:

The open caissons are open both of the top the bottom. They are used on sandy or soft bearing stratum liable to scour and where no firm bed is available for large depth below the surface.

They are generally built of timber, metal, reinforced concrete or masonry. They form the most common type of deep foundations for bridges in India.

Shapes of wells:

The shapes of wells may be circular rectangular. Double D rectangular with D shaped ends twin hexagonal and twin octagonal etc . figure.



The choices of a particular shape depends upon the following factors:

a. The dimensions of the base of the pier or abutment.
b. The ease of sinking
c. The cost of sinking and shuttering
d. The vertical and horizontal forces acting on the well

Q.4. What is coffer dam ? Write down the requirements of coffer dam. 2015,4(b),2019 -7(a)

Ans: Coffer Dam: It is a temporary cofferdam structure which is built to remove water from an area and make it possible to carry on the construction work under reasonable dry condensations.

Requirements:

a. The cofferdam should be reasonably water tight

b. The design and layout of a cofferdam should be such that the total cost of construction maintenance, pumping is minimum

c. It should be generally constructed at the site of work.

d. It should be so planned to facilitate easy dismantling and reuse of materials.

Q.5. Draw a neat sketch of a well foundation showing all components. Describe at least five components briefly. 2007(w) (4), 2016, 7(b)

Ans: The selection of the foundation type suitable for a particular site depends on the following consideration.

a. Nature of sub soil

b. Nature and extend of difficulties by presences of boulder, buried tree trunks, etc. likely to be next with &

c. Availability of expertise and equipments. In case of foundations laid on rock, the rock should be benched by chiseling. In order to another the foundation to rock a number of dowel bars of 38 mm diameter at about 80 cm spacing are provide.

Depending upon their nature depth, foundations have been categorized as follows:

i. Open foundations or shallow foundation &

ii. Deep foundation.

Well components and their foundations. In brief the purpose of each element is as follows.

i. Cutting edge. It provides a comparatively sharp edge to cut the coil below during sinking operation. It usually consists of a mild steel equal angle of side 150 mm.

ii. Curb: It has a two fold purpose. During it acts as an extension staining and bottom plug while after sinking it transfers the load to the soil below. It is made up of reinforced concrete using controlled concrete of grade M 200.

iii. Staining: It is the main body of the well. It also serves dual purpose. It acts as a cofferdam during sinking and a structural member to transfer the load to the soil below after wards. The staining may consist of brick masonary or reinforced concrete. The thickness of staining should not be less than 405 cm nor less than that given by equation.

(Equation)

Here t = minimum concrete staining thickness.

T1 =well depth below bed

D = external diameter of well

K = a constant which is 1

For sandy stratum, 1.1 for soft clay, 1.25 for hard clay 1.3 for hard sail with boulder. The brick work steining should be about 10m more than that for the corresponding concrete steining.

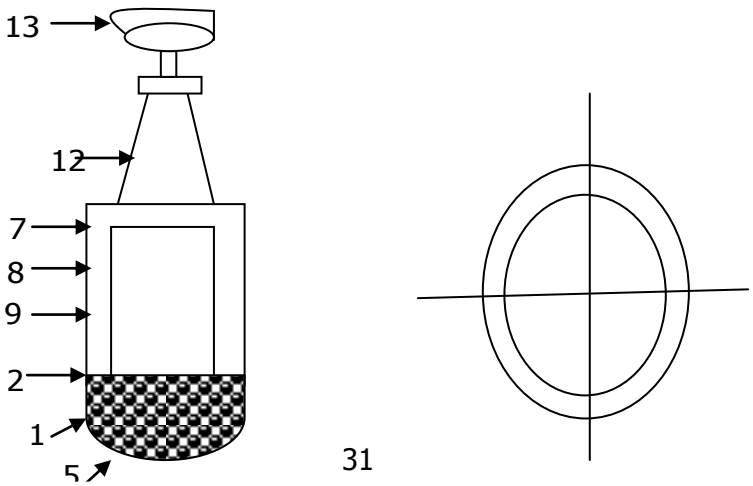
iv. Bottom plug. Its main function is to transfer load from the steining to the soil below.

v. Sand filling. Its utility s doubt fur. It is supported to afford some relief to the steining by transferring directly a portion of load from well cap to the bottom plug.

vi. Top plug, the opinion is divided about the top plug. It is at least servers as a shuttering for laying well cap.

vii. Reinforcement. It provides requisite strength to the structure during sinking and service.

viii. Well cap. It is needed to transfer the loads and moments from the pier to the well to well below. The shape of well cap is similar to that of the well with a cantilevering of dab out 15 cm. whenever 2 or 3 wells of small diameter are needed to support the sub – structure, the well cap should be extended to cover the wells. The well cap is designed with partial fixity at the edges of the wells.



Q.6 Explain briefly the pile driving and load carrying capacity of piles. 2013, 1(c)

Ans: The process of forcing a pile into the ground without excavation is termed as the pile driving. The piles should be driven vertically. Piles are commonly drived by means of a hammer by a crane or by a special device known as pile driver. The hammer is guided between two parallel steel member known as leads. During pile driving, heads, helmets or caps are placed on the top of the pile to receive the blows of the hammer and to prevent damage to the head of the pile. A cushion, consisting og a pad of resilient materials, hard wood or rope, is placed between the drive can and the top of the pile to protect the pile head. Single acting hammers are generally used to drive piles of light or moderate weight in soils of average resistance against driving.

Piles are ordinarily driven to a resistance measured by the number of blows required for the last 1 cm, of penetration. Resistance of 3 to 5 blows per cm are commonly specified for concrete pile.

Load Carrying Capacity of piles: The ultimate load carrying capacity of ultimate bearing capacity of a pile is defined as the maximum load which can be carried by a pile and at which the pile continues to sink without further increase of load. The allowable load Q_a is the safe load which the pile can carry safely and is determined on the basis of (i) ultimate bearing resistance divided by suitable factor of supply, (ii) the permissible settlement and (iii) overall stability of the pile foundation.

CHAPTER: 10

Q.1. What are return walls and wing walls ? 2008 (w)

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

Q.2. Define piers ? 2007 (w) 1(i)

Ans: When a well sinks more on one side than the other then it is known to have tilted . the tilting Is mainly due to unequal dredging and non uniform bearing power of sail.

Q.3. Mention different types of movable bridges? 2006(w) 1(l)

Ans: Different types of movable bridges are swing bride, bascule bridge refractile bridge, life bridge and ferry bridge.

5 MARKS

Q.1. What is wing walls. Write at least three functions of wine wall.

2007(w), 2(c)

Ans: As per their layout in plain wing walls are classified as follows:

1. Straight wing walls
2. Splayed wing walls
3. Return wing walls

Straight Wing Walls:

They are suitable for small bridges constructed across drains with low banks. Generally, they are built for a railway bridge specially in cities, where the cost of the land is high. In case of hard and rocky formulation the wing walls may be constructed in steps. When the sail loose, the foundation should be taken to a uniform depth. Stepped foundation when provided must be built with vertical joint, as otherwise their will be a crack formed due to unequal settlement.

Splayed wing walls:

They are constructed generally at 45^{o} with abutment and are straight or curved in plan. This top is 0.5 m thick and their face batter is 1 in 12 and back batter is 1 in 6. They provide a smooth entry and exist for the following water. They are best suited for the crossing of a river . They are also adopted when the road has to narrow on crossing the bridge, or when two or more roads meet at the approach.

Return wing wall:

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

CHAPTER:11

Q.1. Distinguish between bridge & culvert.2019-6(a)

Ans:-Piers are the intermediate supports of a bridge superstructure & may be of solid or open types.

Q.2. Mention different types of IRC bridge loading 2016, 6(a)

Ans: i. IRC class B loading

ii. IRC AA loading

6 MARKS

Q.1. Define cable bridge 2015, 3(b)

Ans: A cable stayed bridge has one or more towers from which cables support the bridge deck.

→ Cable – stayed bridges may appear to be similar to suspension bridges but in fat they are quite different in principle is in their construction.

→ In suspension bridges large main cables hang between the towers and are anchored at each end to the ground

Advantages:

Cable bridge much greater stiffness than the suspension bridge, so that deformations of the dock under live loads are reduced.

5 marks

Q:Classify and describe briefly each classification of steel and concrete bridge?

Ans:Steel bridges are classified according to the Type of traffic carried, type of main structural system and the position of carriageway relative to the main structural system.

Classification based on type of traffic carried

Bridges are classified as:

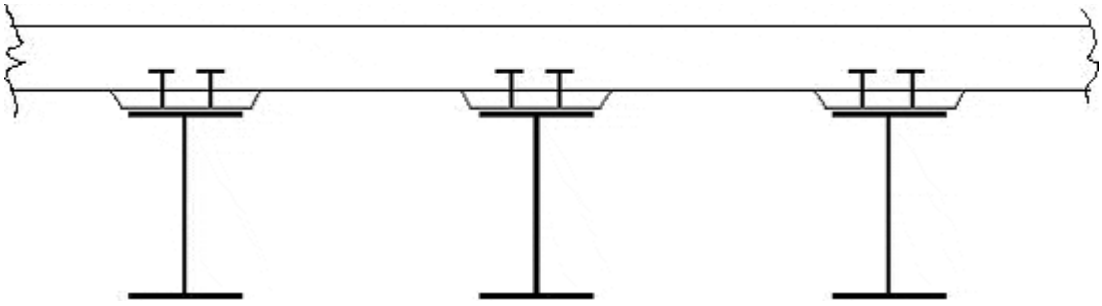
- Highway or road bridges
- Railway or rail bridges
- Road – cum – rail bridges

Classification based on the main structural system

Many different types of structural systems are used in bridges depending upon the span, carriageway width and types of traffic. Classification, according to make up of main load carrying system, is as follows:

(i) Girder bridges

Flexure or bending between vertical supports is the main Structural action in this type. Girder bridges may be either solid web girders or truss girders or box girders



(ii) Rigid frame bridges

In this type, the longitudinal girders are made structurally continuous with the vertical or inclined supporting member by means of moment carrying joints [Fig.3]. Flexure with some axial force is the main forces in the members in this type. Rigid frame bridges are suitable in the span range of 25 m to 200 m.

(iii) Arch bridges

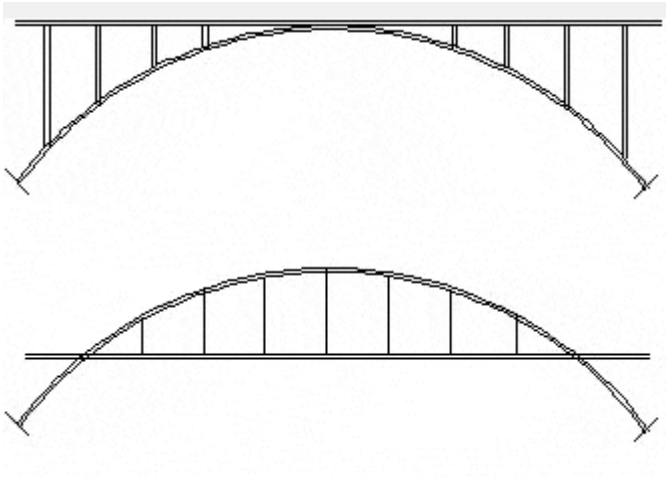


Fig.4 Typical arch bridges

The loads are transferred to the foundations by arches acting as the main structural element. Axial compression in arch rib is the main force, combined with some bending. Arch bridges are competitive in span range of 200 m to 500 m. Examples of arch bridges are shown

Types of concrete

Arch Bridges

Arch bridges derive their strength from the fact that vertical loads on the arch generate compressive forces in the arch ring, which is constructed of materials well able to withstand these forces.

Reinforced Slab Bridges

For short spans, a solid reinforced concrete slab, generally cast in-situ rather than precast, is the simplest design. It is also cost-effective, since the flat, level soffit means that falsework and formwork are also simple. Reinforcement, too, is uncomplicated. With larger spans, the reinforced slab has to be thicker to carry the extra stresses under load. This extra weight of the slab itself then becomes a problem, which can be solved in one of two

ways. The first is to use prestressing techniques and the second is to reduce the deadweight of the slab by including 'voids', often expanded polystyrene cylinders. Up to about 25m span, such voided slabs are more economical than prestressed slabs**.**

S