LECTURE NOTES

ON

RAILWAY & BRIDGE ENGINEERING

For

DIPLOMA 5th SEMESTER

(TH. 3)

As per SCTE & VT Syllabus

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* Classification of Indian Railway : —

According to gauge, Indian railway has been divided into three parts : —

1- Broad Gauge (Distance between two gauge 1.676 m).
2- Meter Gauge (Distance - 1 m)
3 - Narrow Gauge (Distance - 0.762 m)

→ Again Indian Railway has been classified into three parts depending upon the importance of route and traffic carried by the route.

1- Trunk Route : —

2- Main Lines :—

→ The lines other than trunk lines carrying 10 GMT (Gross Million Tonnes) per annum or more for B.G. and 2.5 GMT for M.G.

→ Maximum permissible speed here is 100 kmph/hr incase of broad gauge, and 75 km/hr in case of M.G.

3- Branch Lines :—

→ The lines which carry less than 10 GMT per annu and maximum permissible speed is less than 100 kmph ~~is known~~ are branch lines.

→ In case of M.G less than 2.5 GMT per annum and maximum permissible speed is less than 100 kmph/h are branch lines.

→ In case of narrow-gauge less than 1.5 GMT per annum and maximum permissible speed is less than 60 km/h

2. RAILWAY TRACK, THE PERMANENT WAY

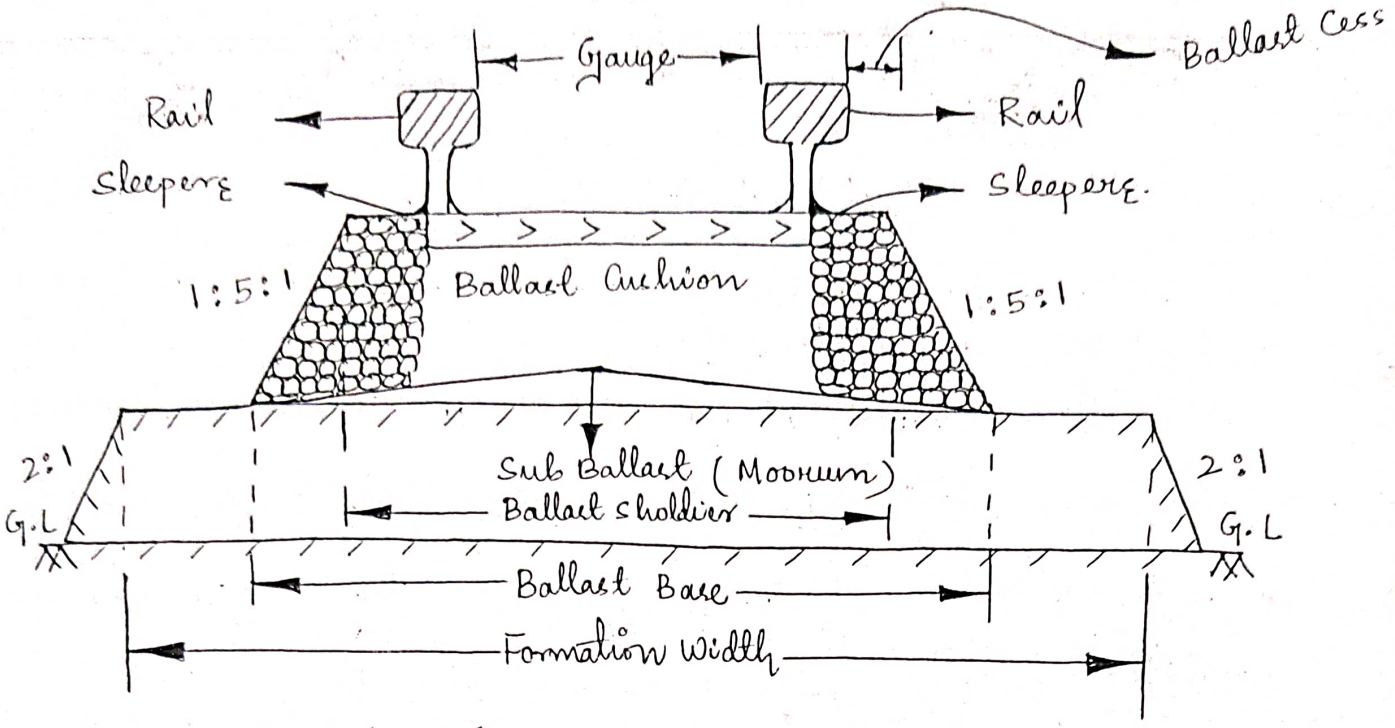

Fig :- PERMANENT WAY

Permanent Way :-

→ The combination of rails fitted on sleepers and resting on ballasts and subgrade is called railway track or permanent way.

→ In permanent way, the rails are joint in series by fish plates and bolts and are fixed to sleepers by the help of chairs.

→ The sleepers are properly spaced and resting on ballast should suitably packed.

→ The rail transmits the wheel loads to the sleepers and the sleepers transmit the load to ballast.

→ The ballast distribute the load over the formation and holds the sleepers.

→ On curved tracks, supercleration is maintained by ballast.

Requirement of an Ideal Permanent way :—

Permanent track is regarded to be semi elastic to achieve higher speed, better comfort and less maintenance.

Basic Requirements :—

→ The gauge should correct and uniform.

→ The rails should be properly levelled and at curves superelevation or cant should be provided.

→ The alligment should be free from kinks an irregularities.

→ The track should be elastic to absorb shocks and vibrations.

→ Drainage system must be perfect for enhancing safety and durability.

→ Joints, points and crossings should be properly maintained and designed.

→ If there is creep, then prevention must be taken.

→ The various components of track such as rails, sleepers, ballast and fittings should be properly maintained.

→ Provision for renewals and replacement should be there.

→ The track's structure should be strong, low initial cost as well as maintenance cost.

3. TRACK MATERIALS

Rails : —

→ The rails can be considered as steel girders for the purpose of carrying axle loads.

They are made of high carbon steel to withstand heavy load and vibration.

→ Flat-footed rails are mostly used in railway tracks.

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Functions of Rails : —

→ Rail provides a smooth hard and frictionless surface for passage of heavy loads and wagons.

→ It bears the stresses developed due to vertical loads and lateral and thermal stresses.

→ Rail material gives minimum wear and tear and failure is minimum.

→ It transmit the loads to the sleepers and reduces pressure on balast.

Requirement of Rails : —

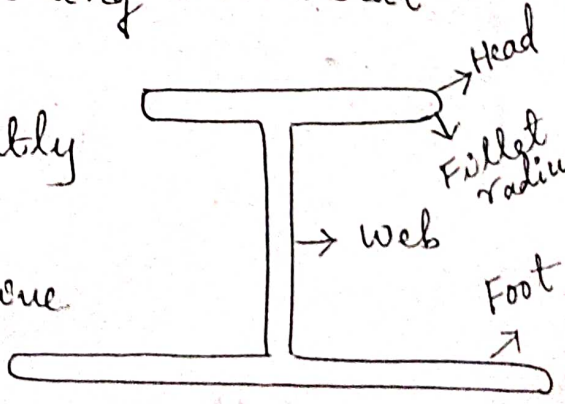
→ The rails should be of proper composition of steel and should be manufactured by open hearth or Duplex process.

→ The vertical stiffness should be high enough to transmit the loads to the sleepers.

→ Rails should be capable of withstanding the lateral forces.

→ Web of rails should be sufficiently thick to bear the load on it.

→ Foots should be wide enough to give stability to rails.



→ Bottom of the head and top of the foot should be designed to enable the fish plates to transmit the vertical load efficiently.

→ Relative distribution of the materials in head, web and foot must be balanced for easy transmission.

→ The fillet radius must be large to reduce the concentration of stresses.

S.Q → The center of gravity of the rail must lie at mid height so that maximum compressive and tensile stress is equal.

S.Q → The tensile strength of rail should not be less than 72 kg/m²

Types of Rail section :—

Mainly 3 types of rail sections are used in the construction of railways:—

i) Double Headed Rail
ii) Bull Headed Reail
iii) Flat ~~Headed~~ Footed Rail.

In India, Flat headed rails are used in maximum.

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Bull Headed Rails :—

→ In this type of rails, the head is made a little thicker and stronger than that of lower part.

→ The positive point was it can resist stress after wear and tear.

Merits :—

→ They keep better alignment and give a solid and smooth track.

→ The rails can be easily disconnected from the sleepers as they have no direct connection.

Demerits :—

→ This is not economic. ~~and~~

→ Less strength and stiffness.

→ Heavy maintenance cost.

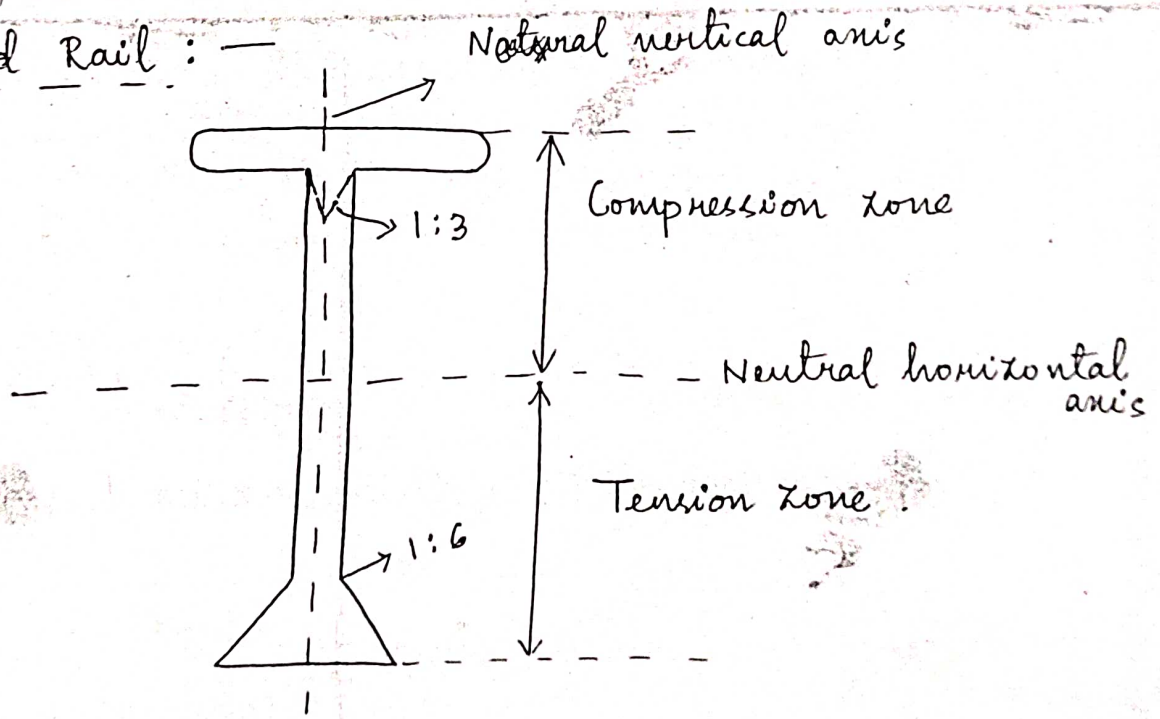
- Double Headed Rail :—

→ This type of tracks are the introductory tracks.

→ The idea behind using these rails was that the rail can be used by inverting when one side is worn out.

→ As this type of rails are not safe and smooth running is impossible, so the use of this type of rails is stopped.

- Flat ~~Headed~~ Footed Rail :—



Merits :—

→ More strength and stiffness.

→ It can be easily laid.

→ In case of points and crossing arrangement is simple.

Demerits : —

→ The fittings get loosen frequently.

→ Straightening of bent nails is difficult.

Length of Rails : —

→ The ~~lengths~~ length of rails of larger length is preferred as they give more strength and economy.

→ The weakest point of track is the joint between two rails. Lesser the number of joints, lesser the maintenance cost, smooth running and more strength.

→ On Indian Railway standards : —

Gauge		Length
Broad Gauge	-	13 m (42 feet)
Metre Gauge	-	12 m (39 feet)
Narrow Gauge	-	12 m (39 feet)

→ Length is governed by the following factors : —

i- Manufacturing cost should be reasonable.

ii- Can easily be transported by the wagons.

iii- Lifting, handling, loading, unloading can easily be done.

Rail Joints and Welding :—

Rail joint is necessary to hold the adjoining ends of a rail in a correct position.

Basically strength of a rail joint is only 50 % strength of rails.

Requirement of an Ideal joint :—

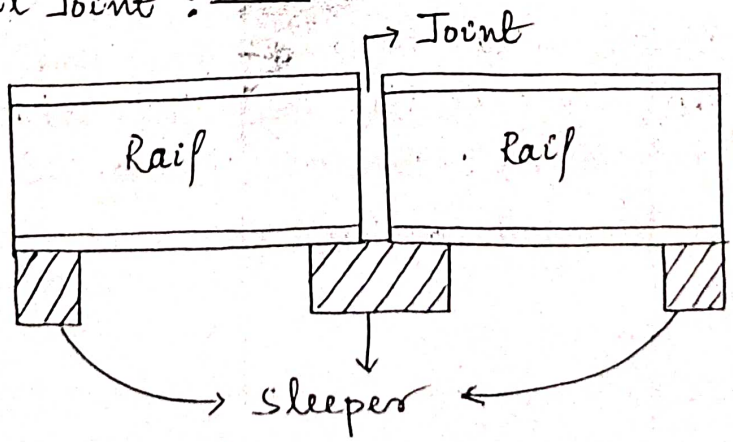
An ideal joint or perject joint is known as the joint which provides the same strength and stiffness as the other rail sections of track.

- The two ends of a rail should remain true in line both laterally and vertically when train moves on the track.
- The rail joints should as strong and stiff as rails.
- The rail joints should provide enough space for thermal expansion and contraction.
- The rail joints should have minimum initial and maintenance cost.
- The joint should be so designed that it can be easily disconnected without disturbing the whole track.
- The rail joints should not allow the rails to be battered in any case.

Types of Rail Joint :—

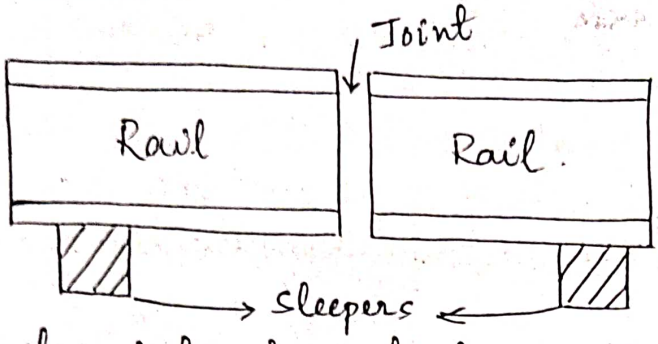
There are 10 types of Rail joint :—

1- Supported Rail Joint :—



→ When the rail ends rest on a single sleeper, called joint sleeper then it is known as supported rail joint.

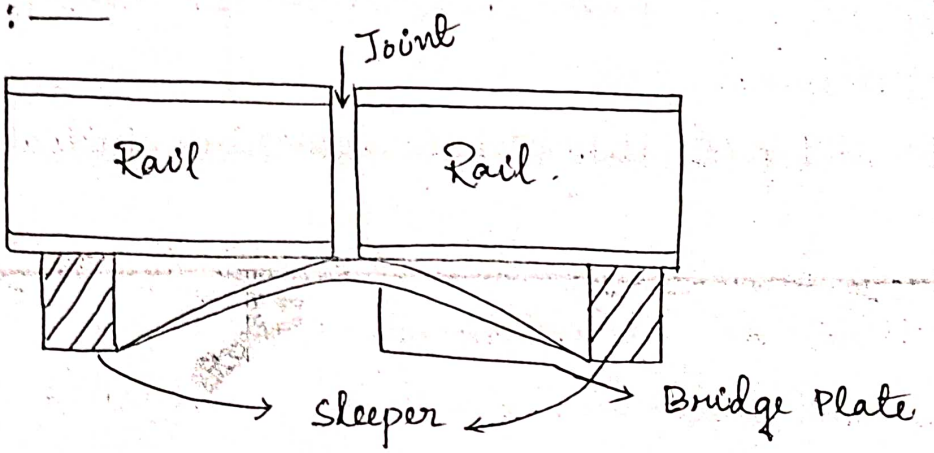
2- Suspended Rail Joint : ——



→ When the rail end lies beyond sleepers then it is called suspended rail joint.

→ It is mostly used in case of timber and steel sleepers.

3- Bridge Joint : ——



→ When the rail ends lie beyond the sleepers and connected by a bridge plate, then this type of joint is known as bridge joint.

4- Base joint : ——

→ Base joint is similar to bridge joint.

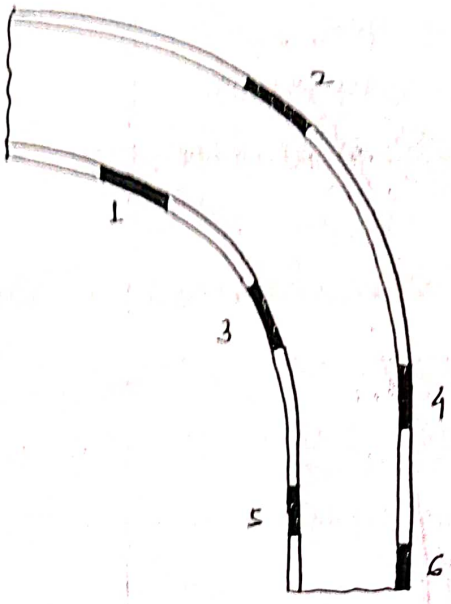
→ The only difference is the inner fish plates are of liar type and the outer fish plates are of special angle type.

→ Due to complicated design, this joint generally doesnot used.

5. Welded Rail Joint : —

→ These are the best joints as they fulfill almost all the requirement of an Ideal joint.

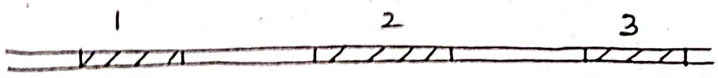
6. Staggered or Broken Joint : —

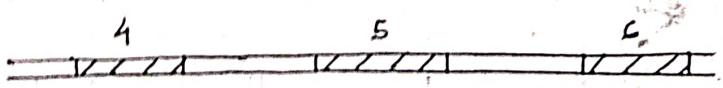


→ In this type of joint, position of joints of one rail track is exactly not the opposite of other rail track.

→ This joints are generally provided on curves when outer curve is greater than inner curve length.

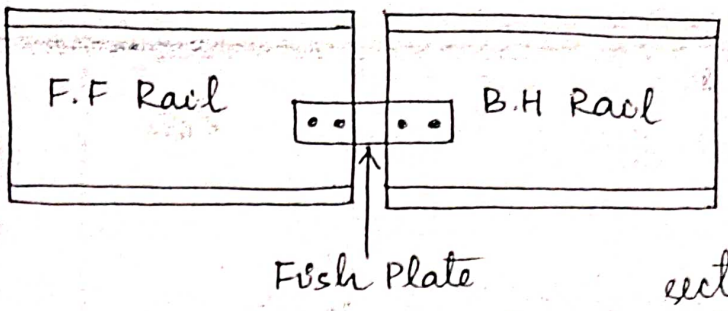
7. Square or Even Joint : —





→ In this joint, position of rail joint of one track is directly opposite to the joint of other track's joint.

8 → Compromise Joint : —



→ In this type of joint, two different rail sections are joined together by the help of a fish plate.

9 → Insulated Joint : —

→ When insulated medium is inserted in a rail joint to stop the flow of current, it is called insulated joint.

10 → Expansion Joint : —

→ In case of bridges for expansion and contraction a gap is provided, known as expansion joint.

→ This gap is 2.2cm.

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Bridge Engineering

Bridge :—

Bridge is a civil engineering structure which provides communication facilities over an obstacle without closing the way underneath and continue in the same direction.

The required medium of communication may be a railway track, road or padestrians.

Components of a Bridge :—

1- Abutments :—

The end support of a superstructure of a bridge is called abutments.

2- Afflux :—

The rise in water level of the river near the bridge over the flood level due to construction / blockage of water near the piers is called afflux.

3- Approach Slab :—

→ The slab provided to join the approach road with the bridge is known as approach slab.

→ One of its end should be raised on the backfill of abutments and should extend into the approach at least by 3.5 m.

→ It should cover the full width of the road.

4- Backfill :—

→ The materials used to fill the space at the back of the bridge is called backfill.

→ It may be broken stone, gravel, or sand etc.

5 - Bed Block : —

→ The block resting over the top of the pier or abutment is called bed block.

→ It provide support to the bearing surface and transforms the load to the pier or abutment.

6 - Caisson Foundation : —

→ It is a deep foundation whose depth is greater than its width.

★ N.B

Bridge	Carriage Width
Single Lane Bridge	4.25 m.
Double Lane Bridge	7.50 m.
Additional Lane	3.50m.

7 - Clear Span : —

The clear distance between any two adjacent supports of a bridge is called clear span.

8 - Effective Span : —

The centre to centre distance between any two adjacent supports is called effective span.

9 - Expansion Joint : —

A gap between the structure is provided to withstand the expansion due to the change in temperature.

10 - Kerb : —

It is the raised portion of roadway slab on both sides.

11 - Pier : —

It is an intermediate support used in a multispan bridge.

12 - A. : —

It is a layer of concrete at the entrance of a culvert to prevent scouring.

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Components of a bridge : —

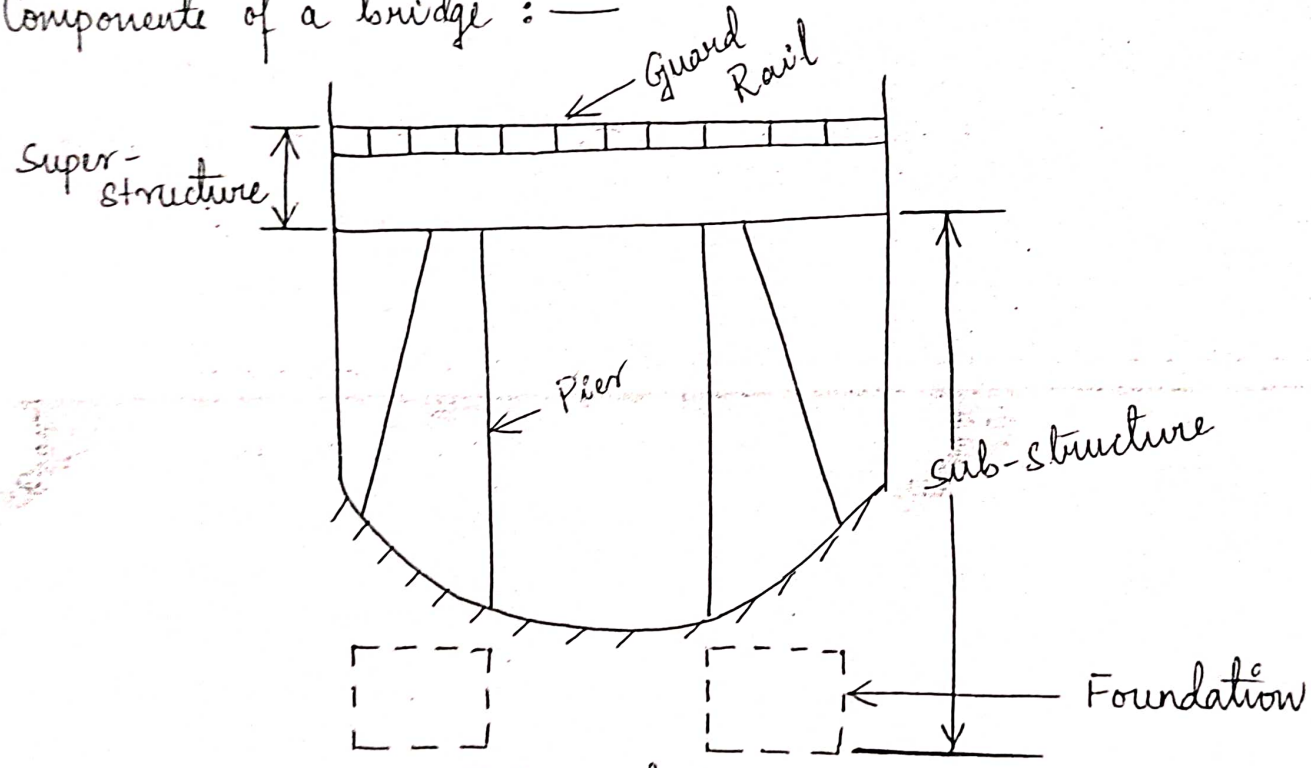

Fig :- Elevation

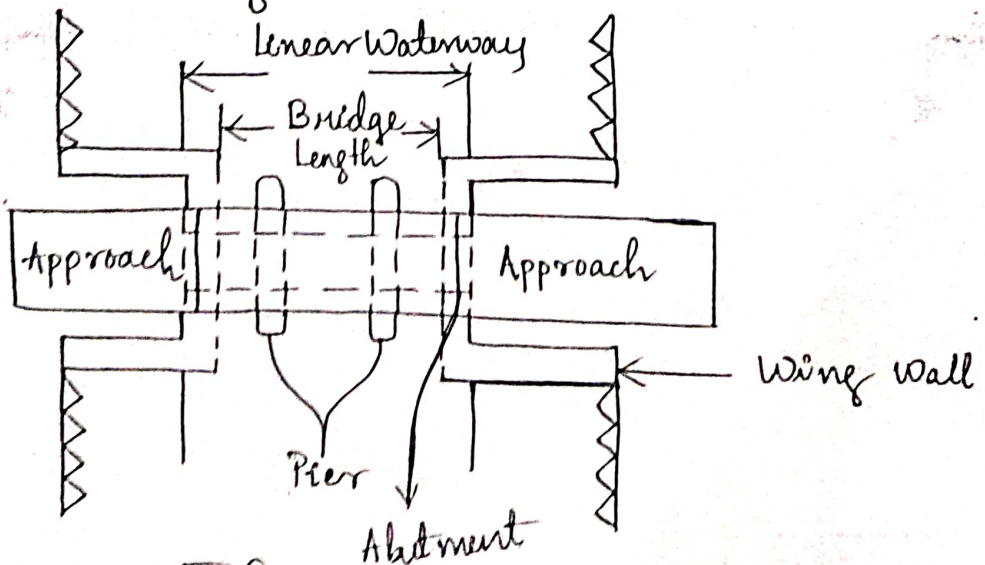

Fig - Plan : —

Bridge Length :—

Bridge Length is the overall length measured along the centre line of the bridge from the end to end of the bridge deck.

Linear Waterway :—

Linear waterway is the length between extreme end of the water surface to the abutment face.

Lower Water Level (LWL) :—

It is the level of the water surface obtained in dry season.

Ordinary Flood Level (OFL) :—

It is the average level of flood which is normal every year.

Highest Flood Level (HFL) :—

It is the level of the highest flood ever recorded.

Classification of Bridge : —

Based upon : —

1- Material used : —

Under this category bridge can be divided as : —

1- Masonary Bridge
2- Steel bridge
3- R.C.C bridge
4- Composite bridge

2- Alligment : — 1- Straight Bridge
2- Skew Bridge

3- Location of Bridge Flow : — 1- Deck
2- Semi Trough
3- Trough

4- Purpose : — 1- Highway Bridge
2- Railway Bridge
3- Foot Bridge

5- Nature of Super-structure : — 1- Truss Bridge
2- Balanced Cantilever
3- Suspension

9 - Span Length : —
1 - Culvert (Less than 6m)
2 - Minor Bridge (6 - 30 m)
3 - Major Bridge (30 - more)
4 - Long Span Bridge (More than 120m

Requirement of Ideal Bridge : —

1 - It serves with maximum safety and convinience.
2 - It is aesthetically sound.
3 - Economical
4 - Reduction of Traffic.

2. Bridge Site Investigation & Planning

6.2.17

- **Selection of Bridge Site :** —

→ Generally three things are considered for deciding the best possible location of the bridge.

1- Detailed Ground Reconnaissance
2- Collection of Adequate Hydraulic Data
3- Sub-soil Investigation

→ The bridge site should such be selected that it can be fullfilled engineering, economic, social, commercial and asthetic benifits.

- **Ideal Bridge site Characteristics :** —

→ Suitable, unyeilding, non-erodable material for foundation should be available at a short depth for the abutments and piers.

→ The stream at the bridge site should be as narrow as possible.

→ There should be a straight reach of stream at ~~each~~ bridge site.

→ The site should have permanent, straight and high banks.

→ The flow of water at the bridge site should be in steady condition.

→ There should no confluence of large tributaries in the vicinity of bridge site.

→ It should have straight approach roads and square alignment.

→ There should be minimum obstruction of natural water-way to have minimum afflux.

→ For economical purpose, easy availability of labour, construction material and transportation facility should be available near the bridge site.

→ For minimum foundation cost, the bridge site should be such that no excessive work is to be carried inside the water.
→ Secure and economical approaches should be possible.
→ The bridge site should be in such a height that waterway is available underneath the bridge for navigation purpose.
→ There should be no adverse environmental conditions.

• Bridge Alignment : —

Depending upon the angle which the bridge makes with the axis of river.
Alignment is of two types : —

1- Square Alignment : — In this type of alignment bridge is at right angle to the axis of river.

2- Skew Alignment : — In this type of alignment, the bridge is some angle with the axis of river apart than 90°.
As far as possible, always square alignment is preferred.

• Advantages of Square Alignment : —

→ Square alignment is easy to construct than that of skew and maintenance is also easy.
→ The water pressure on piers is less in case of square alignment due to the uniform flow of water.
→ Foundation of square alignment is less affected due to scour action.

• Sub Surface Investigation : —

→ Field and laboratory investigation are required to obtain the necessary soil data for design of the bridge.
The process is called soil exploration.

→ In order to design a economical and safe structure, proper foundati is required.

→ The main requirement of sub-soil exploration is : —

1- Nature of soil deposits upto a sufficient depth.
2- Depth, thickness and composition of each soil stratum.
3- Location of ground water
4- Depth to rock and compocition of rock
5- Engineering properties of soil and any chemical properties that can harm a structure.

Advantages : —

1- Suitable and economical structure.
2- Construction schedule can be properly planned.
3- Rate and amount of settlement can determined.
4- Variation in water table and artesial pressure can be found out.

Afflux : —

→ When a bridge is constructed, abutment and piers cause the reduction in natural water way.

→ To carry the maximum flood discharge, the velocity under a bridge increases, this increased velocity gives rise to a sudden boost of water on the upstream side called as afflux.

→ Greater the afflux, greater the velocity of stream and greater the depth of scouring and greater the depth of foundation.

→ Afflux is calculated by following two formulas : —

Clearances : —

→ To avoid traffic rushing, structural clearance diagrams are given.

→ Horizontal clearance is the clear width and vertical clearance is the clear height.

→ In case of superelevation, the horizontal clearance should be increased by an amount of five times of the superelevation. and vertical clearance should be designed according to that.

Free-Board : —

→ Free board is the vertical distance between the H.F.L and the level of the crown of the bridge at its lowest point.

→ It is essential to provide free board in bridges due to following reasons : —

1- Free board allows free floating of materials under the way.

2- It helps in allowing the afflux during the highest flood discharge.

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• Collection of Bridge Design Data :—

Type of Bridge	Free Board
High Level Bridge	600 mm
Earth Bridge	300 mm
Girder Bridge	600 - 900 mm
Navigational Stream	2400 - 3000 mm

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Determination of Flood Discharge :—

Flood discharge can be calculated by the following methods :-

1- Empirical Formula Method :—

It is the most common method which is used to calculate flood discharge.

a- Dickens Formula :—

$$Q = C.M^{\frac{3}{4}}$$

Q = Discharge

M = Area of catchment area.

C = Constant

C varies from 11.02 to 22.04 depending upon the area.

b- Ryves Formula :—

It is only used in southern India.

$$Q = C.M^{\frac{2}{3}}$$

c- Englis Formula :—

This is mainly used in the state of Maharashtra.

$$Q = \frac{123.2M}{\sqrt{M+10.36}}$$

d. Nawab Jang Bahadur's Formula: —

$$Q = C \cdot \left(\frac{M}{2.59}\right) \times (a - b \log A)$$

where, $a = 0.993$

$b = \frac{1}{14}$

$C = 59.5$ for North India,
46.1 for South India.

e - Creager's Formula: —

$$Q = 46\, C_M^{(0.894M - 0.048)}$$

F - Khoshla's Formula: —

$$P = R + L$$

where, P = Rainfall
R = Runoff
L = Losses

G - Basson's Formula: —

$$Q_m = \frac{P_m \times Q_n}{P_n}$$

where, Q_m = Peak flow expected
Q_n = Observed peak flow
P_n = Observed rainfall
P_m = Expected Rainfall.

2:- Rational Method :—

This method is applicable for determination of flood discharge in small culverts only.

It depends upon the following factor :—

1- Rainfall Factor :—

i- Intensity

ii- Distribution

iii- Duration.

2- Catchment area Factor :—

i- Area

ii- Shape

iii- Slope

iv) Porosity of soil

v- Vegetable cover

vi- Initial state of wetness

3- Determination of Discharge by using hydraulic characteristics of stream :—

The hydraulic characteristics to influence the maximum discharge is :- i- Velocity of Flow

ii- Slope of the stream

iii- Cross-sectional area of stream

iv- Size Shape & roughness of stream

4- Using Radioactive Isotopes : —

→ This is the most advanced and new technique for the measurement of flood discharge.

→ Radio isotope Bromine - 82 is injected into the river and the flow of water is calculated by the amount of radio activity in the water.

→ This is the most accurate and efficient method.

→ This method is partically used in monsoon season.

5- Determination of Flood Discharge from flood marks on an existing structure : —

→ In this method, flood discharge is calculated from an existing ~~road~~ railway bridge or culvert over the stream.

1- Broad Crested Weir Formula : —

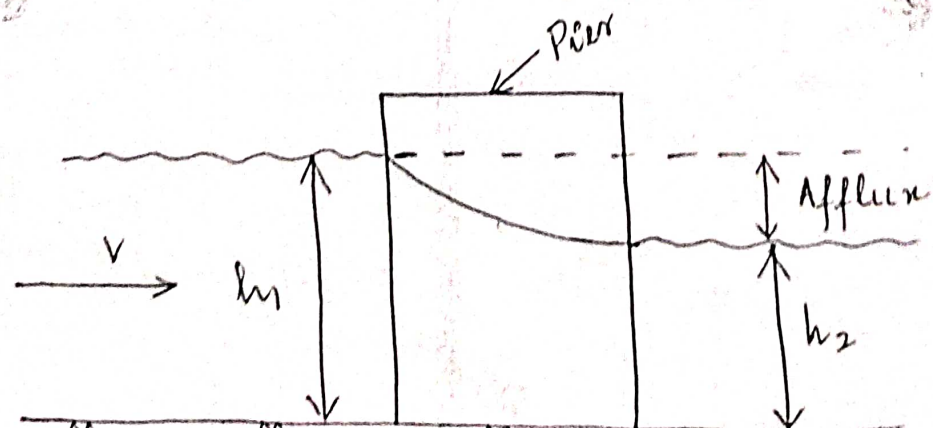
$$Q = 1.70 C_w L \cdot \left(h_1 + \frac{v^2}{2g}\right)^{3/2}$$

where, L = Linear water way under the bridge ~~under~~ in m

h_1 = upstream depth of water

v = Velocity of Approach

C_w = Coefficient of losses due to friction.



Water - Way :—

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

→ The linear measurement of this area along the bridge is known as linear water way. This is artificial linear water way.

→ The natural water way is the unobstructed area of the river through which the water flows.

Fixing of Linear water way :—

→ The following principles must be kept in mind before fixing the linear water way :—

i - The increased velocity due to afflux should not be more than permissible velocity.

ii - There should not be too much heading of up water surface above the bridge.

iii → In high bridge, free-board should not be more than 600 mm.

iv - Clearances should be provided in case of bridges.

Economics Span :—

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

→ The overall cost of the bridge depends upon :—

i - Cost of the raw materials

ii - Availability of skilled labours

iii - Span Length

iv - Nature of stream

v - Climatic & other conditions.

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Types of Rail Joint :—

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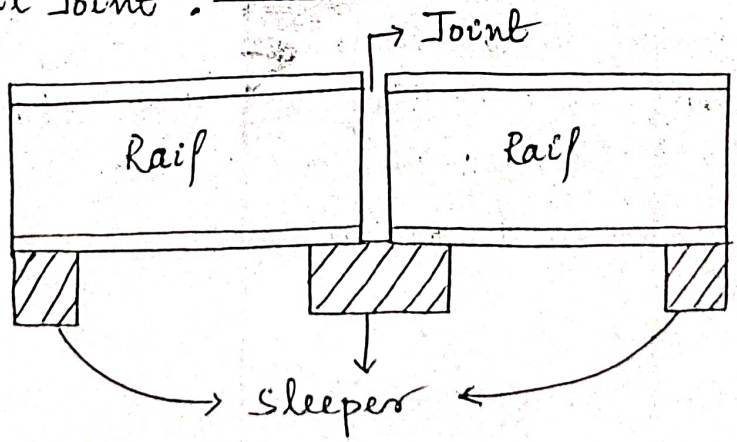

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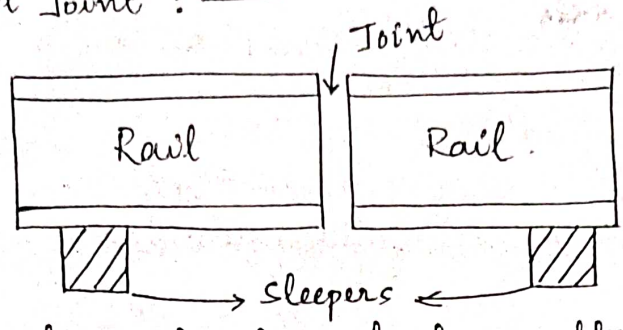
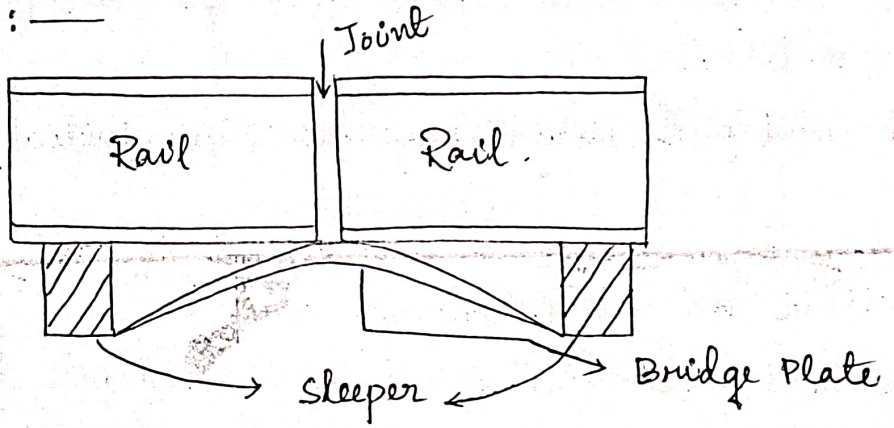


→ When the rail end lies beyond sleepers then it is called suspended rail joint.

→ It is mostly used in case of timber and steel sleepers.

3- Bridge Joint : —



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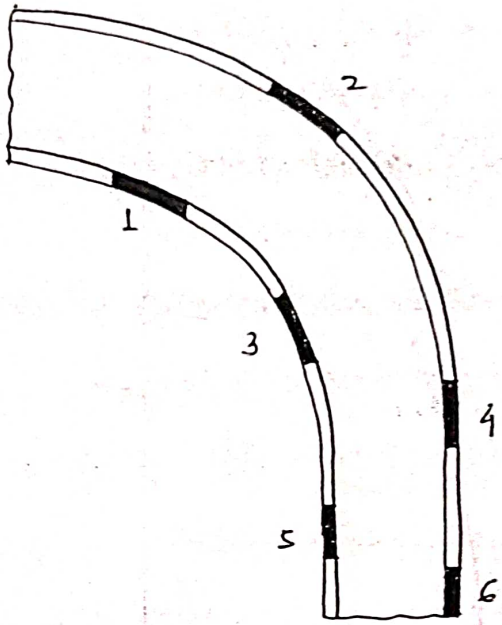

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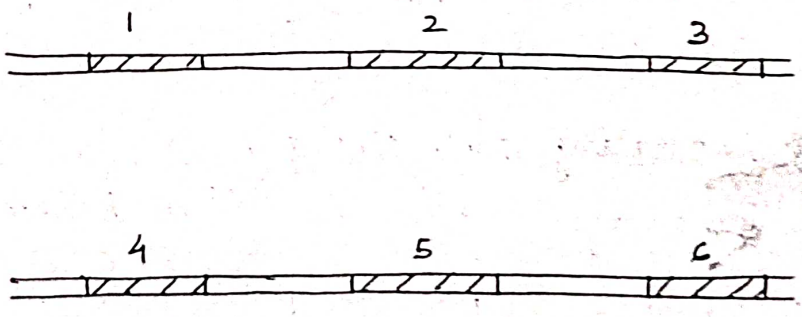
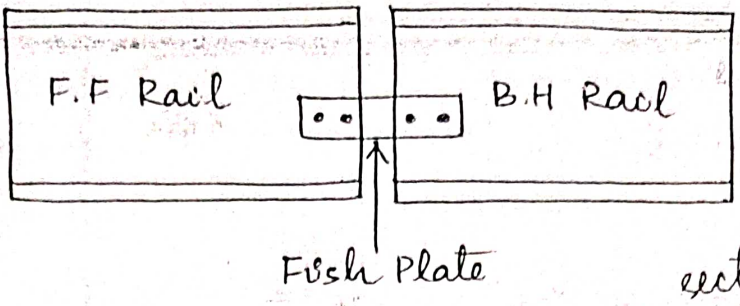
→ This joints are generally provided on curves when outer curve is greater than inner curve length.

7- Square or Even Joint : —



→ In this joint, position of rail joint of one track is directly opposite to the joint of other track's joint.

8 → Compromise Joint : —



→ In this type of joint, two different rail sections are joined together by the help of a fish plate.

9 → Insulated Joint : —

→ When insulated medium is inserted in a rail joint to stop the flow of current, it is called insulated joint.

10 → Expansion Joint : —

→ In case of bridges for expansion and contraction a gap is provided, known as expansion joint.

→ This gap is 2.2cm.

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Welding of Rails : —

Purpose of Welding : —

→ To increase the length of rails by reducing the number of joints, fish plates.

→ It helps in increasing the strength and also economic.

→ To repair the damaged rails, and thus increasing their life.

→ To build up worn out points, and rails on curves.

→ To built up the burnt portions or other defects in rail.

Advantages of welding :—

→ It increases the life span of a rail, and also decreases maintenance cost by 20 to 40 %.
→ It reduces the creep due to the increase in the length of rail.
→ Expansion effect due to temperature is reduced.
→ Long rail lengths dampen the intensity of high frequency vibration due to moving loads.
→ It increases the life of rails due to less wear action.
→ It helps in track circuiting on electrical tracks.
→ Welded rails on large bridges are helpful as they result in better performance.
→ The cost of track construction decreases due to less number of joints and fish plates.

Creep of Rails :—

Creep :—

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

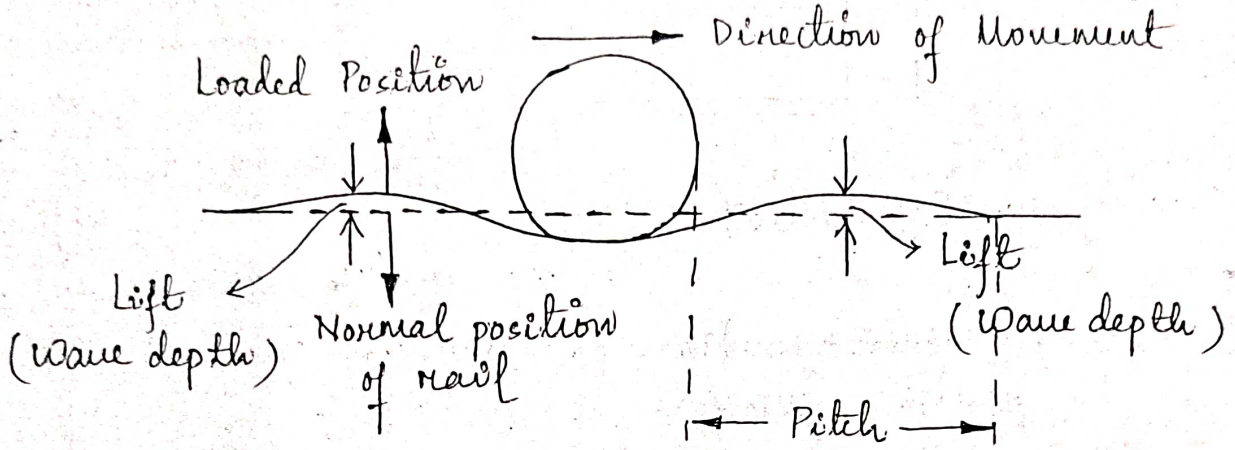
→ The creep can be noticed by the following observations :—

1- Closing of successive expansion spaces and opening out of joints at the point from where the creep starts.

Theories / Cause of Creep : ——

There are various causes which explain the probable causes of creep : —

1- Wave Theory : —



→ In this theory, wave motion is formed due to the moving of wheels.

→ It results the rail deflection under the load which is main cause of creep.

→ The wheels push the wave in the direction of traffic. As the wheels move, the lift infront of the moving load is carried forward and causes creep whereas the lift at the rear gets back to the normal position.

→ The wave action can be reduced by : —

a- Angular and heavy ballast which develops good interlock.

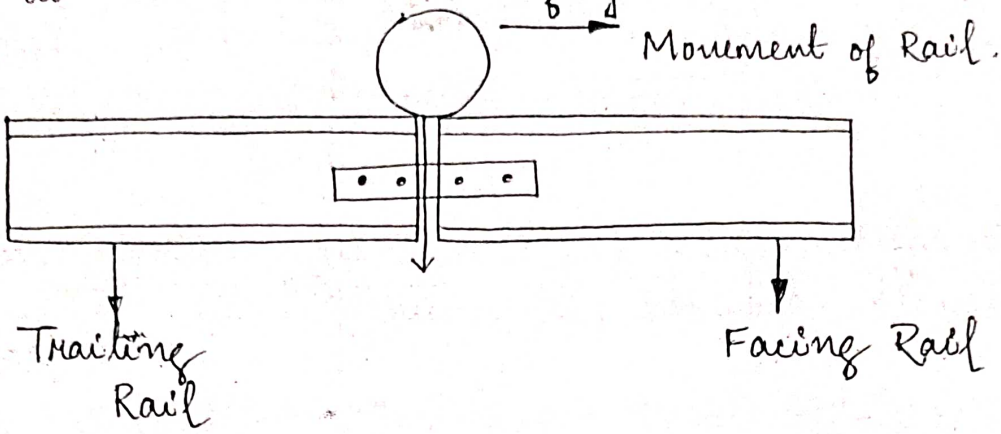
b- Stiffness of track

c- Lesser sleeper spacing

d- Bigger section of the rail.

2- Percussion Theory :—

→ This theory states that the creep is due to impact of wheels at the rail end ahead of joints.



→ When the wheels leave the trailing rail and strike the facing rail end, it pushes the rail forward resulting in creep.

→ The creep by this theory increases due to :—

I- Week and loose fish bolts.
II- Worn out Fish Plates
III- Loose packing of ballast
IV- Wide Expansion Gap
V- Heavy loads moving at high speed.

3- Drag Theory :—

→ This theory states that backward thrust due to locomot -ves have a tendency to push the rail track & backward

→

4- Starting, Accelerating, Slowing down, Stopping :—

→ In the above four cases, the wheels tends to push the rail backward creating creep action.

5 → Expansion and Contraction of rails due to temperature :—

→ Due to variation in temperature creep occurs due to contraction and expansion.

6- Unbalanced Traffic :—

→ In a single lone system, if heavy traffic runs in one direction, it will cause creep.

Assignment

Write the effects of Creep on a Railway system :—

Remedies of Creep :—

→ If creep is not prevented in time, then it will cause derailment.

→ Following are the steps to prevent it :—

1- Pulling back the rails :—

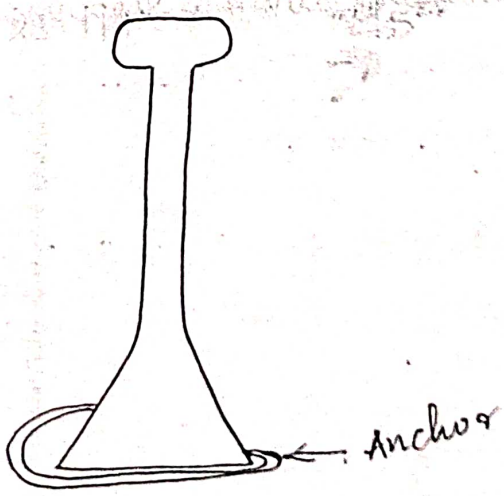
→ If creep is distinctly visible the need is to pull back the rails to its original position. (Crow Bars)

→ The rails are pulled to the original position by the help of crow bars and the position of hooks relative to sleepers must be maintained.

→ It is very slow and tedious process and is possible incase of small length.

2- Provision of Anchors :—

→ The creep of the track can be prevented by the use of anchors.



→ Anchors are fitted on the foot of rail and kept on the sleepers to prevent creep action.

→ If creep occurs in both direction, anticreepers are provided on both the sides of the ~~so~~ sleepers.

→ Anchors are fixed to rails by :—

1 - Wedging Action
2 - Clamping
3 - Spring Grip

3- Use of steel sleepers :—

→ Steel sleepers are best sleepers which can effectively prevent the rail from creeping.

→ Sleepers must have a good grip with ballast to resist the moment of sleepers in ballast.

→ The feeling of isolation has been removed.
→ By travelling together, the restrictions like caste and religion has been removed.
→ The social outlook has been broadened.
→ Railway plays a very pivotal role to connect the religious centres of the country.
→ It provides a safe and comfortable journey for the passengers.

Political Advantages : —

→ Railway has united peoples of different cast, religions and traditions.
→ Railway has contributed towards the development of a national mentality.

→ The role of railway during emergencies and war situations is really significant.

→ Railway has helped in mass immigrations.

Economical Advantages : —

→ Mobility of people has increased which helps in equal distribution of population.

→ Mobility of labourers has contributed in the development of industries.

→ During famines, railway has played a vital role in transporting foods and cloths.

→ Mobility of raw material also helped in growth of industrialization.

→ Railway gives maximum employment in the country which helps to remove / eradicate unemployment.

→ Land values have increased due to industrialization which helps in the increase of ~~railway~~ national wealth

→ Due to the mobility of products a price stabilization has been ~~increased~~ established throughout the country.

→ Commercial farming is very much increased by railway network.

Techno-Economic Advantages :—

→ Cost saving in transportation.

→ Energy efficiency (Railway consume 1/7th of the fuel than that of the road sector)

→ Environmental freendly.

→ Higher safety

→ Efficient use of lands.

SLEEPERS :—

Sleepers are members which are laid transverse to the rails and on it rails are fixed and supported.

- **Function of sleepers :—**
  - → To hold the rails in its proper position by maintaining the gauge distance.
  - → To hold the rails in a proper level and support the rails.
  - → It acts as an elastic member by absorbing the blows and vibrations.
  - → It distribute loads from rails to ballast and sometimes girders in case of bridges.
  - → It helps in maintaining the proper track at super elevation
  - → It gives longitudinal and lateral stability to the rails.
  - → It helps in rectifying the track geometry in the life period

- **Requirement of sleepers :—**

  As the per the requirement, an ideal sleeper should have the following characteristics :—

  - → It should be economical & minimum initial maintenance cost.
  - → The fittings in the sleepers should be designed in such a way that they can be easily adjusted at the time of maintenance.
  - → The weight of the sleepers should not be too heavy or too light for easy handling.
  - → It should able to resist the crossing of the ballast below it.

→ It should be provided in such a spacing that easy removal and replacement of ballast can be possible.

→ It should be capable of resisting heavy shocks and vibrations during the passage of heavy loads.

→ It should be long lasting and should not damaged during the construction / laying process.

→ The insulation of rails can be provided easily where track circuiting is required.

→ An ideal sleeper should have antisapotage & anti theft qualities.

• Classification of sleepers : —

Sleepers are classified into following categories : —

i - Wooden sleeper

ii - Metal sleeper : - a - Steel sleeper
b - Cast Iron sleeper

iii - Reinforced Concrete sleeper (R.C.C) : - a - Reinforced
b - Prestressed

Dt - 21.3.17

1 - Wooden sleepers : —

→ Once a time, wooden sleepers were considered as one of the best sleepers in railway.

Below are advantages & disadvantages : —

Advantages : —

→ It is easily available in all parts of India.
→ Fittings are simple and can be easily carried out.
→ Easy to lay, relay, handle, lift, & and maintain.

→ less noisy track.
→ Suitable for all types of ballast.
→ It is best for track circuiting and moreover it is economical.

Disadvantages : —

→ Difficult to maintain the gauge.
→ Easy wear and tear, decay, attack by vermine and cracking.
→ Minimum service life and high maintenance cost (12 to 15 years)

*. Types used for timber are : —
→ Hard wood like sal and teak
→ Soft wood like chir and Deodar

Metal Sleepers : —

→ Metal sleepers are either of steel or cast iron, but cast iron is used more as it is prone to less corrosion.

Requirements : —

→ They should bear the tensile and compressive stresses.
→ Should provide enough space for rails.
→ Tamping and packing of ballast should not disturb the sleeper.
→ Insulators can be provided for track circuiting.
→ It should be economical.
→ Easy fixation and and removal of rail can be done.

Advantages :—

→ These are uniform in strength and durability.
→ Performance of fittings are better and hence creep is lesser.
→ It is economical, long life span and easy maintenance.
→ Gauge can be easily adjusted and maintained.
→ Good scrab value, easy manufacturing and susceptible to fire hazards.

Disadvantages :—

→ More ballast is required than other type of sleepers.
→ More number of fittings are required.
→ Metals are subjected to rust or corrosion.
→ As it is good conductor of electricity, fear of track circuiting is always there.
→ These are not suitable for bridges, points and crossings.

Types of Cast Iron Sleepers :—

1- Pert or Bowl sleepers
2- Plate sleepers
3- Box sleepers
4- C.S.T-9 sleepers (Combination of Box & Plate sleeper)
5- Rail Free Duplex sleepers.

Steepers (steel sleepers) : —

Advantages : —

→ These are casted in one piece and manufacturing is simple.
→ Much more longer life span.
→ The gauge can be easily adjusted and fittings are simple.

Disadvantages : —

→ Cracks can be easily developed in case of heavy loading.
→ It is liable to corroppion.
→ Material cost is high than the other sleepers.
→ As it is a good conductor, so chances of track circuiting is there.

*. Types of steel sleepers used in India : —

1 - Key Type
2 - Clip - Bolt Type
3 - Spring or saddle Type

Concrete Sleepers : —

→ This is the best ideal sleeper used in railway.

Advantages : —

→ These sleepers are free from decay and attacked by vermines.
→ Maximum life span of 40 to 60 years.
→ These are not affected by moisture, chemical action of ballast, subsoil salts.
→ No difficulty in Track Circuiting.
→ Minimum joint is required and greater stability can be achieved.

→ Higher elastic modulus and hence can withstand fast and heavy loads.

Disadvantages : —

→ Weight is 2 to 3 times heavier than other sleepers and hence difficult to handle.

→ They damage the bottom edge during the packing.

→ Scrab value is almost nil.

→ Incase of derailment, damages in concrete sleepers are heavy.

Reinforced Concrete sleeper : —

This is of two type : —

1- Through Type

2 - Composite or Block & Tie Type

Pre-stressed Concrete sleepers : —

→ Maximum permissible compressive strength - 211 kg/cm²

→ Compressive strength of 28 days cube - 422 kg/cm²

→ Initial stress - 8.82 kg/cm².

Disadvantages : —

→ Heavy damage in derailment.

→ Uneconomical

→ More rigid in nature.

→ Maintenance is high

→ Design and construction is complicated.

LAYING OUT AND MAINTENANCE

Dt - 29.3.17

Construction of Track : —

→ Basically there are three steps for the construction of a railway track : —

1- Earthwork : — (Formation & Consolidation)

2- Laying of a railway Track

3- Laying of Ballast

Laying of Railway Track : —

→ The operation of laying out rails and sleepers on the formation, is known as laying out of railway track.

→ The point from where laying starts is known as base and the point on which the new track is carried out is known as rail head.

Method of Laying : —

→ The railway track is laid by the following methods : —

1- Tramline Method / side Method : —

→ In this method, a temporary tramline is laid by the side of proposed track for carrying out the materials.

→ This is suitable where double line tracks are designed.

→ This is mainly adopted in flat surfaces and progress of work is slow. (1.6 km / day)

2- Telescopic Method : —

→ This method is used mainly in India. In this method the materials are transported to the farthest point of a new track and unloaded there.

→ From that point, the materials are carried out to different rail heads.

* Operations In Telescopic Method : —

1- Collection & preparation of material at depot.

2- Transportation of material from depot to worksite.

3- Unloading of material at worksite and carrying them to the rail heads.

4- Fixing the rails to the sleepers and joining of two rails by fish plates.

5- Packing etc of track of correct level and alignment.

3. American Method : —

→ In this method, special track laying machineries are used for laying out work.

→ It is first used in America and now a days Britain & America are using this method.

Laying Out of Ballast : —

→ The laying of ballast is taken up after two to three monsoon seasons so that the track can be settled down.

Maintenance :—

→ In India conventional maintainance is carried out by the help of labours and hand tools.

→ It is two types :—

1 - Daily Maintenance
2 - Periodic Maintenance

→ The maintenance of track includes the maintenance of following items :—

1 - Surface of Rail
2 - Track Alignment
3 - Gauge
4 - Proper Drainage
5 - Track Components.
6 - Bridges and its approaches.
7 - Rolling stock.
8 - Points & Crossings.
9 - Level Crossings
10 - Tunnels.

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Permanent Way Inspector :—

→ Permanet way Inspector is the incharge of maintenance of 80 to 120 km of railway.

→ Under each permanent way inspector ~~three~~ there are three to four assistant permanent way Inspector.

Duties of Permanent Way Inspector : —

a. Duties In Field : —

→ The PWI is responsible for maintaining the track in safe condition.

→ He inspects the track at least 2 to 3 times a week and note downs defects and kilometers.

→ He inspects the track by the help of push trolley or a break van.

→ He keep all the records like defects and maintenance of track, progress of maintenance and relay of track.

→ He gives instruction to the APWI.

→ At the time of accidents he should prepare the track ASAP and inquiries the cause of accident.

b. Duties In office : —

→ He takes care of labours and materials.

→ He controls the workshop such as welding and carpentary.

→ He prepares the estimate for the maintenance work.

c. Miscellaneous Duties : —

→ He attains the monthly meeting of PWI's at division office.

→ He attains the special inspection by divisional engineer or assistant section engineer.

→ He represents the assistant section engineer in his absence.

POINTS AND CROSSINGS

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→ Points, Crossings, Turnouts, Cross overs are the terms related to the arrangements of different routes either parallel or diverging to afford the train to move from one route to another.

• Necessity : —

The problem of diversion of trains from one track to another can be solved by special arrangements known as points & crossings.

• Necessity : —

→ Points and crossings provide flexibility of movement by connecting one line to another.

→ It helps in imposing restriction over turnouts.

→ Also from safety aspects points and crossings are important as they can reduce weak points.

Points of Switches : —

→ A switch consists of a stock rail and a tung rail.

Components of switch : —

1 - Stock Rail
2 - Tung Rail
3 - Heel Block / Distance Block
4 - Stretcher Bar
5 - Gauge Tie Plate
6 - Sliding Plates / Chairs
7 - Studs or Stops

1- Stock Rails :—

→ These are the main rails of the track to which the tong rail is connected.

2- Tong Rails :—

→ These rails are secondary rails lie between the stock rails.

→ Generally tong is provided in between 0.64 to 0.95 cm

→ Tong rails are supported on sliding plates and is connected by stretcher bars near the toe.

→ Tong rails are so connected that both the tong rails move together to the same distance and maintain the gauge.

→ This distance is known as 'throw of switch'.

3- Heel Block / Distance Block :—

→ These blocks are inserted between the heel of the tong rail and stock rail.

→ These are made of cast iron and are used to maintain a proper distance between stock rail and tong rail.

4- Stretcher Bar :—

→ These are provided at the toe so that each tong covers the equal distance.

5- Gauge Tie Plate :—

→ This is provided below the chairs at the toe.

→ Its main use is to hold the track rigidly to the definite gauge.

Dimension :— 25 x 1.25 cm.

6- Sliding Plate / Chair : —

→ These are special plates provided under the stock and tong nails.

7- Studs / Stops : —

→ These are fixed between the stocks and tong nails.

→ Its main use is to prevent the lateral bending of tong nail and maintain correct allignment.

Types of Switches : —

There are two types of switches : —

1- Sub-Switch

2- Split Switch.

1- Sub Switch : —

→ In this type of switch no separate tongue rail is provided and some portion of the track is moved from side to side.

→ It is an old form of switch and is no more used now a days.

2- Split Switch : —

→ In this type of switch, a tongue rail is combined with the stock rail.

→ This is classified as :—

1- Loose Heel Type (Articulated Type)

2- Fixed Heel Type (Flexible Type)

1- Loose Heel Type : —

→ In this type, tongue rails are joined to stock rails by the help of fish plates.

→ The two front bolts are kept loose and the rear two bolts are tightened.

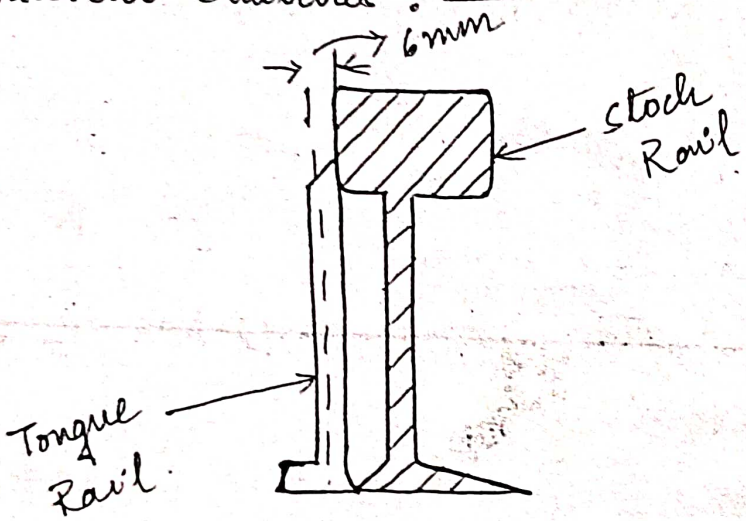
→ The loose bolts allow the through of switch.

2- Fixed Heel Type : —

→ This is the improvement over loose heel type.

→ In this, all the four bolts are tight and it gives a satisfactory result.

1- Undercut switches : —



→ Incase, the height of tongue and stock rail is same, then a portion is cut out at the flange, at the foot of the stock rail so-that the tongue rail can be fixed.

Dicadvantage : —

The main dicadvantage is it becomes weak as a portion is cut out.