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Railway Terminology —

Ballast:
Ballast is the granular material packed under and around the sleepers to ballast. It helps in providing elasticity to the track.

Ballast Crib:
The loose ballast between the two adjacent sleepers is known as "ballast crib".

Bearing plates:
To reduce the intensity of pressure, particularly on soft variety of sleepers, a rectangular plate of mild steel or cast iron is introduced between the rails and the sleepers. This plate is called bearing plate. It distributes the load over a larger area of timber sleepers.

Blocks:
To provide the required gap between the two rails, steel pieces called blocks or "Heel blocks" are used. Such blocks are used between main rails and check or guard rails.

Boxing :-

The process of filling the ballast around the sleepers is called boxing of the ballast. This ballast boxes the sleeper.

Broad Gauge :

The Gauge of a track in which the distance between the running faces of two track rails is 1.676 metre is termed as Broad Gauge.

Narrow Gauge :

The Gauge of a track in which the distance between the running faces of two tracks rails is either 0.762 metre or 0.61 m.

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Sleepers :

Sleepers are the members laid transversely under the rails which are meant to support the rails over them and transfer the load from rails to ballast.

Sleeper Density :

Sleeper density represents the number of sleepers per rail length in metres.

Sleeper Crib :

A track is temporarily supported for repairs and alteration work by girders, piers, etc. over a stack of timber crib. This is adopted on small bridges and culverts where dry bed is available.

Metre Gauge :

The gauge of a track in which distance between the running faces of two tracks rails is 1 metre.

Coning of wheels :

The wheels are coned at a slope of 1 in 20 to prevent from rubbing the inside face of the rail head and to prevent lateral movement of the axle with its wheels. This is known as coning of wheels.

Creep of Rails

Creep is the longitudinal movement of rails in a track. Its occures due to several reasons. The effect of creep tends to drag the track if ballast is insufficient to hold the rails.

Fish Plates:

These plates, resembling in shape to a 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 temperature variation. They are made of steel.

Equilibrium Cant or Superelevation:

If the cant or superelevation on the curved track is provided on the basis of Average or Equilibri speed of the trains running over that section, then such a cant is called Equilibrium cant.

Negative Cant or Negative Superelevation:

When the turnout or branch line branches off from a main line on the curve on the opposite side, then at a point from where both the tracks bifurcate or diverge, it is not possible to provide cant for both the tracks at the same place. In such cases, on the branch line where the outer rail is below the inner rail is said to have negative cant or Superelevation.

Audible Signal or fog signal :-

Sometimes a container containing suitable explosive is put on the top of the rail so that there is explosion with a loud voice when wheels pass over the rails. This arrangement is called audible or fog signal or a detonator.

Buckling of Rails :-

The railway track gets out of the original position due to buckling if the expansion of rails due to rise in temperature ~~rails~~ is prevented

prevented during hot weather. This is known as buckling due to rise in temperature rails.

Cant Deficiency :-

The equilibrium cant is provided on the basis of the average speed of different trains on the track. This equilibrium cant or superelevation will fall short of that required for speeds higher than average speed. This shortage of cant is called cant deficiency.

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Rails :-

Rails are steel girders which provide the hard and smooth surface for movement of wheels of a locomotive and railway vehicles.

Bull Headed Rails :-

B.H. rails are those in which head is made little thicker and stronger than lower part i.e. foot by adding more metal at the top.

Flat Footed Rails :-

Flat footed rails are also known as flat bottom (or foot), so that they can be fixed directly on the sleepers, avoiding the necessity of chairs. They are also called Vignole's rails.

Chairs :-

C.I chairs are used to hold the bull-headed and double-headed rails. These chairs are fixed to sleepers by round spikes.

Spikes :-

Spikes are used for fixing rails to the wooden sleepers. There are various types of spikes commonly used for holding F.F. rails.

Gradient :-

Any departure of the railway track from the level is known as grade or gradient. It is called an upgradient when the track rises in the direction of motion, and a down gradient when track falls below in the direction of movement.

Greade Compensation :-

The amount of gradient is reduced wherevere a curve and greadient have to be preovided together. The reeduction in greade is known as greade compensation on curves.

Hauling Capacity :-

Hauling capacity of locomotive is the total load which can be hauled by it. It indicates the powere of the locomotive.

Left Hand

A turnout is called a left hand turnout when the direction is towareds the left of the main treack in facing direaction.

Right Hand Turenout :-

A turenout is called a right hand turnout when the diveresion is towareds the right of main route (treack) in facing direction.

Keys :-

Keys are the tapered pieces of timber or steel to fix the rails to the chairs on metal sleepers.

Locomotive :-

It is a machine which transferes chemical energy of fuel into mechanical energy of motion. Fuel may be water and coal or diesel or electricity.

Points and Crossings :-

Points, crossings, cross-overs, and turnouts, etc. are contrivances or arrangements by which different routes either parallel or diverging are connected to afford for the train to move from one track to another.

Packing :-

The process of ramming the ballast underneath the sleeper is known as "Packing".

Packing Gang :-

Those labourers who bring the track to the correct level and alignments by packing ballast under it are called Packing gang.

Parmanent Track :-

It is the track which is of parmanent nature and handles the normal commercial traffic for which it is meant. It is also called permanent way.

Check Rails :-

Check rails are provided on the opposite side of the crossing location for guiding one wheel of the vehicle and thus to check the tendency of another wheel to climb over the crossing.

Heel :-

Tapered rails at location where they are fixed to the main rails is called Heel.

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Advantages of Railways :-

Railways have brought about many political, social and economic changes in the life of Indian peoples:

(a) Political Advantages :-

i) Railway have united the people of people of different castes, religions customs and traditions.

ii) With the adequate network of railways, the central administration has becomes more easy and effective.

iii) Railways have contributed towards development of a national mentality in the minds of people.

iv) The role of railways during emergencies in mobilising troopps and war equipment has been very significant.

v) Railways have helped in the mass migration of the population.

(b) Social Advantages :-

i) The feeling of isolation has been removed from the inhabitants of the Indian villages.

ii) By travelling together into the compartment without any restriction of caste, the feeling of caste difference has disappeared considerably

iii) The social outlook of the masses has been broadened through railways journeys.

iv) Railway has made it easier to reach places of religious importance.

v) Railways provide a convenient and safe mode of transport for the country.

(c) Economic Advantages :-

i) Mobility of people have increased, thereby the congested areas can be relieved of congestion and the sparsely populated areas can be developed.

ii) Mobility of labour has contributed to industrial development.

x) Commercial farming is every much helped by the railways network throughout the country.

(d) Techno-Economic Advantages :-

i) Cost saving in transportation of long haul bulk traffic.

ii) Energy - Efficiency (railway consume one-seventh of fuel used by the road sector).

iii) Environment friendliness.

iv) Higher safety (fatal accidents one-tenth of road sector in India).

v) Efficient Land use and ease in capacity expansion.

Classification of Indian Railway :-

Railway Board has classified the Indian railway lines on the basis of the importance of route, traffic carried and maximum permissible speed on the routes, into the following 3 main categories :

(a) Trunk Route

(b) Main lines

(c) Branch lines

Railways Board has given the following specifications for these lines.

1) Trunk Route's :-

The following 6 Routes of B.G and 3 routes of M.G have been classified as trunk Routes.

On B.G → 1) Delhi - Mughalsarai - Howarh. 2) Delhi - koto - Mumbai. 3) Delhi - Jansi - Nagpur - Chennai. 4) Howrah - Bagpur - Mumbai. 5) Mumbai - Guntakul - chennai. 6) Howrah - Vijyawada - Chennai.

On M.G → 1) Lucknow - Gorakhpur - Guwahati. 2) Delhi - Jaipur - Ahmedabad. 3) Chennai - Madurai - Trivandrum

2) Main Lines :-

All lines other than trunk routes carrying 10 Gross Million Tonnes (G.M.T) per annum or more for B.G. and 2.5 G.M.T or more for M.G. or where maximum permissible speed allowed is 100 km.p.h. for B.G. and 75 km.p.h for M.G. are classified as main lines.

3) Branch Lines :-

These are classified on the basis of following criteria:

All those B.G. lines which carry less than 10 Gross Million Tones (G.M.T) per annum and have maximum permissible speed of less than 100 kmph are classified as Branch lines. For M.G. tracks, all those lines which carry less than 2.5 G.M.T. per annum and have maximum permissible speeds less than 75 km.p.h are classified as Branch lines.

The track specifications would vary depending upon the requirements of traffic subject to the followings conditions:

i) B.G. locomotive (WG/WP type) and Bobs wagons would be allowed to operate over all branch lines at a reasonable speed.

ii) M.G. engines (YG/YP types) and wagons with a maximum axle load of 12 tonnes would be permitted to operate on all branch lines at a reasonable speed.

iii) No new rails will normally be used on branch lines.

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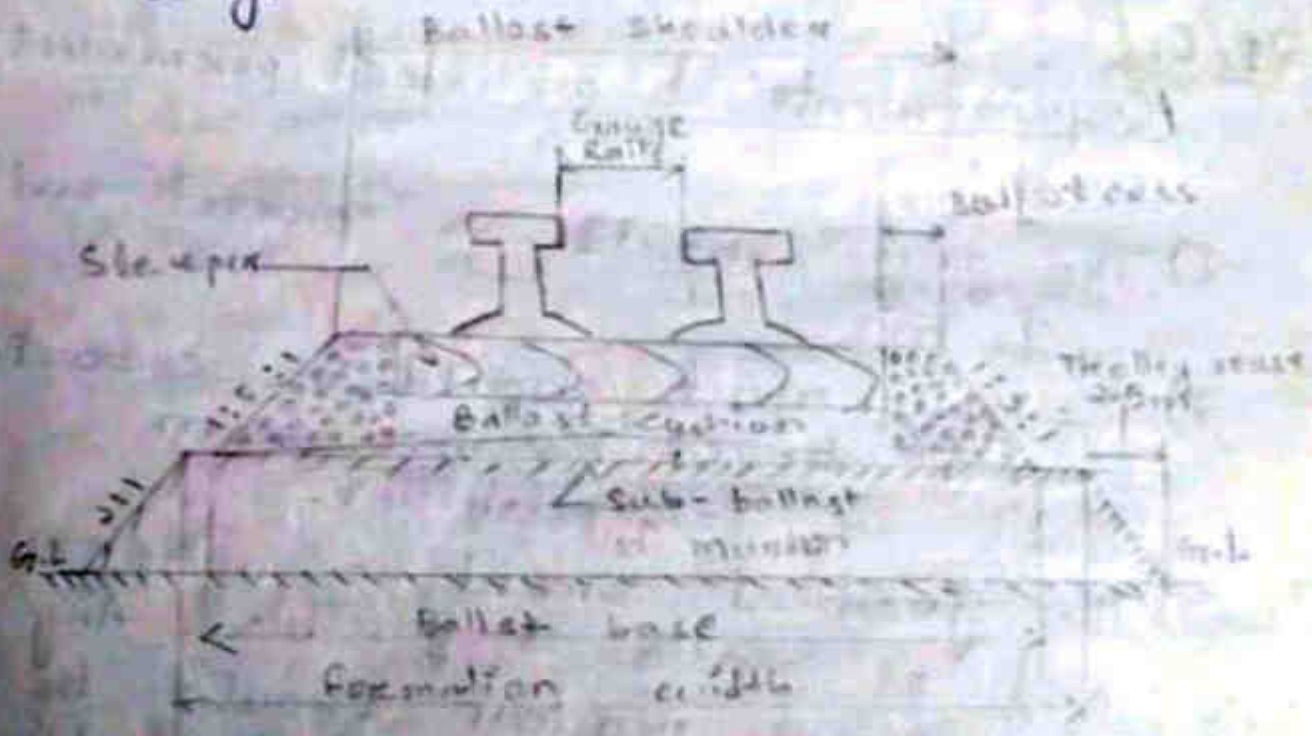
Railway Track
PERMANENT WAY

Permanent way :- The combination of rails, fitted on sleepers and resting on ballast and subgrade is called the railway track or permanent way.



Typical Cross-section of a permanent way on Embankment.

* The sleepers properly spaced, resting on ballast, are suitably packed and boxed with ballast.
* The layers of ballast rests on the prepared subgrade called the formation.
* The rails act as gireders to transmit the wheel load to the sleepers.
* On curved treacks, supere-elevation is maintained by ballast and the formation is levelled.

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Requirements of an ideal permanent way:

i) The gauge should be correct and uniform.
ii) The alignment should be correct, i.e., it should be free from kinks or irregularities.
iii) The gradient should be uniform and as gentle as possible. Any change of gradent should be followed by a smooth vertical curve, to give smooth riding quality.

iv) The track should be resilient & elastic in order to absorb shocks and vibrations of running track.

v) The track should be resilient and have enough lateral strength, so that alignment is maintained even due to effects of (a) side thrust on tangent lengths and centrifugal force on curves (b) lateral forces due to expansion of rails, particularly in case of welded rails.

vi) Drainage system must be perfect for enhancing safety and durability of track.

vii) Joints, including points and crossings which are regarded to be weakest points of the railway track, should be properly designed and maintained.

viii) If there is trouble from the creep, the preventionary measures should be to prevent it.

ix) There should be adequate provision for easy renewals and replacements.

x) The track structure should be strong, low in initial cost as well as

Gauges in Railway Track

The Gauge of a railway track is defined as the clear distance between inner or running faces of two track rails. The distance between the inner faces of a pair of wheels is called the "wheel gauge".

Different Gauges in India & Abroad

The gauge then maintained was 5' (1.524 m). Subsequently, the adoption of flanges inside the wheel on rails changed the definition of gauge. The position of rails of track was not changed in view of economy and clear distance between inner faces was defined by gauge.

* A gauge of 1.435m is the standard gauge in most of the countries even today.
* In India, the East India company adopted 1.676 m (5'-6') gauge as the standard gauge. In 1871,

in order to build cheap railways for the development of the country, the government adopted a metre gauge i.e., 1 m wide. In addition to board gauge (standard gauge) and metre gauge for hilly areas and for developing poor areas, India has 0.762 m.

* Thus, in India the following gauge are used :—

Types of gauge	Gauge width
i) Standard gauge (B.G.)	= 1.67 m
ii) Metre gauge (M.G.)	= 1.0 m
iii) Narrow gauge (N.G.)	= 0.762 m
iv) Feeder track-gauge (L.G.) (or light gauge)	= 0.610 m

Selection of Gauge :

The following factors govern the choice among the different gauge.

1) **Cost of Construction** :- There is little increase in the initial cost if we select a wider gauge (say B.G.), this is due to following reasons:

(a) The cost of bridges, tunnels, station buildings, staff quarters, signals, cabins and level crossings is the same for all the guages.

(b) The cost of earthwork, (in making embankment and cuttings) ballast, sleepers, rails, etc. would proportionally increase with increase in gauge width.

(c) There is little preportional increase in the acquisition of land for permanent track with increase in gauge.

(d) The cost of rolling stock is independent of the gauge used for the same volume of traffic.

2) Volume and Nature of Traffic: It is evident that with greater traffic volume and greater load carrying capacity, the trains should be run by a better traction technique or by better locomotives. For heavier loads and high speed, the wider gauges are required because

subsequently the operating cost per tonne-km is less for higher carrying capacity.

3) Development of the Area :- Narrow gauges can be used to develop the thinly populated area by joining the under developed areas with developed or urbanised areas.

4) Physical Features of the Country :- Use of narrow gauge is warranted in hilly regions where broad and metre gauges are not possible due to steep gradients and sharp curves. In plains also, where high speed is not required and the traffic is light, N.G. is a right choice.

5) Speed of Movement :- The speed of a train is almost proportional to the gauge. Speed is the function of diameter of wheel, which in turn is limited by the gauge. The wheel diameter is generally 0.75 times that of the gauge.

Raile

The raile on the track can be considered as steel girders for the purepose of carrying axle loads. They are made of high carbon steel to withstand to withstand wear and tear. Flat-footed rails are mostly used in railway track.

Functions of Rails

Rails in the railway track serve the following purpose:

i) Rails provide a hard, smooth and unchanging surface for passage of heavy moving loads with a minimum friction between the steel rails and steel wheels.

ii) Rails bear the streesses developed due to heavy vertical loads, lateral and breaking forces and thermal stresses.

iii) The rail material used is such that it gives minimum wear to avoid replacement changes and failures of rails due to fatigue.

iv) Rails transmit the loads to sleepers and consequently reduce pressure on ballast and formation below.

Composition of Rail steel

To meet the above functions, rails should be of good steel meeting all its requirements. Generally rails are made by open hearth process:

(a) For Ordinary Rails:

High carbon steel with following composition is used:

Carbon (c) — 0.55 to 0.68 per cent
Manganese (Mn) — 0.65 to 0.90 per cent
Silicon (Si) — 0.05 to 0.3 per cent
Sulphur (S) — 0.05 per cent or below
Phosphorus (P) — 0.06 per cent or below

(b) For Rails on points and crossings:

Medium carbon steel with following composition is used:

Carbon (C) — 0.5 to 0.6 per cent
Manganese (Mn) — 0.95 to 1.25 per cent
Silicon (Si) — 0.05 to 0.20 per cent

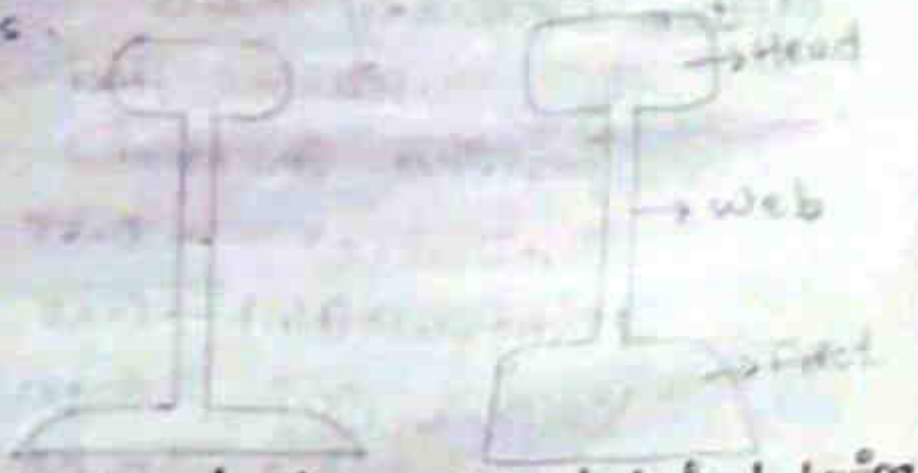
Sulphur (S) – 0.06 per cent or below
Phosphorus (P) – 0.06 per cent or below

For carbon steel with a rail section of 24.8 kg/m.

Requirement of Rails :

i) They should be of proper composition of steel.

ii) Economical section :- strength, durable & thickness



(Wider foot) (Head & foot having same section)

iii) Balance distribution of material in head, web & foot.

iv) Economical & balanced distribution of metal.

a) **Head** :- * Adequate depth (Aspects)
* Wider running surface

b) **Web** :- Sufficient thick to resist lateral loads, having adequate flectural

rigidity.

c) **Foot** :- Wide enought to resists the veretical load.
→ Stable againt twisting at & over turning.
→ Distribution to larege area.
→ The C.G of the rail section must lie approximately at mid height, so that max. tensile & compressive stresses are equal.

Types of rail section :-

There are three types of rail section.

1. Double headed rails (DH rails)
2. Bull headed rail (BH rails / Vignole's rail)
3. Flat-footed rail (FF rail)

Double headed rails :-

→ The rails used looks like dumbel.
→ Design to use from both sides.
→ Explain showed such indentation are foremed in the lower table due to which smooth running over that surface at the top was impossible.

Bull headed rails :-

Head was made a little thicker and stronger than the lower part by adding more metal to it, so that even after wear, it can withstand stresses. (Continous use for a longer period).

Flat - footed rails :-

→ Under heavy loads, the foot was found sinker ~~work~~ in wooden sleepers, making spikes work loose.

→ To remedy this steel bearing plates were introduced between the sleeper & rails, to distribute the load uniformly.

→ Most commonly used in India.

F.F. Rails :-

Merits :-

i) They have more strength and stiffness, both vertically and lateral.

ii) No chairs or keys are required.

iii) In points and crossing, the arrangement are simpler.

iv) Fitting of rails with sleepers is simplere.

Demerits :-

i) Fitting get loosened more frequently.

ii) The straightening of bent rails, replacing of rails and dehogging of battered rails are difficult.

R.H. Rails :-

Merits :-

i) Give more solid and smoother treack.

ii) The rails are easily disconnected from sleepers as they have no direct connection with the latter.

iii) Heavy chairs with larger bearing on sleepers give longer life and greater stability.

Demerits :-

i) Require additional cost of iron chairs.

ii) Less strength and stiffness.

iii) Heavy maintenance cost.

iii) During famines, railways have played the vital role in transporting food and clothing to the affected areas.

iv) Growth of industries has been promoted due to transportation of raw materials through railways.

v) Speedy distribution of finished product is achieved through railways.

vi) Railways provide employment to millions of people and thus help in solving the unemployment problems of the country.

vii) Trade developed due to railways thereby has increased the earnings and standard of living of Indian people.

viii) Land values have increased due to industrial development which ultimately result in the increase of national wealth.

ix) Due to the mobility of products through railways, the price stabilisation of commodities could be possible.

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Length of Rails :-

The rails of largere length are preferered to emaller length of rails, because they give morce strength and economy for a railway track.

Standard length, on indian rails,

B.G length = 12.80 m, 13 m

M.G length = 11.89 m, 12 m

Rail Failures :-

(1) The sudden failurce of a rail is generally due to defects in its manufacture, although causes may also exist.

(2) Two such other common causes are abrupt change of section of rail.

(3) Notches with corenercs in the foot of the rails.

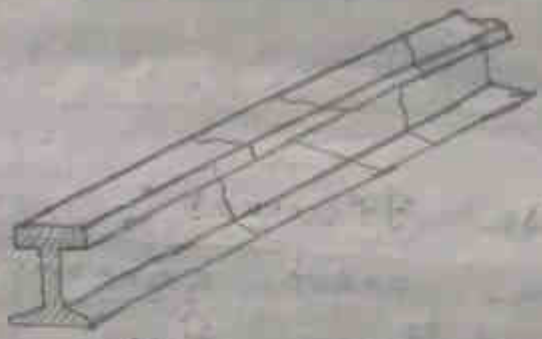
(i) Crushes Heads :-

Crushes heads aree those which have either sagged or flattened. Besides the defect of manufacturee, crushed heads ~~either~~ are due to

a) Slipping of wheels
b) Flat spots on wheels which are developed due to skidding of wheels.
c) Weak suppored at the rail end.

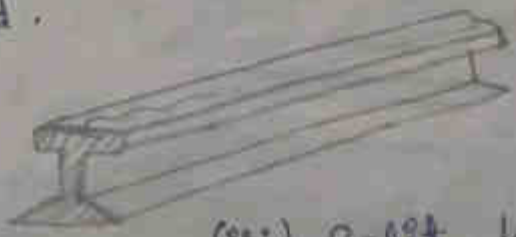
(i) Crushed head

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



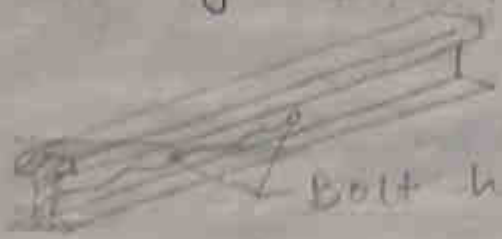
(ii) Square or Angular crack

iii) Split Heads :-
In this, cracks occur in the middle of the head or pieces are split from the side to the end of the head.



(iii) Split head

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



iv) Split web

v) Horizontal Fissures :-
These are developed in the rail head.

vi) Transverse fissures :-
This is the most common cause of rail failures. It is a cross wise crack which starts from a point inside the head and spreads like contours shape gradually.

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

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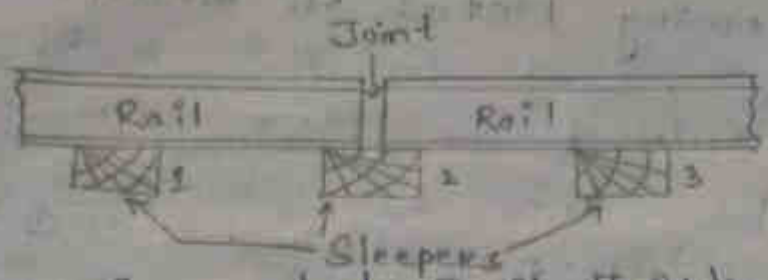
Rail Joints :-

Rail joints are necessary to hold together the adjoining ends of the rails in the correct position, both in the horizontal and vertical planes.

Types of Rail Joints :-

The following types of joints are commonly used on Indian and foreign railways :

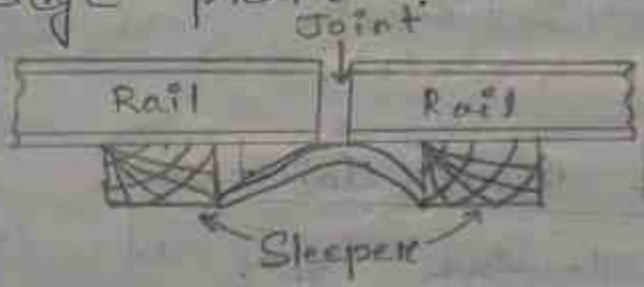
1. **Supported Rail Joints :-**
When the rail ends rest on a single sleeper called a "Joint sleeper" it is termed as "support joint". The duplex joint sleeper with othere sleepers is an example of the suppoted joint.



Supported Rail Joints

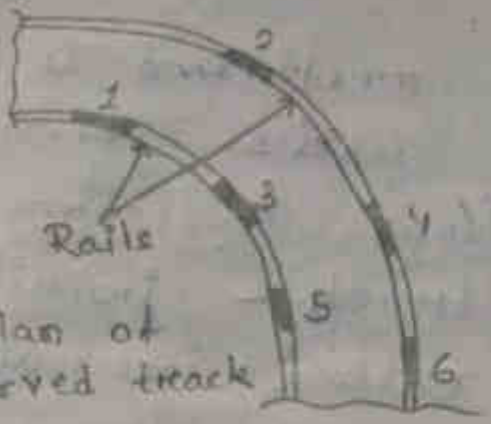
2. **Bridge Joint** :-

The rails 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"



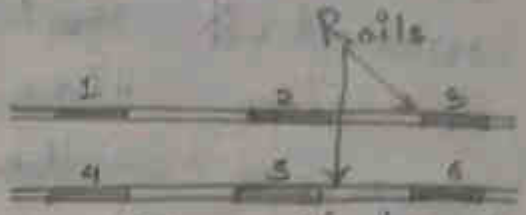
3. **Staggered or Broken Joint** :-

In this types of joint, the joints of one railway track is the basis of its nomenclature. In this type of joint, the joints of one rail track are not directly opposite to the joints of the other rail track.



Plan of curved track

Staggered Rail Joint



Plan of track

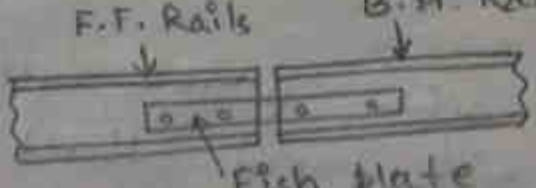
Square or Even rail joint.

4) 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 the joints of other rail track.

5) Compromise Joint :-

Where two different rail sections are required to be joined together, it is done by means of fishplates which fit both the rails.



6) Insulated Joint :-

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

7. Expansion joint :-

In bridges, provision for expansion and contraction is kept for gireders and rails both. In view of stresses produced in rails and fish plates. Welded joints are considered as the most perfect and stronger type of joints.

Welding of Rails :-

Purpose of welding -

i) To increase the length of the rail by joining two or more rails. ~~and~~

ii) To repaire the worn out or damaged rails and thus increase their life.

iii) To build up worn out points and rails on the sharp curves.

iv) To build up the burnt portion of rails head which is caused due to slippage of wheels over the rails or other defects or spots in rail steel.

Advantages of welding rails

1) It satisfies the condition of a perfect joint and hence increases the life of a rail.

2) It reduces the creep due to increase in the length of rail and in turn friction as well.

3) Expansion effect due to temperature is reduced which in turn also reduces the creep.

4) Due to discontinuity of joints, a source of track weakness is reduced.

5) Long rail lengths being heavier dampen the intensity of high frequency vibrations due to moving loads.

6) Welding increases the life of rails due to decrease in the wear of rails at joints.

7) Welding faciliates track circuiting on electrified tracks.

8) Welded rails provides on large bridges for the span length are helpful as they result in bettere performance.

9) Welded rails provicion on curves is undere investigation. However, maximum curve length may be welding depending upon resistance and latereal displacement of track.

10) The cost of track construction by welding of rails decreases due to less number of rail joints.

Creep of Rails

Creep :-

Creep is common to all railway tracks, but varies in magnitude considerably, the rail, in some places., moves by several centimeter in a month while in other locations the movement of rails may be negligible.

Indications of creep :-

Occurrence of creep can be noticed from the following observations:

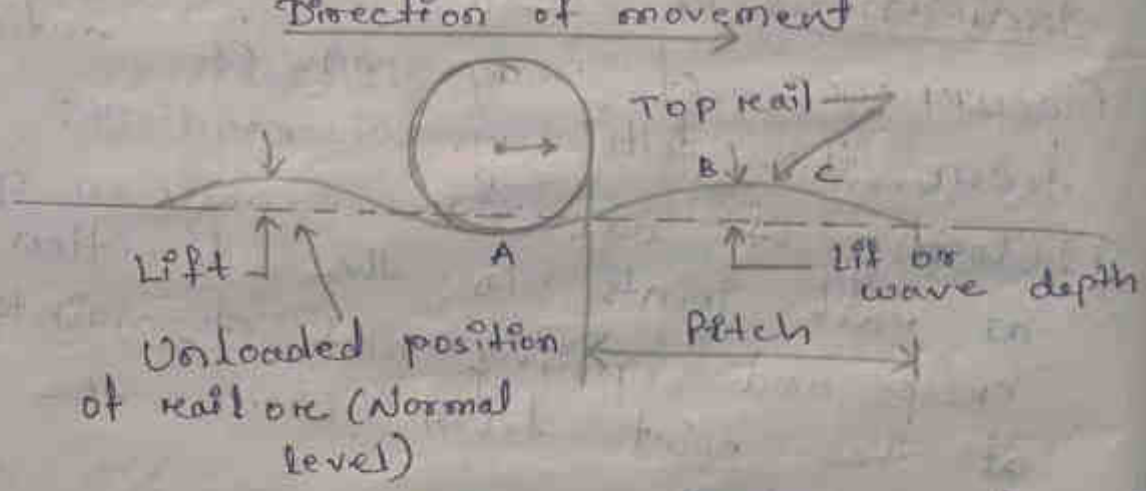
i) Closing of successive expansion spaces at rail joints in the direction of creep and opening out of joints at the point from where the creep starts.

ii) Marks on flanges and webs of rail made by spike heads, by scraping or scratching as the rails slide.

6/Nov

Causes of creep :-

1. Wave Action or wave theory :-
Wave motion is set up by moving loads of wheels. The vertical reverse curve ABC is formed in the rails ahead of the wheels, resulting from the rail deflection under the load, is the chief causes of creep.

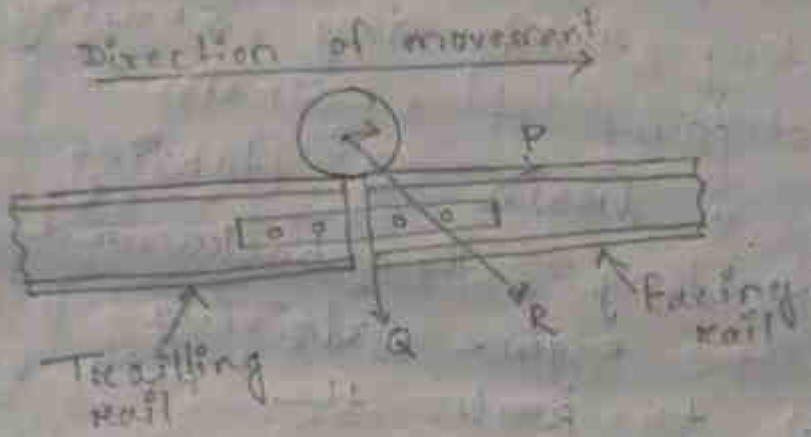


The pitch and depth of wave depend upon the following :

i) Track modulus
ii) Stiffness of track
iii) Stability of formation.

2) Percussion Theory :-
The creep is due to impact of wheels at the rail end

ahead at joints. The horizontal component 'p' of 'R' tends to cause creep while the vertically. to make a battered rail end. Though the creep is very small in single impact but cumulative effect of numbers of wheels in quick succession results in sufficient creep.



The creep by this theory will increase due to following factors:

i) Due to weak and loose fish bolts,
ii) Due to worn out fish plates,
iii) Due to loose packing at joints,
iv) Due to wide expansion gap,
v) Due to heavy axle loads moving at high speed.

3) Drag 'or' Dragging Theory :-
It states that backward thrust on driving wheels of the locomotive of train has got a

tendency to push the rail off the track backward while the other wheels of the locomotive and the vehicles push the rail in the direction of travel as explained in wave action theory and they have greater effect.

4) Starting, Accelerating, slowing down or stopping of a Train :-
When a train is starting or accelerating, the backward thrust of the engine driving wheels tends to push the rails backward.

5) Expansion or contraction of rails due to temperature :-
Creep also occurs due to variation in temperature. The creep in this case is influench by the range in temperature variation, location of track, wheather exposed or shady surroundings, etc.

6) Unbalanced Traffic :-

(a) In a single line system if heavy equal traffic runs in both directions the creep is almost balanced.

(b) In the double line system, trains on a particulare line being unidirectional, creep occurs in both the lines.

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Redemedies 'or' Prevention of creep

Prevention is always better than cure. If creep is not prevented in time, it will result in derailment.

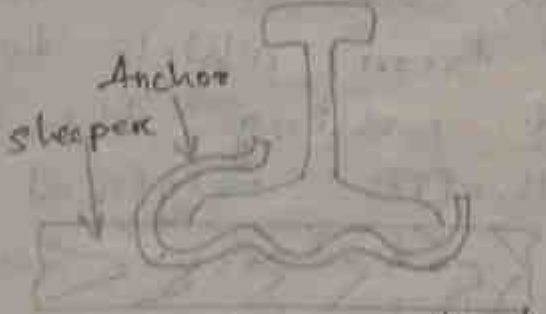
(1) Pulling Back the Rails :-

If creep is distinctly visible, the remedy is to pull back the rails to their original position. For doing this, first inspect the track, note the extent of pulling back distance and determine the point from which to begin. Now start pulling the rails back to their original positions by means of crow bars and hooks provided through the fish

bolt holes of rail. In pulling back, the position of joints relative to sleepers must be maintained; and both the rail joints must be in their relative position.

(2) Provision of Anchores or Anticreepers :-
The creep of the track can be prevented by use of Anchors and sufficient crib ballast. For creep of 7.5 cm to 15 cm, in a month 4 - anchores per rail and for creep of 22.5 cm to 25 cm. 6 - anchores per rail are used in the Indian practice.

Anchore placed by Wedging action



Anchor placed by a Spring Grip

The following points should be considered for efficient maintenance of Anchors :

i) The creep anchors should be strong enough to resists the movement of rails due to creep.

ii) The achors should butt against the sleepers otherwise they do not function effectively.

iii) The anchors should be uniformly distreibuted over the entire rail length.

iv) Defective anchors must be reneweed to prevent accumulation of creep.

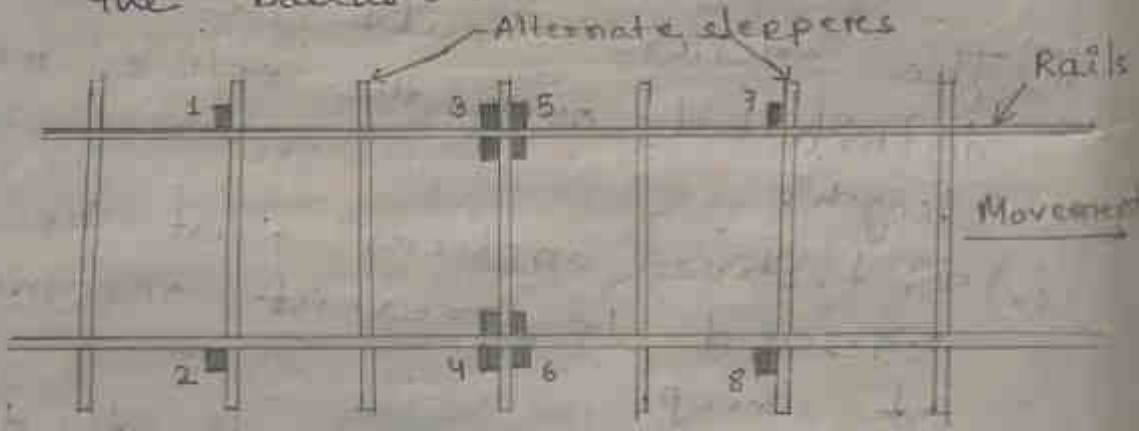
v) Anchors should be fixed to good eound sleepers only.

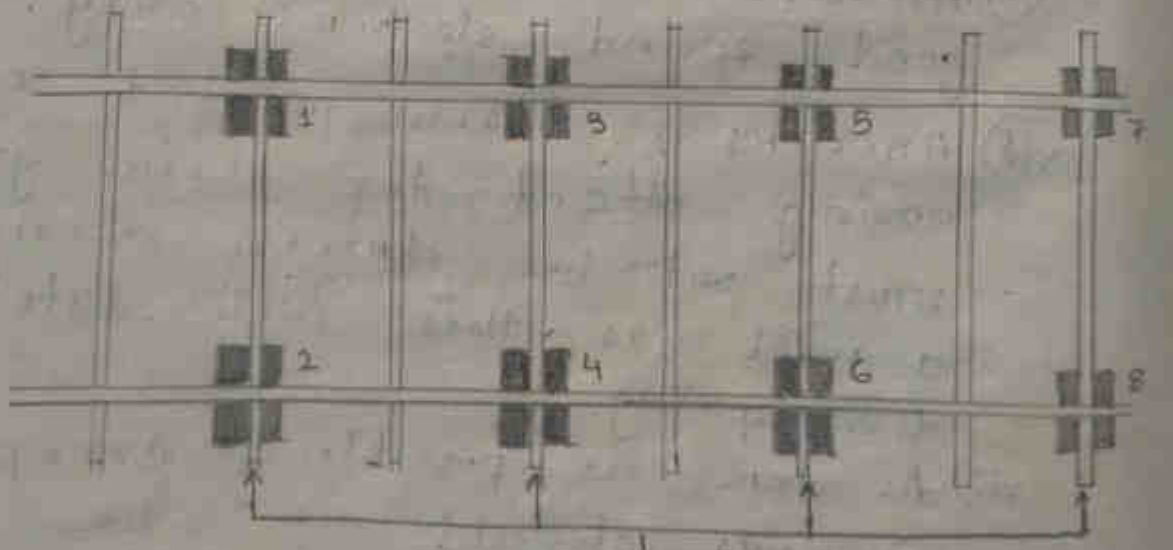
vi) Anchores, which depend on spring effect for theire grip must not be dreiven along a rail as this coill destory the spreing.

vii) As fare as possible, creep anchors should not be provided on the railway bridged.

③ Use of steel sleepers :-

Sleepers should be of such a type and with such fittings that they effectively prevent the rail from creeping on them. Secondly, the sleepers must have a good grip with the ballast to resist the movement of the sleepers in the ballast.





Anchore Locations.

Sleepers

Sleepers are members generally laid transverse to the rails on which the rails are supported and fixed, to transfer the loads from rails to the ballast and subgrade below.

Function of sleeper :-

i) To hold the rails to correct gauge.

ii) To hold the rails in proper level or transverse tilt i.e., level in turnouts, cross-overs, etc., and at 1 in 20 tilt in straight tracks.

iii) To act an elastic medium in between the ballast and rails to absorb the blows and vibrations of moving loads.

iv) To distribute the load from the rails to the index area of ballast underlying it or to the girders in case of bridges.

v) To support the rails at a proper level in straight tracks

and at proper supereelevation on curves.

vi) Sleepers also add to the longitudinal and lateral stability of the permanent track on the whole.

vii) They also provide means to rectify track geometry during service life.

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Requirements of sleepers

i) The sleepers to be used should be economical, i.e., they should have minimum possible initial and maintenance ~~cot~~ costs.

ii) The fittings of the sleepers should be such as ~~easy~~ that they can be easily adjusted during maintenance operations such as easy lifting, packing, removal and replacement.

iii) The weight of sleepers not be too heavy ore excessively light, i.e., they should have moderate weight, for ease of handling.

iv) The design of sleeper be such that the gauge, alignment of track and levels of the rails can be easily adjusted and maintained.

v) The bearing area of sleepers below the rail seat and over the ballast should be enough to resist the crushing due to rail seat and crushing of the ballast underneath the sleeper.

vi) The sleepers design and spacing should be such as to facilitate easy removal and replacement of ballast.

vii) The sleepers should be capable of resisting shocks and vibrations due to passage of heavy loads of high speed trains.

viii) The design of the sleepers should be such that they are not damaged during packing processes.

ix) The insulation of rails should be possible for track circuiting if required, through sleepers.

x) The design of sleeper should be such that they are not pushed

out easily due to moving treain especially with steel sleepers with rounded ends.

xi) An ideal sleeper should also have an anti-sabotage and anti-theft qualities.

Classification of sleeper

Sleeper can be classified according to the material's used in their construction, in the following categories :-

1. Wooden sleeper
2. Metal sleeper
   (a) Cast iron sleeper
   (b) Steel sleeper
3. Concrete sleeper
   (a) Rainforced concrete sleeper
   (b) Prestressed concrete sleeper

Timber or Wood sleeper

Wood sleepers are regarded to be best as they fulfil almost all the requirements of an ideal sleeper.

The life of timber sleepers depends upon their ability :-

i) Wear
ii) Decay
iii) Attack by Vermin, i.e.,
iv) Quality of the timber used.

Advantages :-

i) Timber is easily available in all parts of India.
ii) Fitting for wooden sleepers are few and simple in design.
iii) These sleeper are able to resist the shocks and vibrations due to heavy moving loads and also given less noisy track.
iv) Wooden sleepers are easy to lay, relay, pack, lift and maintain.
v) These wooden sleepers are a suitable for all types of ballast.
vi) They are best for track - circuited operations and moreover, wooden sleepers are over-all economically.

Disadvantages :-

i) The sleepers are subjected to wear, decay, attack by white ants, spike killing, warping, cracking, end splitting, rail cutting etc.

ii) It is difficult to maintain the gauge in case of wooden sleepers.

iii) Track is easily disturbed, i.e., alignment maintenance is difficult.

iv) Wooden sleepers have got minimum service life (12 to 15 years) as compared to other types of sleepers.

v) Maintenance cost of wooden sleepers is highest as compared to other sleepers.

Types of Timbers for sleepers :

The following types of timbers are used for wooden sleepers.

i) Hard wood such as, sal and teak.

ii) Soft wood such as, chir and deodar.

Metal Sleepers :-

Due to the growing scarcity of wooden sleepers, their high cost and short life, metal sleepers are now being widely adopted in India.

Metal sleepers are either of steel or cast iron. Cast iron is in greater use than steel for sleepers because it is less prone to corrosion.

i) They should bear the tensile and compressive stresses which come on to them.

ii) They should provide sufficient area for rails, i.e., area on ballast should be at least equal to that of wooden sleepers.

iii) Tamping and packing of ballast should not disturb the sleeper.

iv) For track circuiting, insulation should be possible.

v) Metal sleepers should be overall economical as compared to wooden sleepers.

vi) The design of metal sleepers should be such that they provide.

(a) Ease in fixation and removal of rails without disturbing the sleepers.

(b) Ease in pushing out the sleepers and replacing them without disturebing the rail and the ballast.

Advantages :-

i) Metal sleepers are uniform in strength and durability.

ii) In metal sleepers, the performance of fitting is better and hence lesser creep occures.

iii) Metal sleepers are economical as life is longer and maintenance is easier.

iv) Gauge can be easily adjusted and maintained in case of metal sleepers.

v) For metal sleepers, frequent renewal is not required.

vi) They have good scrap value, easy in manufacturing and not

susceptible to fire - hazards.

Disadvantages :-

i) More ballast is required than other type of sleepers.

ii) Fitting required are greater in number, and difficult to maintain and inspection.

iii) Metals, C.I., or steel, are liable to rusting / corrosion.

iv) Metal being good conductor of electricity interferes with track circuiting.

v) Metal sleepers are unsuitable for bridges, level crossing and in case of points and crossings.

vi) These sleepers are only suitable for stone ballast and for rails for which they are manufactured.

Cast - Iron - Sleeper :-

Cast iron sleeper have been extensively used in India and on a shall scale in South America.

There are following types :

1. Pot or Bowl sleeper.
2. Plat sleeper
3. Box sleeper
4. C.S.T.-9 sleeper
5. Rail free Duplex sleeper.

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Concrete sleepers :-

These sleepers were ended due to chronic shortage of good wooden sleepers and need for better for better design and economy of sleepers on sustainable basis.

These sleepers are mainly of two types ;

(a) Reinforced concrete sleepers.
(b) Pre - stressed concrete sleepers.

Advantages of concrete sleepers :-

i) These sleepers are free from natural decay and attack by vermin, insects, etc.

ii) They have maximum life when compared to other sleepers, the life under normal condition is 40 to 60 years.

iii) This is not affected by moisture, chemical action of ballast, cinder and sub-soil salt.

iv) There is no difficulty in the track-circuiting, required for electrifying the track.

~~v) There is no difficulty~~

v) The high weight of sleepers helps in minimising joint maintenance by providing longer welded lengths, greater stability of the track and better resistance against temperature variation.

vi) The sleepers have higher elastic modulus and hence can withstand the stresses induced by fast and heavy traffic.

vii) Concrete sleepers in the elastic fastenings offers an ideal track in respect of gauge, cross-level and alignment.

Disadvantages of Concrete sleepers :-

i) The weight of concrete sleepers is as high as 2.5 to 3 times of wooden sleepers, requiring the mechanical appliance for handling.

ii) These sleepers require pads and plugs for spikes.

iii) The damage the bottom edge during the packing.

iv) The scrap value is almost nil.

v) The damage to the concrete sleepers is very heavy in case of derailment.

Reinforced Concrete sleepers :-

These are of two types :

i) Through type

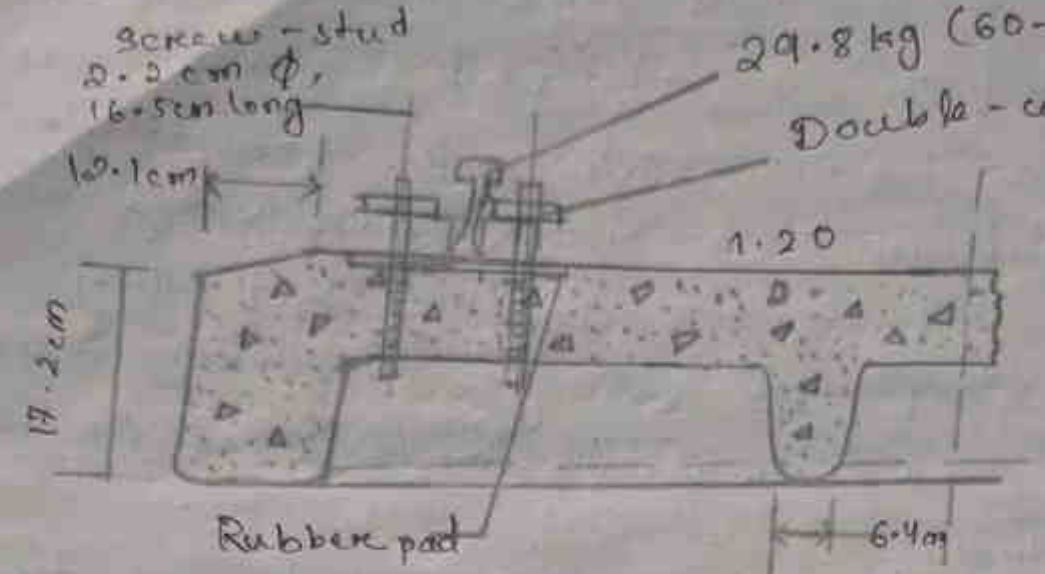
ii) Composite or Block and Tie type.

In the through type, when concrete sleeper is stressed, cracks on the tension side are inevitable. Though the cracks are very small and almost invisible but they tend to enlarge with repetition of the impact loadings of the fast trains.

These composite or block and tie types of sleepers are not subjected to same degree of tensile stress and have given excellent results in France where a steel tie of inverted T-section is used.

Pre-stressed concrete sleepers :-

All the disadvantages of reinforced concrete sleepers have been eliminated by prestressing technique for sleepers. In pree-stressed concrete sleepers, the concrete is put under a very high initial compression.



Pre-stressed concrete sleeper

Disadvantages of pre-stressed concrete sleepers :-

i) These are heavily damaged in case of derailments.

ii) The bed of the ballast is specially prepared.

iii) These are uneconomical.

iv) The standard of maintenance for the track, where these sleepers are used, is to be kept very high.

v) They are more rigid in nature.

vi) The design and construction is complicated by even then the desired strength is not developed at the centre of sleepers.

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Ballast :-

Ballast is the granular material usually broken stone or brick, shingle or kankar, gravel or sand placed and packed below and around the sleepers to transmit load from sleepers, to ~~is~~ formation and at the same time allowing drainage of the track.

Functions of Ballast :-

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

ii) It holds the sleepers in 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 level of the two lines of a track and for correcting track alignment.

v) It provided good drained foundation immediately below the sleepers and helps to protect the top surface of the formation. This is achieved by providing coarse and rough aggregates with plenty of voids.

Requirements of the good Ballast:

i) It should be able to withstand hand-packing without disintegrating. In other words, it should resists 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 cleaned to provide good drainages.

iii) It should offere reesistance to abrasion and weathering. Abrasion means weare due to rubbing action of pareticles with each othere and weathering means cracking and shatteering of the material due to variation in temperature, moisturee and freexing. Non-porous particles of ballast are usually more dureable due to better resistance agaist abrasion and weathering.

iv) It should not producee any chemical action with reail and metal sleepers.

v) The sixe of stone ballast should be 5cm for wooden sleepers, 4cm for metal sleepers and 2.5cm for turnouts and crossovers.

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

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

viii) The ballast should be available in nearby quarries so that it reduces the cost of supply. It should also fulfil the requirements of quality, amount to treatic, life and maintenance cost.

Types of Ballast :-

The different material used as ballast in India are broken stone, gravel, sand, ashes or cinders, soft aggregates like moorum, kankar, overburnt and broken brickbats, blast furnace slag and sometimes selected earth.

1) Broken stone :-

This is the best material for the ballast and almost all important tracks are provided with stone ballast. Broken stone satisfies all the specifications and requirements of a good ballast mentioned above. Where such hard stone is not available, sandstone and limestone which make fairly good ballast are used.

2) Gravel or River Pebbles or shingle :-

Gravel comes ~~not~~ next in rank for its suitability for use as ballast and is used in large quantities in many counties. This is obtained either from river beds or from gravel pits. The smooth pebbles are broken, otherwise they are liable to displace the sleeper due to smoothness of its particles and the packing does not hold.

3) Ashes or cinders :-
This material is available in large quantities on railways from coal being used in locomotives. It has excellent drainage properties as it is very porous. It is cheap and is largely used in sidings but cannot be used for main lines as it is cheap and is largely used in sidings but cannot be used for main lines as it is very soft and gets reduced to powder under wheel loads and makes the track very dusty.

4) Sand :-
It is resonably good material as ballast as it is cheap and provides good drainage. Sand ballast also produces a silent track and has been found to be particularly good for

packing pot sleeper. The great drawback of the sand is its blowing effect due to vibration. The sand gets into the moving parts and on the track and causes heavy wear. The maintenance of the track is, therefore, difficult.

5) Moorum :—

It is the soft aggregate and is the result of decomposition of laterite and has a red ore sometimes a yellow colour. The best moorum for ballast is that which contains large quantities of small laterite stone. It is recommended as a ballast for sidings and main tracks when they are newly laid and the embankments are not sufficiently consolidated.

6) Kankar :—

It is lime agglomerate which is common in certain clayey soils and is dug out of the ground. Where stone is not easily available, it is used as

road metal and as ballast for railway tracks. It is soft in nature and reduces to powder under loads. It is used for M.G. and N.G. tracks with light traffic and where a better type of the ballast is not available.

7) Brick Ballast :-
Where no stone or substitutable for use as ballast, overburnt bricks are broken into small size and used. It powders easily and produces a dusty track. Rails of tracks laid on brick ballast many a time get corrugated. Brick ballast, however, is fairly good for drainage.

8) Blast Furnace slag :-
Which is a by-product in the manufacture of pig iron

forms a suitable ballast material. It should, however, be hard, of high density and free from gas holes. Slag, suitable for use as ballast, is obtained by pouring molten slag collected at the blast furnace into shallow pits of thin layers, allowing it to cool, and then by digging, crushing and screening.

9) Selected Earth :-

For sidings, earth, if of suitable quality, is sometimes used as ballast. It is also sometimes used on new formation as a temporary measure. Indurated clay and decomposed rock are suitable materials.

Treack Fitting And Fastenings

Propose and Types

Treack fittings and Rail fastening are used to keep the rails in the proper position and to set the points and crossings properly. They link the rails endwise and fix the rails either on chairs fixed to sleepers or directly on to the sleepers.

~~1) Fish Plates~~

2) Spikes

~~3) Dog~~

1) Fish Plates :-

Fish plates are used in rail joints to maintain the continuity of the rails and to allow for any expansion or contraction of the rail caused by temperature variation.

Requirements of fish plates :-

i) They must support the underside of the rail and top of the foot.

ii) They should allow a free movement of rails for expansion and contraction, for this purpose, they should not touch the web of the rail.

iii) They must be of such as section as to bear the stresses due to lateral and vertical bending moments.

iv) They should hold the ends of the rail both laterally in line and vertically in level.

v) They should be provided against the wear of fish plates due to impact, expansion and contraction.

Sections of fish plates

→ Various section have been designed to bear the stresses due to lateral and vertical bending.

→ To increase the strength of a fish plate, the depth of fish plate is increased.

→ Various other types of fish plates with different depths, sections, weights and lengths are in use on Indian Railways.

→ The wear of fish-plates, due to impact of wheels, and expansion and contraction, is inevitable. The section of the fish plate should be such that the play caused by wear at the surface of contact, can be adjusted by means of further tightening the fish-bolts.

2) Spikes :-

For holding the rails to the wooden sleepers, spikes of various types are used. These can be used with or without bearing plates below the rails.

The requirements of a good spike are

i) First of all, the spike should be strong enough to hold the rail in position and it should have enough resistance against motion to retain its original position so that it does not lead to creep undere any circumstances.

ii) The spike should be as deep as possible, for better holding power.

iii) The spike should be easy in fixing and removal from the sleepers.

iv) The spike should be cheap in cost.

v) It should be capable of maintaining the Gauge.

a) Dog spikes : For holding the F.F. rails to a wooden sleeper, dog spikes are commonly used. These are simply stout nails to hold rail flanges with timber sleepers. The section of the spike is square – shape and bottom part is either pointed, blunt or chisel shaped. They are cheapest, easy in fixing and removing from sleepers and maintain a better gauge than screw spikes.

For proper use of dog spikes, the following important points should be noted carefully :

i) Holding powere of pointed dog spike at bottom is maximum.

ii) The holding of dog spike is less than 50 %. of the holding power of screw spike, but its use is more than screw spike

due to its cheapness, easy fixation and extraction, and extraction, and better hold of the Gauge.

iii) Four to six spike per sleeper depending upon light to heavy traffic on tangent tracks and 6 to 8 spikes per sleeper on curves are used to counteract the side thrust.

iv) The spikes in sleepers should have staggering position, otherwise the rails due to less holding powere would have a tendency to move out of position, resulting in change of gauge which may be dangerous.

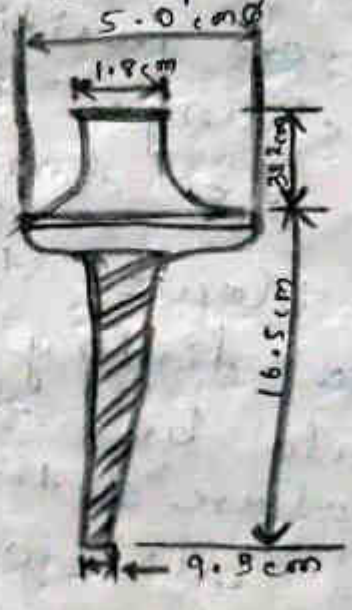
v) The blows to the spikes, while fixing to the sleepers, should be vertical and regulare to have minimum hole dia and maximum holding powere due to friction.

vi) Use of bore holes before fixing to the sleepers,

should reduces the holding power but power.

b) Screw Spikes : These are tapered screw with V-threads used to fastern the rails with timber sleepers. The head is circular with a square projection.

Screw spikes have more than double the holding power to that of dog spikes and can also resist lateral thrust in a better way as compared to dog spikes.



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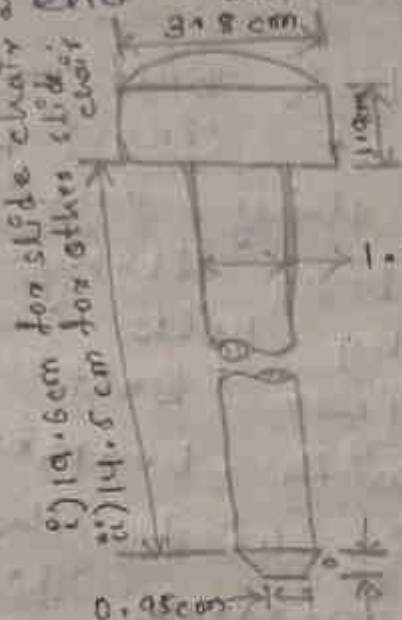
(c) Round Spikes : Round spikes with a head either cylindrical or hemi-spherical are used

for fixing chairs of B.H. Rails to wooden sleepers and for fixing slide chairs of points and crossing. These have a blunt end and limited use.

d) ~~Stad~~



d) Standared Spikes: These are used for Cast Iron chairs only to fix them with timber sleepers.

e) Elastic spikes: Actually, when we use the dog spikes, the disadvantage is that due occurs. To overcome this difficulty, Elastic Rail Spike co., Ltd. introduced this specific type of spike. The advantage of this spike is that its head absorbs the wave-motion without getting loose.

3) Bolts :-

The following types of bolts are used for fixing various track - components in position.

i) Dog or Hook Bolt :- Where sleepers rest directly on a girder, they are fastened to the top flange of the girder by bolts called dog bolts. Two bolts per sleeper along with bearing plates invariably used. The rails are themselves fixed to sleepers by spikes.

There are two types :

(a) ~~Dog or Hook Bolt~~ Straight Lip : For securing sleepers to plate girder spans.

(b) Sloping Lip : For ~~steep~~ securing sleepers to joist spans, flange of R.S.J

ii) Fish Bolts :- The fish bolts have to undergo shear due to heavy transverse stresses. Fish bolts are made of

medium or high carbon steel. For 44.70 kg rails, a bolt of 2.5 cm dia. and 12.7 cm length is used. In the beginning of installation of fish bolts, they generally get loosened by vibrations in the track.

iii) Rag Bolts :- These are used to fix longitudinally, the sleepers of timbers or concrete to the walls of ash pits.

iv) Fang Nut and Bolt :- It is used for fastening slide chairs to sleepers under the switches. These are used in locations where gauge is to be preserved. This is an alternative to round spike or screw spike.

Chairs for R.H. and D.H. Rails

i) C.I. Chairs : For holding Double-headed and Bull-headed rails, the chairs are used. B.H. rails are supported on CI. Chairs fixed to the sleepers by round spikes. In case of C.I. sleepers, chairs are casted with the sleepers.

In case of steel sleepers, the chairs are welded to the steel sleepers. The weight of each chair is nearly 20.4 kg. The B.H or D.H. rail is placed between the two jaws of a chair and pressed against the inner jaw by inserting tapered keys.

The wooden key is oval in section either tapered or straight. Metal key is generally used as its strength is more and life is 10 times that of wooden key though they are costly.

ii) Slide chairs :-

These are plates of special shapes on which the stock and tongue rails rest. The stock rail is bolted to the projecting arm on the chair and tongue rail slide laterally. The chairs are usually 12 cm to 15 cm wide and of length increasing towards the heel.

They are of two types:
i) Pressed up lug type
ii) Riveted lug type, in which a separated big piece is riveted to the base plate.

3/NOV

Blocks :-
When two rails run very close as in case of check rails, etc. small blocks are inserted in between the two rails and bolted to maintain the required distance or spacing. Depending upon the requirements, they may touch either the webs or the riding faces or both. For detailed description of blocks, please refer the chapter on "Points and crossing.

Keys :-
Keys are small tapered pieces of timber or steel to fix rails to fix rails to chairs or metal sleepers.

Morgan key :-

This key is about 18 cm long and tapered. These are patented by Morgan hence known as Morgan key.

These keys suit the C.I. chairs, plate sleepers and steel sleepers. Generally, two keys are required for one link of steel sleepers with the rail.

Bearing plates

Bearing plates are rectangular plates of Mild steel (M.S.) or cast iron (C.I.) and are used below f.f. rails to distribute the load on a large on a large area of timber sleeper particularly of softer variety.

Subgrade and Embankments

Embankment :-

It is a raised bank of earth or other materials constructed above the natural ground. It is constructed when railways have to be carried in low grounds or valleys.

Cutting :-

The raised ground or hill is cut or excavated for providing the railways line at the required level below ground level.

Formation :-

The preparred surface which is ready to receive ballast is called formation. The stability of the track depends upon the quality of the formation under it.

Width of formation :-

Width of the formation is the width of the prepared surface

to receive ballast. It depends upon:

(a) The number of tracks to be laid side by side.

(b) The gauge types.

25/Nov/21

Gradients and Grade Compensation

A) Gradient :-

Any departure of the track from the level is known as grade or gradient. An up or rising gradient is one when the track rises in the direction of movement, and a down or falling gradient is one when the track falls in the direction of movement.

Gradient is measured either

i) by the extent of rise / fall in 100 units horizontal distance

ii) the horizontal distance travell for a rise / fall in 1 unit.

Gradients are provide on the tracks due to the following reasons:

i) To provide a uniform rate of rise or fall as far as possible.
ii) To reach the various stations located at different elevations.
iii) To reduce the cost of earth work.

1) Ruling gradient :-

→ The ruling gradient on a section may be defined as the gradient which determines the maximum load that the engine can haul on the section. In other words, it is the maximum gradient allowed on the track section.

→ It is remarkable that steep gradients necessitate more powerful locomotives, smaller train load, lower speed and costly haulage. It is, therefore, desireable to climb a slope at as a gentle rate as possible. As a rule, rising gradients must be followed by falling gradients.

2) Momentum gradient :-

Those gradient on a section which through more severe than the ruling gradient, do not determine the maximum load of the train but on account of their favourable position on track, the train before approaching them acquires sufficient momentum to negotiate them, are known as momentum gradients. For example, in valleys, a falling gradient is usually followed by a rising gradient.

3) Pushers or Helper gradient :-

The important effect of a ruling grade is its limit on locomotive capacity. If the ruling grade is severe, it may mean that during larger portion of its journey, the locomotive would have its unused capacity for carrying higher loads.

Pushers gradients are very important in mountainous terrain where

steeper gradients are necessary to reduce the length of the track.

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4) Gradients in station yards :-

The gradients at station yards have to be sufficiently low due to the following reasons:

(i) To prevent the movement of standing vehicles on the track due to the effect of gravity combined with a strong wind and / or a gentle push.

(ii) To prevent additional resistance due to grade on the starting vehicles, which is about twice at the start than vehicle in motion. However, a certain minimum gradient is required to be provide for drainage.

B) Grade compensation on curves :-

The rulings gradient is the maximum gradient on a particular section, but if a curve lies on a ruling gradient, the resistance due to gradient is increased by that due to curvature and this further increases the resistance beyond the ruling gradient.

27/10/20

Exp 1 If the ruling gradient is 1 in 150 on a particular section of Board Gauge and at the same time a curve of 4 degree is situated on this ruling gradient, what should be the allowable ruling gradient?

Solu As per recommendation of I.S., grade compensation of B.G. is 0.04 percent per degree of curve.

Then compensation for 4° curve

$= 0.04 \times 4 = 0.16$ percent

Now, ruling gradient 1 in 150

$= \frac{1}{150} \times 100 = 0.67$ percent

So, maximum allowable gradient or actual gradient to be provide $= 0.67 - 0.16 = 0.51$ percent

or, $\frac{0.51}{100}$ i.e., 1 in 196 (Ans)

Exp 2 What should be the actual ruling gradient?

(a) If the ruling gradient is 1 in 200 on a B.G. and

(b) A curve of 3° is superimposed on the above track section of B.G.

Sol^n Assume gradient compensation on B.G. equal to 0.04% per degree of curve.

Compensation for 3° curve
$= 3 \times 0.04 = 0.12\%$.

Whereas, reading gradient is 1 in 200 i.e., 0.50%.

So actual reading gradient to be used $= 0.5 - 0.12 = 0.38\%$.

or $\frac{0.38}{100} = \frac{1}{\frac{100}{0.38}} = 1$ in 264 (Ans)

Speed of the train

The speed of the train depends upon the strength of the track and the power of the locomotive. The use of diesel traction and electric traction which can run the trains at higher speeds, also requires the strengthening of the existing tracks.

The following dynamic effect in their operation :-

i) Various parasitic motions such as pitching, rolling, bouncing and oscillations of the vehicles.

ii) Resonance between the frequency of application of load and elastic oscillation of the

track structure as a whole one its components.

iii) Inertia or springing action of the track in, from and behind the wheels.

iv) Effect of unbalanced weights.

v) Effect of unspring masses.

29/Nov

Superelevation or Cant

When a train moves round a curve, it is subjected to a centrifugal force acting horizontally at the centre of gravity of each vehicle radially away from the centre of the curve. This increases the weight on the outer rail. To counteract the effect of centrifugal force, the level of the outer rail is raised above the inner rail at a horizontal curve is 'called superelevation'. The term 'cant' is frequenetly used as a synonym for superelevation but truely speaking cant should be used to represent the angle of a transverse slope.

Objects of providing superelevation:-

The following are the objects of providing superelevation on curves:

i) To introduce the centripetal force for counteracing the effect of centrifugal force, this will result in the faster movement of train on curves. This will also prevent derailment and reduces the side weare and creep of rails.

ii) To provide equal distribution of wheel loads on two rails so that there is no tendency of track to move out of position due to more load on outere rail. This reduces the weare of rails, eqaipment and results in saving in maintenance cost.

iii) To provide an even and smooth running track to ensure comfortable ride to passengers and safe movement of goods.

Relation of superelevation:-

W = Weight of moving vehicle in kg

v = Speed of vehicle in m/sec

V = Speed of vehicle in km.p.h

R = Radius of curve in metres
G = Gauge of track in metres
g = Acceleration due to gravity in m/sec^2
α = Angle of inclination
S = Length of inclined surface in metres.

Equilibrium cant :-

When the lateral forces and wheel loads are almost equal, the cant is said to be in equilibrium. This equilibrium cant is provide on the basis of a average speed of the train.

Limits of supercelevation and cant - Deficiency :-

As discussed in the previous article, superelevation should be provided in such a way as to time. There are limits to the amount of supercelevation which may be provided safely. Normally, the maximum value of Supercelevation, according to the Railway Board $\frac{1}{10}$ th of gauge. But, recently, the following value of maximum supercelevation have

been prescibed on Indian Railway varying from $\frac{1}{10}$th to $\frac{1}{12}$th of gauge.

Cant Deficiency :-

The equilibrium cant is provided on the basis of equilibrium speed of different trains. But this equilibrium cant or superelevation falls short of that required for the high speed trains. The shortage of cant is called "Cant Deficiency".

30/Nov/21

Points and Crossings —

Definition :-

Points, crossing, turnouts, cross-overs and such related terms are contrivance or arrangements by which different routes either parallel or diverging are connected and afford the means for trains to move from one route to another. These connections are not only useful for trains to move from one route to another but also help for marshalling and shunting work in station yards.

Necessity of points and crossing :-

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 direction of movements of vehicles is controlled by the driver and the steers according to his own sweet will. But this is not true in case of railways because the wheels are provided with flanges inside, so the direction of movement and the diversion of the vehicles to another track are controlled automatically by the wheel flanges rather than the driver as in case of roads. The knowledge of the points & crossings is important in following ways for the operating personnel:

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

ii) They also help for imposing restrictions over turnouts which necessarily retard the

iii) From safety aspect, it is also important as points and crossings are weak kinks or points in the track and vehicles are susceptible to derailments at these places.

Turnouts

Turnout is the simplest combination of points and crossing which enables one track either a branch line or a siding, to take off from another track. So the object of turnout is to provide facilities for safe movement of trains in either direction on both the track.

Important term used in points & crossing :-

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

ii) Trailing Direction :-
If someone stands at the crossing and looks towards the switches, then the direction is called "Trailing Direction".

iii) Trailing points 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 train is reserved for facing direction.

iv) Trailing Points of Turnouts : are those on the opposite side of facing points 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 train is reserved for trailing direction only.

So every point may be a 'facing' or 'trailing' point or both, depending upon the direction of movement of trains.

v) Right - Hand and Left - Hand Turnouts
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 a 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.

vi) 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.

Crossings

A 'crossing' or a 'frog' is a device which provides two flangeways through which the wheels of the flanges may move, when two rails intersect each other at an angle.

The flanged wheels of the train jump over the gap from throat to 'nose' of crossing and to check the wheel flanges from striking the nose, the opposite wheel flanges are guided by use of 'check rails' inside the running rails.

Types of crossings :-

Crossings can be classified as below:

(A) On the basis of shape of crossing.

1) Acute angle crossing :-

This types of crossing is widely used. This crossing is obtained when a left-hand rail of one track crosses a right-hand rail of another track or vice versa. If the angle of intersection of the approaching rails is acute angle, it is termed as acute angle crossing.

(a) Point and splice rails :-

An acute angle is formed either by a point rail and a splice rail or by combination of two point rails. These are made of a special steel.

(b) A pair of wing rails :-

These are bent at the ends. One end of the wing rails is connected to lead rails whereas the other end is flared. This flaring is done to facilitate the entry and exit of flange wheels to the gap.

(c) A paire of check rail :

These are subsidiary rails parallel to the running rails. They are flareed at end for guiding the wheel flanges. They are provided on the opposite sides of the crossing angles to serve the following propose :

i) To guide the wheel flanges.
ii) To prevent weare and rocking of wheels.
iii) To prevent derailment at level crossings.

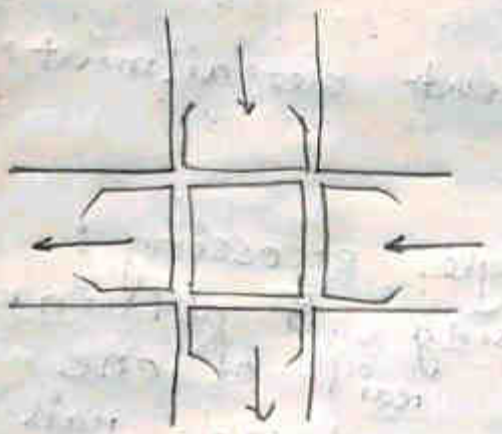
Dec

2) Obtuse angle crossing :

This crossing is obtained when left-hand rail of one track crosses right-hand rail of another track or vice versa at an obtuse angle.

In diamond crossing, a paire of special crossings is used which is called "Obtuse crossing". In case of obtuse angle crossing the long wing rails do not convey the wheels as in case of acute angle crossing, rather act as check rails.

3) Square crossing :-
When two straight tracks cross each other at right angles, they give rise to square crossing. This type of crossing must be avoided on main lines because there is heavy wear due to dynamic loads.



(B) 1) Spring or movable crossing:
In such a crossing, own coing rail is movable and is held against the Vee of the crossing with a strong helical spring. By doing so, it makes the main track continuous and this crossing becomes very useful when there is high

speed traffic on main tracks and light speed traffic on the branch line or a turnout. This type of crossing is used in U.S.A. but in India spring crossing is not favoured because there is a danger of accident in case of spring failure.

2) Ramped crossing :-
In case of complicated yard layout with heavy but slow speed traffic, the throat to nose clearance is negotiated by use of special manganese steel blocks over long distance. The wheel flanges roll over this distance - extending from a little beyond the throat to little bayond the nose. The top level of these special blocks is so arranged that the tread of the wheel is taken off the table by the wheel flange riding the blocks.