SKDAV GOVT.POLYTECHNIC ROURKELA

DEPARTMENT OF CIVIL ENGINEERING

LECTURE NOTES

Year & Semester: 3rd Year, VI Semester
Subject Name: RAILWAY ENGINEERING

RAILWAY ENGINEERING

INTRODUCTION

In the year 1832 the first Railway running on steam engine, was launched in England. Thereafter on 1st of August, 1849 the Great Indian Peninsular Railways Company was established in India. On 17th of August 1849, a contract was signed between the Great Indian Peninsular Railways Company and East India Company. As a result of the contract an experiment was made by laying a railway track between Bombay and Thane (56 Kms).

- On 16th April, 1853, the first train service was started from Bombay to Thane.
- On 15th August, 1854, the 2nd train service commenced between Howrah and Hubli.
- On the 1st July, 1856, the 3rd train service in India and first in South India commenced between Vyasarpadi and Walajah Road and on the same day the section between Vyasarpadi and Royapuram by Madras Railway Company was also opened. Subsequently construction of this efficient transport system began simultaneously in different parts of the Country. By the end of 19th Century 24752 Kms. of rail track was laid for traffic. At this juncture the power, capital, revenue rested with the British. Revenue started flowing through passenger as well as through goods traffic.

Organizational structure

Railway zones

Indian Railways is divided into several zones, which are further sub-divided into divisions. The number of zones in Indian Railways increased from six to eight in 1951, nine in 1952 and sixteen in 2003. Each zonal railway is made up of a certain number of divisions, each having a divisional headquarters. There are a total of sixty-eight divisions. Each of the sixteen zones is headed by a general manager who reports directly to the Railway Board. The zones are further divided into divisions under the control of divisional railway managers (DRM).

Advantages of Railways

The railways offers various advantages and for the purpose of convenience, they can be described in following three categories.

1. Economic Advantages

   i) Employment to people in the form of staff required for smooth working of railways.

   ii) Encouragement to commercial farming.

   iii) Increase in cost of land thereby increase of national wealth.

   iv) Industrial development and growth because of mobility of labour and raw materials.

v) Stabilization of prices due to easy, speedy & efficient mobility of products & natural resources.

vi) Increase in mobility of people and thereby relieving some extent the congestion of big cities.

vii) Transporting food and clothes in times of emergencies like floods and famines etc.

2. Political Advantages

i) Easy control of the central administration.

ii) Development of a national mentality in the minds of people.

iii) Migrating population on a mass scale.

iv) Mobilizing troops and war equipments in times of war and emergencies.

v) Unity of people of different castes, customs and religions.

3. Social Advantages

i) Broadening the social outlook of masses as people can visit all the parts of country and be proud of this great country.

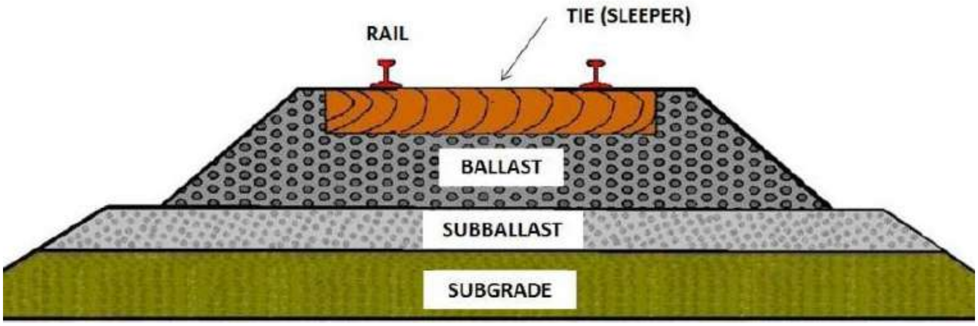
ii) Easy access to religious places of importance.

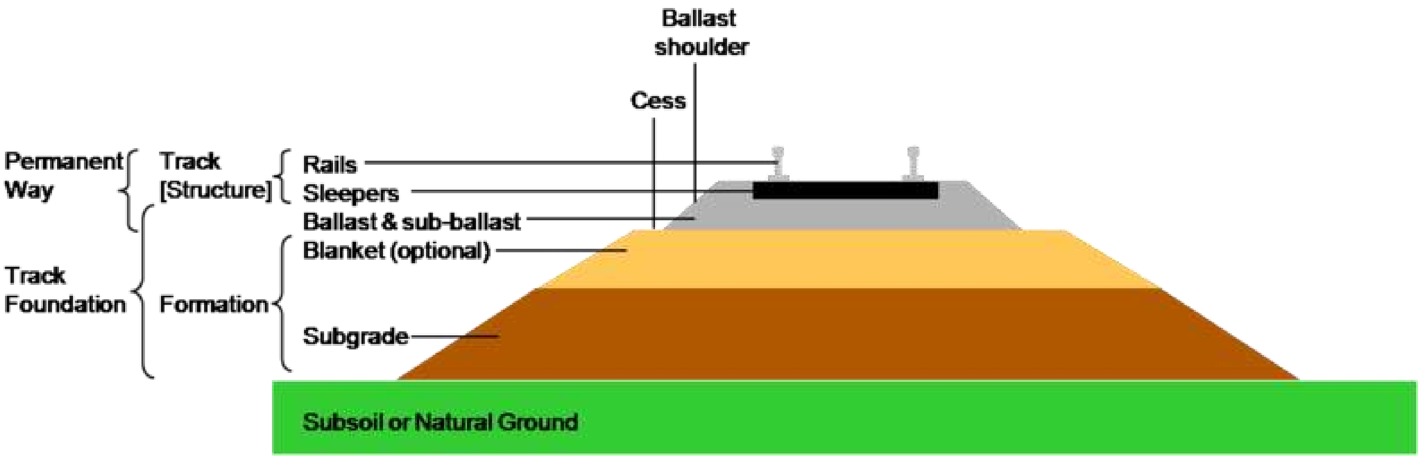
iii) Providing convenient and safe mode of transport.

iv) Removal of feeling of isolation as the railway has proved to be the most safe, economic and comfortable mode of conveyance.

CHAPTER-2

Permanent way





The finished or completed track of a railway line is commonly known as Permanent Way. It essentially consists of following three parts.

1. Rails
2. Sleepers
3. Ballast

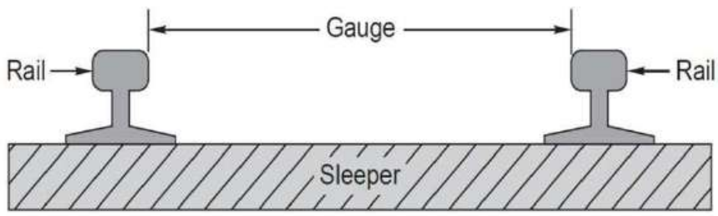
The rails are fixed with each other by means of various rail fastenings and they rest on sleepers which are laid at right angles to them. The sleepers in turn rest on ballast which is spread over the formation ground prepared for the railway track.

Requirements of an ideal permanent way

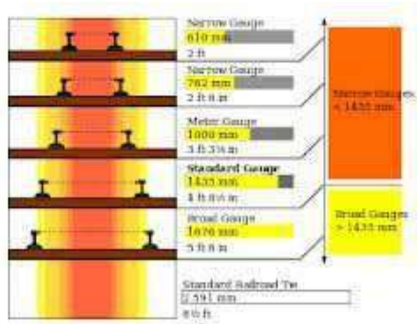
1. The gauge of track should be uniform and there should not be varying gauges.
2. There should be minimum friction between the wheels of rolling stock and the rails.
3. Facilities should be provided at various points along the permanent way to repair, replace or renew the damaged portion of the track.
4. The design of the permanent way should be such that the load of the train is uniformly distributed over it.
5. The components of the permanent way should be so selected as to produce a permanent way with a certain degree of elasticity to prevent the shocks due to impact.
6. The gradient provided on the permanent way should be even and uniform.
7. The special attention should be given on the design of permanent way on curves.
8. The overall construction of the permanent way should be such that it requires minimum maintenance.
9. The permanent way should possess high resistance to damage at the time of derailment.
10. The drainage facility should be perfect & The rail joints should be properly designed and maintained.

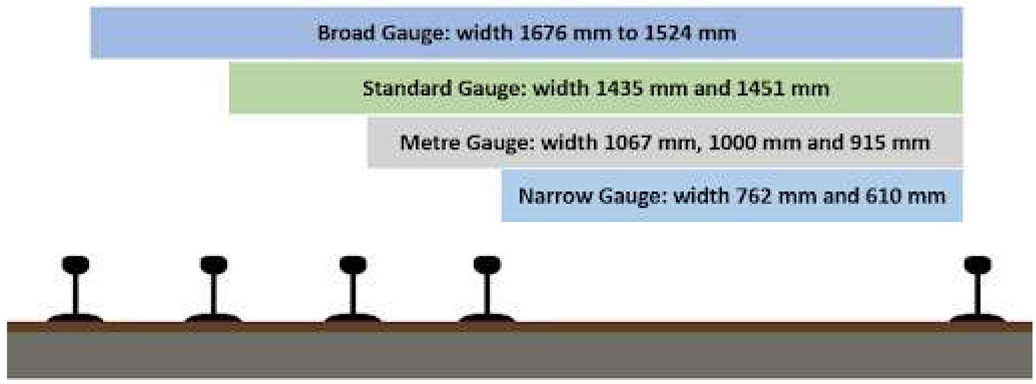
Rail Gauges

In India, the gauge of a railway track is defined as the clear minimum perpendicular distance between the inner faces of the two rails.



Gauge





DIFFERENT GAUGES ON INDIAN RAILWAYS

The East India Company intended to adopt the standard gauge of 1435 mm in India also. This proposal was, however, challenged by W. Simms, Consulting Engineer to the Government of India, who recommended a wider gauge of 1676 mm (5 '6 "). The Court of Directors of the East India Company decided to adopt Simms's recommendation and 5'6 " finally became the Indian standard gauge. In 1871, the Government of India wanted to construct cheaper railways for the development of the country and 1000 mm metre gauge was introduced. In due course of time, two more gauges of widths 762 mm (2 '6 ") and 610 mm (2 '0 ") were introduced for thinly populated areas, mountain railways, and other miscellaneous purposes. The details of the various gauges existing on Indian Railways are given in Table below.

Name of gauge	*Width (mm)*	*Route (km)*	*% of route (km)*
Broad gauge (BG)	1676	55,188	85.6
Metre gauge (MG)	1000	6809	10.6
Narrow gauge (NG)	762	2463	3.8
	610		
Total all gauges		64,460	100

Broad Gauge: - When the clear horizontal distance between the inner faces of two parallel rails forming a track is 1676mm the gauge is called Broad Gauge (B.G)

This gauge is also known as standard gauge of India and is the broadest gauge of the world.

The Other countries using the Broad Gauge are Pakistan, Bangladesh, SriLanka, Brazil, Argentine, etc.50%

India's railway tracks have been laid to this gauge.

Suitability: - Broad gauge is suitable under the following Conditions:-

(i) When sufficient funds are available for the railway project.

(ii) When the prospects of revenue are very bright.

This gauge is, therefore, used for tracks in plain areas which are densely populated i.e. for routes of maximum traffic, intensities and at places which are centers of industry and commerce.

2. **Metre Gauge**: - When the clear horizontal distance between the inner faces of two parallel rails forming a track is 1000mm, the gauge is known as Metre Gauge (M.G) The other countries using Metre gauge are France, Switzerland, Argentine, etc. 40% of India's railway tracks have been laid to this gauge.

Suitability:- Metre Gauge is suitable under the following conditions:-

(i) When the funds available for the railway project are inadequate.

(ii) When the prospects of revenue are not very bright.

This gauge is, therefore, used for tracks in under-developed areas and in interior areas, where traffic intensity is small and prospects for future development are not very bright.

3. **Narrow Gauge**:- When the clear horizontal distance between the inner faces of two parallel rails forming a track is either 762mm or 610mm, the gauge is known as Narrow gauge (N.G) The other countries using narrow gauge are Britain, South Africa, etc. 10% of India's railway tracks have been laid to this gauge.

Suitability: - Narrow gauge is suitable under the following conditions:-

(i) When the construction of a track with wider gauge is prohibited due to the provision of sharp curves, steep gradients, narrow bridges and tunnels etc.

(ii) When the prospects of revenue are not very bright. This gauge is, therefore, used in hilly and very thinly populated areas. The feeder gauge is commonly used for feeding raw materials to big government manufacturing concerns as well as to private factories such as steel plants, oil refineries, sugar factories, etc.

CHOICE OF GAUGE

The choice of gauge is very limited, as each country has a fixed gauge and all new railway lines are constructed to adhere to the standard gauge. However, the following factors theoretically influence the choice of the gauge:

Cost *considerations*

There is only a marginal increase in the cost of the track if a wider gauge is adopted. In this connection, the following points are important

(a) There is a proportional increase in the cost of acquisition of land, earthwork, rails, sleepers, ballast, and other track items when constructing a wider gauge.

(b) The cost of building bridges, culverts, and runnels increases only marginally due to a wider gauge.

(c) The cost of constructing station buildings, platforms, staff quarters, level crossings, signals, etc., associated with the railway network is more or less the same for all gauges.

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

Traffic considerations

The volume of traffic depends upon the size of wagons and the speed and hauling capacity of the train. Thus, the following points need to be considered.

(a) As a wider gauge can carry larger wagons and coaches, it can theoretically carry more traffic.

(b) A wider gauge has a greater potential at higher speeds, because speed is a function of the diameter of the wheel, which in turn is limited by the width of the gauge. As a thumb rule, diameter of the wheel is kept 75 per cent of gauge width.

(c) The type of traction and signalling equipment required are independent of the gauge.

Physical features of the country

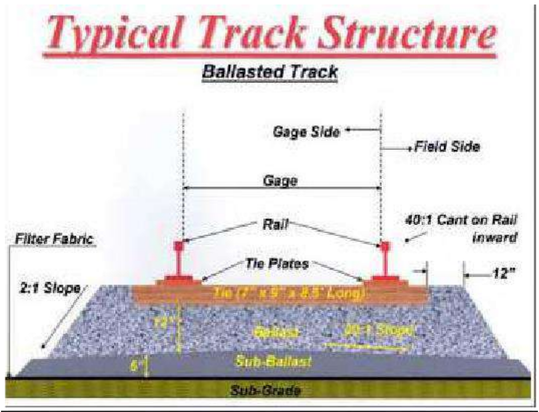
It is possible to adopt steeper gradients and sharper curves for a narrow gauge as compared to a wider gauge.

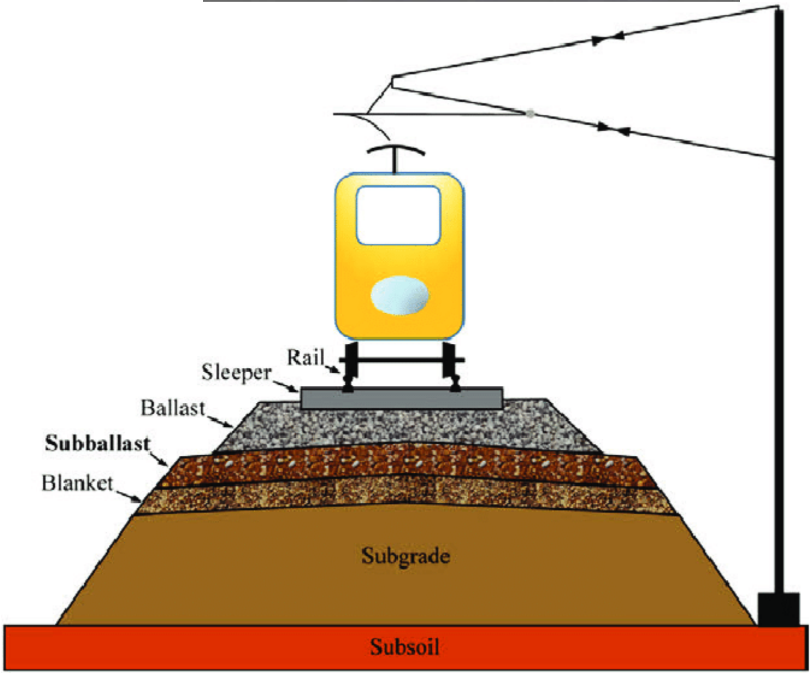
***Uniformity of* gauge**

The existence of a uniform gauge in a country enables smooth, speedy, and efficient operation of trains. Therefore, a single gauge should be adopted irrespective of the minor advantages of a wider gauge and the few limitations of a narrower gauge.

CHAPTER-3

TRACK MATERIALS





RAILS

Introduction

Rails are the members of the track laid in two parallel lines to provide an unchanging, continuous, and level surface for the movement of trains. To be able to withstand stresses, they are made of high-carbon steel. Standard rail sections, their specifications, and various types of rail defects are discussed in this section.

FUNCTION OF RAILS

Rails are similar to steel girders. They perform the following functions in a track:

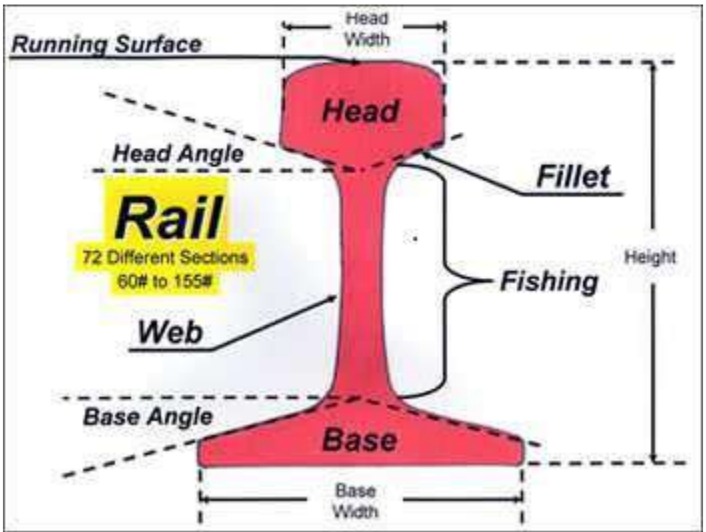
(a) Rails provide a continuous and level surface for the movement of trains.

(b) They provide a pathway which is smooth and has very little friction. The friction between the steel wheel and the steel rail is about one-fifth of the friction between the pneumatic tyre and a metalled road.

(c) They serve as a lateral guide for the wheels.

(d) They bear the stresses developed due to vertical loads transmitted to them through axles and wheels of rolling stock as well as due to braking and thermal forces.

(e) They carry out the function of transmitting the load to a large area of the formation through sleepers and the ballast.



REQUIREMENTS OF AN IDEAL RAIL SECTION

The requirements of an ideal rail section are as follows:

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

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

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

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

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

Fishing angles These must ensure proper transmission of loads from the rails to the fish plates. The fishing angles should be such that the tightening of the plate does not produce any excessive stress on the web of the rail.

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

Weight of rails

Though the weights of a rail and its section depend upon various considerations, the heaviest axle load that the rail has to carrv olavs the most important role. The following is the thumb rule for denning the maximum axle load with relation to the rail section:

Maximum axle load = 560 x sectional weight of rail in Ibs per yard or kg per metre

- For rails of 90 Ibs per yard,

Maximum axle load = 560 x 90 Ibs = 50,400 Ibs or 22.5 tonnes

- For rails of 52 kg per m,

Maximum axle load = 560 x 52 kg = 29.12 tonnes

- For rail of 60 kg per m,

Max. axle load for 60 kg/m rail = 560 x 60 kg = 33.60 tonnes

Length of rails

Theoretically, the longer is the rail, the lesser would be the number of joints and fittings required and the lesser the cost of construction and maintenance. Longer rails are economical and provide smooth and comfortable rides. The length of a rail is, however, restricted due to the following factors:

(a) Lack of facilities for transport of longer rails, particularly on curves

(b) Difficulties in manufacturing very long rails

(c) Difficulties in acquiring bigger expansion joints for long rails

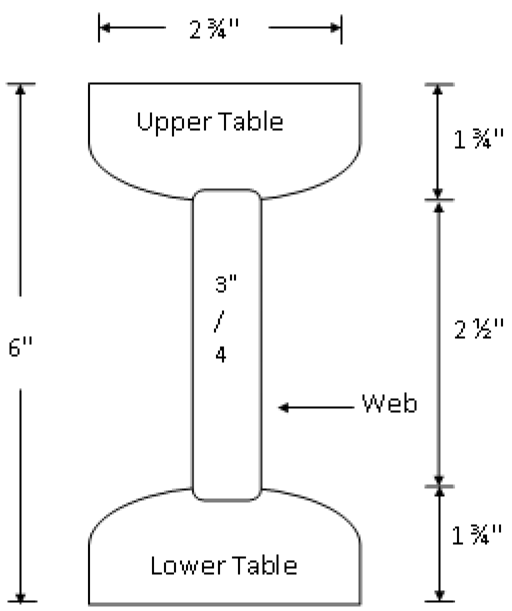
(d) Heavy internal thermal stresses in long rails

Taking the above factors into consideration, Indian Railways has standardized a rail length of 13 m (previously 42 ft) for broad gauge and 12 m (previously 39 ft) for MG and NG tracks. Indian Railways is also planning to use 39 m, and even longer rails in its track system. Now 65 m/78 m long rails are being produced at SAIL, Bhilai and it is planned to manufacture 130 m long rails.

<u>TYPES OF RAIL SECTIONS</u>

Double headed rails:

These were the rails which were used in the beginning, which were double headed and consisting of a dumb-bell section. The idea behind using these rails was that when the head was worn out in course of time, the rail can be inverted and reused. But as time passed indentations were formed in the lower table due to which smooth running over the surface at the top was impossible.

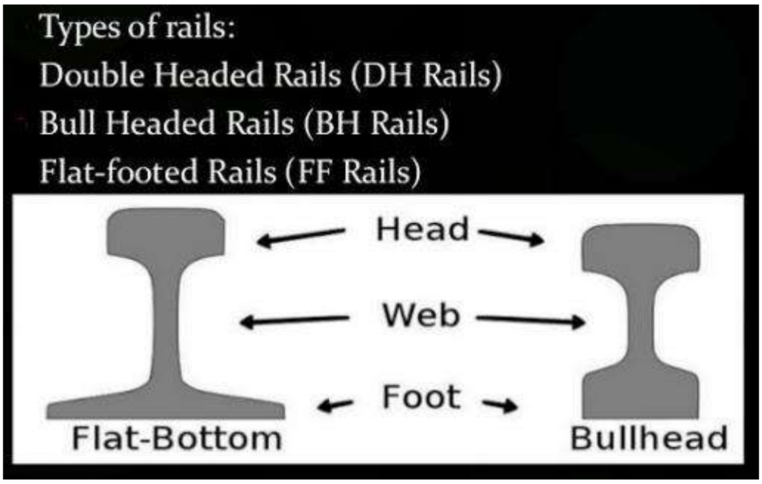


Bull headed rails:

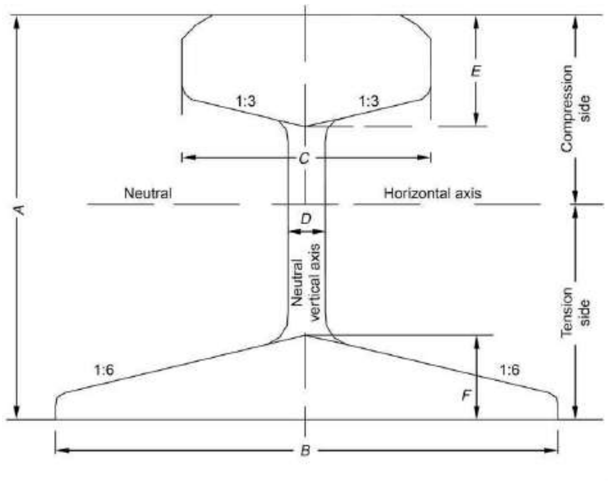
In this type of rail the head was made a little thicker and stronger than the lower part by adding more metal to it, so that it can withstand the stresses.

Flat footed rails:

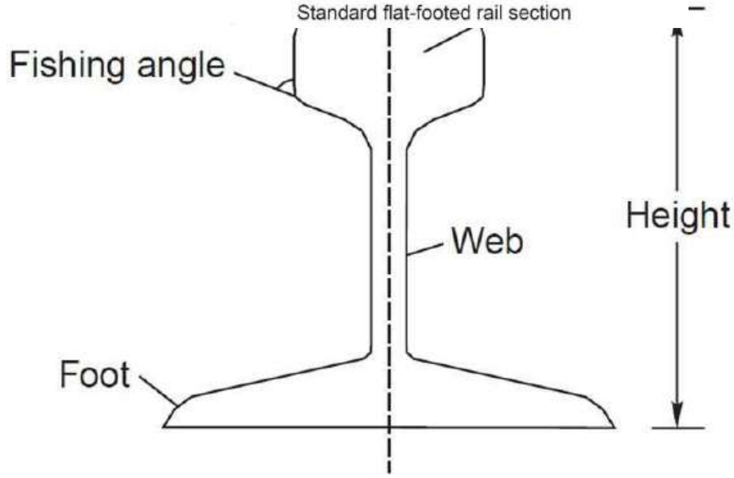
These rails are also called as vignole's rails. Initially the flat footed rails were fixed to the sleepers directly and no chairs and keys were required. Later on due to heavy train loads problems arose which lead to steel bearing plates between the sleeper and the rail. at rail joints and other important places these are the rails which are most commonly used in India.



. RAIL JOINTS



Standard flat-footed rail section



Flat-footed rail

Although a rail joint has always been an integral part of the railway track, it is looked upon as a necessary evil because of the various problems that it presents. Earlier, rails were rolled in short lengths due to difficulties in rolling and the problem of transportation. With increase in temperature, rails expand and this expansion needs to be considered at the joints. It was, therefore, felt that the longer the rail, the larger the required expansion gap, and this too limited the length of the rail. A rail joint is thus an inevitable feature of railway tracks, even though it presents a lot of problems in the maintenance of the permanent way. This chapter discusses the various types of rail joints and their suitability on a railway track.

ILL EFFECTS OF A RAIL JOINT

A rail joint is the weakest link in the track. At a joint, there is a break in the continuity of the rail in both the horizontal and the vertical planes because of the presence of the expansion gap and imperfection in the levels of rail heads. A severe jolt is also experienced at the rail joint when the wheels of vehicles negotiate the expansion gap. This jolt loosens the ballast under the sleeper bed, making the maintenance of the joint difficult. The fittings at the joint also become loose, causing heavy wear and tear of the track material. Some of the problems associated with the rail joint are as follows.

Maintenance effort

Due to the impact of moving loads on the joint, the packing under the sleeper loosens and the geometry of the track gets distorted very quickly because of which the joint requires frequent attention. It is generally seen that about 30 per cent extra labour is required for maintenance of a joint.

Bonded main line 6-bolt rail joint on a segment of 76.9 kg/m rail. Note how bolts are oppositely oriented to prevent complete separation of the joint in the event of being struck by a wheel during a derailment.

Lifespan

The life of rails, sleepers, and fastenings gets adversely affected due to the extra stresses created by the impact of moving loads on the rail joint. The rail ends particularly get battered and hogged and chances of rail fracture at joints are considerably high due to fatigue stresses in the rail ends. ***Noise effect***

A lot of noise pollution is created due to rail joints, making rail travel uncomfortable.

Sabotage chances

Wherever there is a rail joint, there is a potential danger of the removal of fish plates and rails by miscreants and greater susceptibility to sabotage.

Impact on quality

The quality of the track suffers because of excessive wear and tear of track components and rolling stock caused by rail joints.

Fuel consumption

The presence of rail joints results in increased fuel consumption because of the extra effort required by the locomotive to haul the train over these joints.

REQUIREMENTS OF AN IDEAL RAIL JOINT

An ideal rail joint provides the same strength and stiffness *a*s the parent rail. The characteristics of an ideal rail joint are briefly summarized here.

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

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

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

Flexibility It should provide flexibility for the easy replacement of rails, whenever required.

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

Elasticity: It should provide adequate elasticity as well as resistance to longitudinal forces so as to ensure a trouble-free track.

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

TYPES OF RAIL JOINTS

The nomenclature of rail joints depends upon the position of the sleepers or the joints.

Classification According to Position of Sleepers

Three types of rail joints come under this category. ***Supported joint***

In this type of joint, the ends of the rails are supported directly on the sleeper. It was expected that supporting the joint would reduce the wear and tear of the rails, as there would be no cantilever action. In practice, however, the support tends to slightly raise the height of the rail ends. As such, the run on a supported joint is normally hard. There is also wear and tear of the sleeper supporting the joint and its maintenance presents quite a problem. The duplex sleeper is an example of a supported joint (Fig. below).

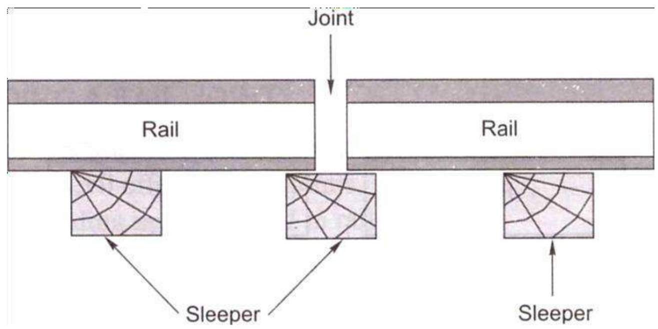


Fig. Supported rail joint

Suspended joint

In this type of joint, the ends of the rails are suspended between two sleepers and some portion of the rail is cantilevered at the joint. As a result of cantilever action, the packing under the sleepers of the joint becomes loose particularly due to the hammering action of the moving train loads. Suspended joints are the most common type of joints adopted by railway systems worldwide, including India (Fig. 16.2).

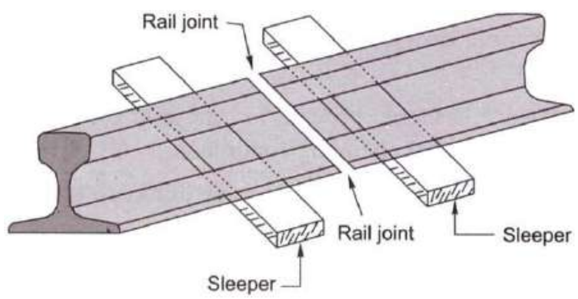


Fig. Suspended joint

Bridge joints

The bridge joint is similar to the suspended joint except that the two sleepers on either side of a bridge joint are connected by means of a metal flat [Fig. (a)] or a corrugated plate known as a bridge plate [Fig. 16.3(b)]. This type of joint is generally not used on Indian Railways.

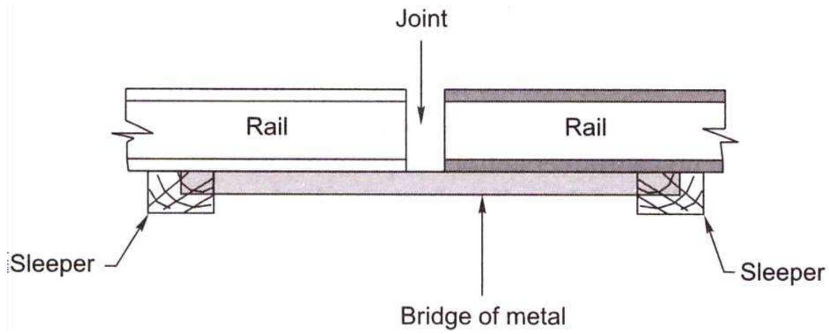


Fig. (a) Bridge joint with metal flat Joint

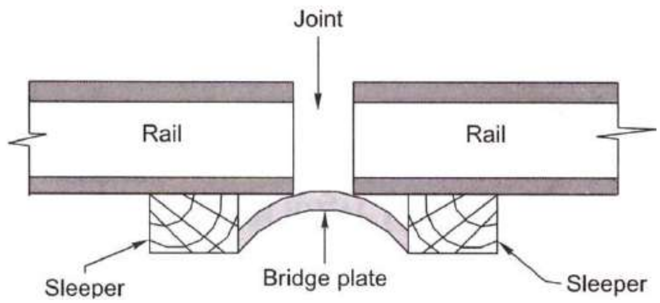
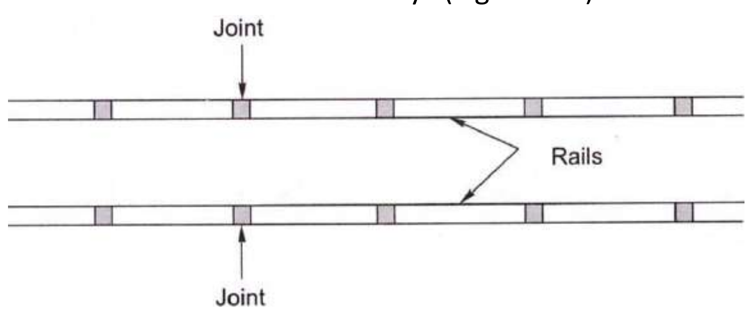


Fig. (b) Bridge joint with bridge plate

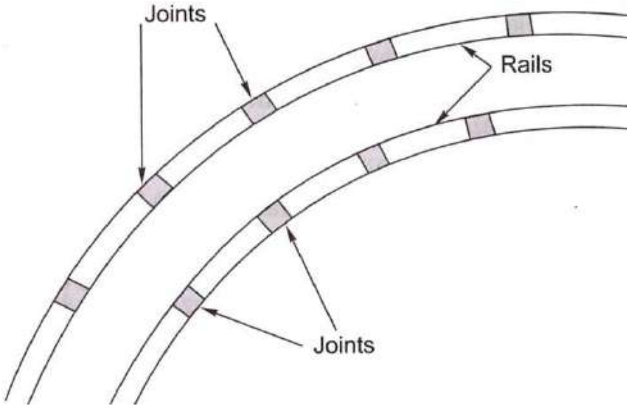
Classification Based on the Position of the Joint

Two types of rail joints fall in this category.

Square joint In this case, the joints in one rail are exactly opposite to the joints in the other rail. This type of joint is most common on Indian Railways (Fig. below).



Staggered joint In this case, the joints in one rail are somewhat staggered and are not opposite the joints in the other rail. Staggered joints are normally preferred on curved tracks because they hinder the centrifugal force that pushes the track outward (Fig. below).



WELDING A RAIL JOINT

The purpose of welding is to join rail ends together by the application of heat and thus eliminate the evil effects of rail joints.

There are four welding methods used in railways.

a) Gas pressure welding

b) Electric arc or metal arc welding

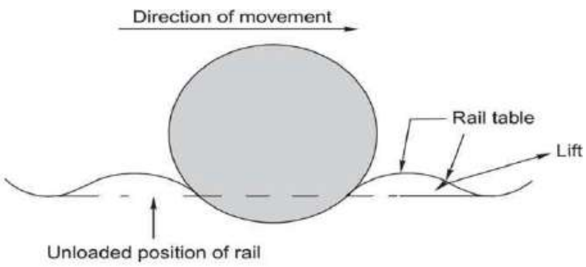
c) Flash butt welding

d)Thermit welding

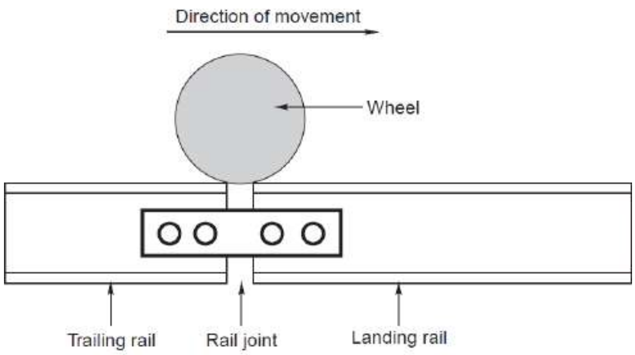
CREEP OF RAIL

Creep is defined as the longitudinal movement of the rail with respect to the sleepers. Rails have a tendency to gradually move in the direction of dominant traffic. Creep is common to all railway tracks, but its magnitude varies considerably from place to place; the rail may move by several centimeters in a month at few places, while at other locations the movement may be almost negligible

Creep in rails denotes longitudinal movement of rails in the track.

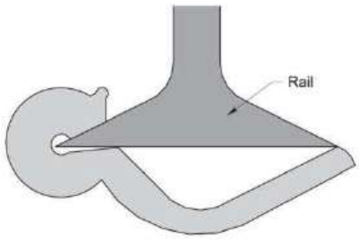


Wave motion theory for development of creep

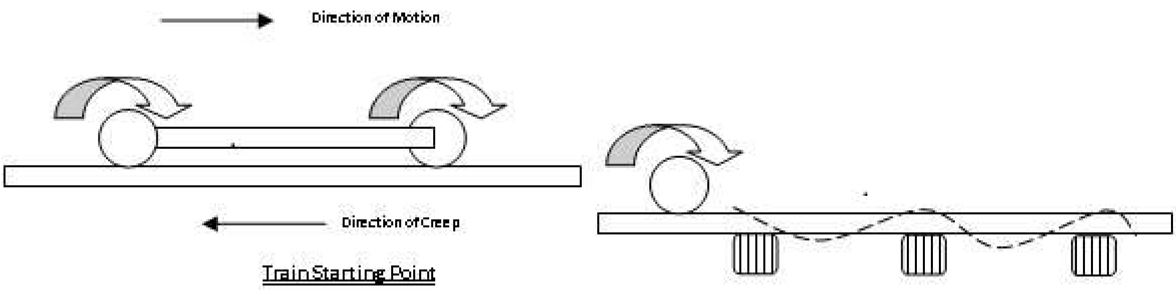


Percussion theory for development of creep

The following figure shows a type of Fair V-anchor which is used in the track to prevent creep of rails.



Fair V anchor



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

CAUSES OF CREEP

The main factors responsible for the development of creep are as follows.

Ironing effect of the wheel The ironing effect of moving wheels on the waves formed in the rail tends to cause the rail to move in the direction of traffic, resulting in creep.

Starting and stopping operations When a train starts or accelerates, the backward thrust of its wheels tends to push the rail backwards. Similarly, when the train slows down or comes to a halt, the effect of the applied brakes tends to push the rail forward. This in turn causes creep in one direction or the other.

Changes in temperature Creep can also develop due to variations in temperature resulting in the expansion and contraction of the rail. Creep occurs frequently during hot weather conditions.

Unbalanced traffic In a double-line section, trains move only in one direction, i.e., each track is unidirectional. Creep, therefore, develops in the direction of traffic. In a single-line section, even though traffic moves in both directions, the volume of traffic in each direction is normally variable. Creep, therefore, develops in the direction of predominant traffic.

Poor maintenance of track Some minor factors, mostly relating to poor maintenance of the track, also contribute to the development of creep. These are as follows:

• Improper securing of rails to sleepers

• Limited quantities of ballast resulting in inadequate ballast resistance to the movement of sleepers

• Improper expansion gaps

• Badly maintained rail joints

• Rail seat wear in metal sleeper track

• Rails too light for the traffic carried on them

• Yielding formations that result in uneven cross levels

• Other miscellaneous factors such as lack of drainage, and loose packing, uneven spacing of sleepers

EFFECTS OF CREEP

The following are the common effects of creep.

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

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

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

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

Effect on interlocking The interlocking mechanism of the points and crossings pets disturbed bv creep.

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

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

ADJUSTMENT OF CREEP

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

(i) A careful survey of the expansion gaps and of the current position of rail joints is carried out.

(ii) The total creep that has been proposed to be adjusted and the correct expansion gap that is to be kept are decided in advance.

(iii) The fish plates at one end are loosened and those at the other end are removed. Sleeper fittings, i.e., spikes or keys, are also loosened or removed.

(iv) The rails are then pulled back one by one with the help of a rope attached to a hook. The pulling back should be regulated in such a way that the rail joints remain central and suspended on the joint sleepers.

The pulling back of rails is a slow process since only one rail is dealt with at a time and can be done only for short isolated lengths of a track. Normally, about 40-50 men are required per kilometre for adjusting creep. When creep is required to be adjusted for longer lengths, five rail lengths are tackled at a time. The procedure is almost the same as the preceding steps

except that instead of pulling the rails with i rope, a blow is given to them using a cut rail piece of a length of about 5 m.

CREEP ADJUSTER

A creep adjuster is normally used when extensive work is involved. The creep adjuster is set at the centre of the length of the track, to be tackled, with the wide joints behind it and the jammed joints ahead of it. The following steps are adopted while using a creep adjuster:

(i) Expansion liners of the correct size are put in all the expansion gaps,

(ii) All the keys on the side (with wide joints) of the creep adjuster are removed and all fish bolts loosened,

(iii) The creep adjuster is then used to close up the gaps to the required extent by pushing the rails forward. A gap of a few inches is left between the rail ends opposite the adjuster,

(iv) The corrected rails are then fastened with keys. After that, the rails on the other side of the adjuster are tackled,

(v) The operation leaves some of the expansion gaps too wide which are tackled by the creep adjuster when it is set in the next position,

(vi) The corrected rails are then fastened and the adjuster is shifted to the new position,

The whole process is repeated again and again till the requisite attention has been paid to the entire length of the rail. In the end it may be necessary to use a rail with the correct size of closure (bigger or smaller) to complete the work.

PORTIONS OF TRACK SUSCEPTIBLE TO CREEP

The following locations of a track are normally more susceptible to creep.

• The point where a steel sleeper track or CST-9 sleeper track meets a wooden sleeper track

• Dips in stretches with long gradients

• Approaches to major girder bridges or other stable structures

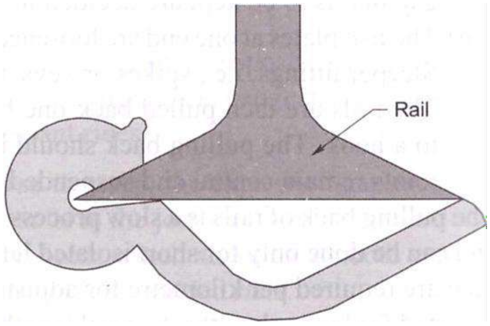
• Approaches to level crossings and points and crossings

• Steep gradients and sharp curves

MEASURES TO REDUCE CREEP

To reduce creep in a track, it should be ensured that the rails are held firmly to the sleepers and that adequate ballast resistance is available. All spikes, screws, and keys should be driven home. The toe load of fastenings should always be slightly more than the ballast resistance. Creep anchors can effectively reduce the creep in a track. At least eight of these creep anchors must be provided per panel. Out of the large number of creep anchors tried on Indian Railways, the 'fair T' and 'fair V anchors, have been standardized for use. The fair 'V anchor, which is more popular, is shown in Fig. below. The creep anchor should fit snugly against the sleeper for it to be full;- effective. The following measures are also helpful in reducing creep,

(a) The track should be well maintained—sleepers should be properly packed and the crib and shoulder ballast should be well compacted.



(a) A careful lookout should be kept for jammed joints that exist in series. In the case of a fish- plated track, more than six consecutive continuously jammed joints should not be permitted. In the case of SWR tracks, more than two consecutive jammed joints should not be permitted at rail temperatures lower than the maximum daily temperature (Tm) in the case of zones I and II and lower than (Tm - 5°C) in the case of zones III and IV. Regular adjustment may be necessitated on girder bridges.

(b) Anticreep bearing plates should be provided on wooden sleepers to arrest creep, but joints sleepers should have standard canted bearing plates with rail screws.

Sleepers &Ballast

Sleepers are the transverse ties that are laid to support the rails. They have an important role in the track as they transmit the wheel load from the rails to the ballast. Several types of sleepers are used on Indian Railways. The characteristics of these sleepers and their suitability with respect to load conditions are described in this section.

FUNCTIONS AND REQUIREMENTS OF SLEEPERS

The main functions of sleepers are as follows:

(a) Holding the rails in their correct gauge and alignment

(b) Giving a firm and even support to the rails

(c) Transferring the load evenly from the rails to a wider area of the ballast

(d) Acting as an elastic medium between the rails and the ballast to absorb the blows and vibrations caused by moving loads

e) Providing longitudinal and lateral stability to the permanent way

(f) Providing the means to rectify the track geometry during their service life

Apart from performing these functions the ideal sleeper should normally fulfill the following requirements.

a) The initial as well as maintenance cost should be minimum.

b) The weight of the sleeper should be moderate so that it is convenient to handle.

c) The designs of the sleeper and the fastenings should be such that it is possible to fix and remove the rails easily.

d) The sleeper should have sufficient bearing area so that the ballast under it is not crushed.

e) The sleeper should be such that it is possible to maintain and adjust the gauge properly

f) The material of the sleeper and its design should be such that it does not break or get damaged during packing.

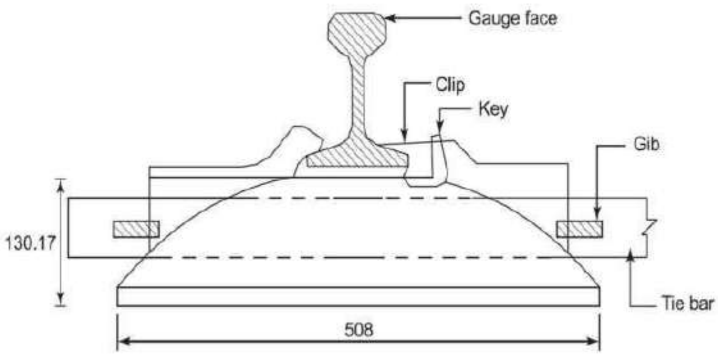
g) The design of the sleeper should be such that it is possible to have track circuiting.

h) The sleeper should be capable of resisting vibrations and shocks caused by the passage of fast moving trains,

Classification of Sleepers

Sleepers can be classified into the following types according to the material of construction.

1. **Wooden sleepers**
2. **Metal sleepers**
   - Cast iron sleepers



CI pot sleeper (dimensions in mm)

3. **Steel sleepers**
4. **Concrete sleepers**
   - Reinforce concrete sleepers
   - Prestressed concrete sleepers

Timber or Wooden Sleepers

wooden sleepers are regarded as the best as they satisfy almost all the requirements of a good sleeper. The life of timber sleepers depend upon their ability to resist

- Wear and tear
- Decay
- Attack by white ants
- Quality of the timber used

Advantages:

- It is easily available in all parts of india
- Fittings are few and simple in design
- They are easy to lay, relay, pack, lift and maintain
- They are suitable for all types of ballast
- They are able to resist the shocks and vibrations of the heavy moving loads
- They are economical

Disadvantages:

- They are subjected to decay, attack by white ants, warping, cracking and end splitting
- It is difficult ot maintain the gauge in the case of wooden sleepers.
- It is difficult to maintain the alignment in the case of wooden sleepers.
- They have got minimum service life(12 to 15 yrs) as compared to other types of sleepers

Concrete Sleepers

Concrete sleepers are made of a strong homogeneous material, impervious to effects of moisture and unaffected by the chemical attacks. It is moulded easily to size and shape required and it is an ideal material to with stand stresses introduced by fast and heavy traffic.

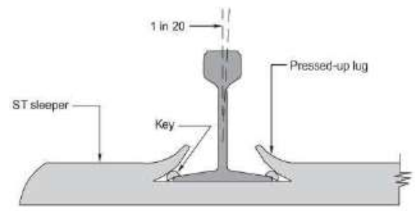
Advantages

1. The concrete sleepers are quite heavy and thus provide longitudinal, lateral and vertical stability. Because of their weight, these sleepers are more suitable to LWR tracks.
2. The concrete sleepers result in reduced rail bending stresses.
3. The concrete sleepers reduce the wear of rolling stocks.
4. The concrete sleepers produce less vertical motion and thus provide a comfortable journey due to less noise.
5. The concrete sleepers have flat bottoms. That’s why mean modern method of track maintenance i.e. MSP and machine maintenance can be suitably employed.
6. The concrete sleepers are neither in flammable nor subjected to damage by corrosion or termite.
7. These sleepers have a long useful life of 50 years. It means rail and sleeper renewals can be matched.
8. The concrete sleepers with their fastening system maintain gauge, cross levels, twist, alignment, longitudinal level and unevenness of the track.
9. The concrete sleepers are suitable for track circuiting.
10. The concrete sleepers can be manufactured from local resources.

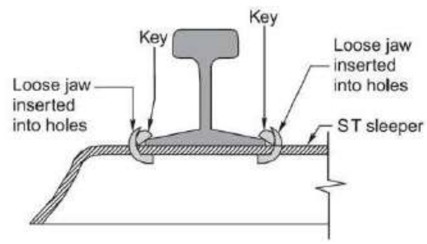
Disadvantages

1. They are not economical because of high cost of construction.
2. In case of derailments, heavy damage is caused.
3. High standard of maintenance of track is required.
4. The design and construction are both complicated.
5. They are more rigid.
6. They do not have any scrap value.

Steel sleepers



ST sleeper with pressed-up lugs



Sleeper with loose jaws inserted into holes

Steel sleepers are lightweight, dimensionally more accurate than wooden or concrete and regarded as an effective technical solution for modern rail networks.

Advantages of steel Sleepers

1. They are manufactured by a simple operation.
2. They can be easily handled as theses are light in weight as compared to other types of sleepers. Hence, damages during handling and transporting are less.
3. Less number of fastenings are required and that too simple in nature.
4. The maintenance and adjustment of gauge are easy as compared to the other of sleepers.
5. These sleepers are rolled sections in one piece.
6. Their life is longer than that of other types of sleepers.
7. They provide better lateral rigidity to the track.
8. They are not attacked by vermins.
9. They are not susceptible to fire hazards.
10. Their scrap value is good.

Disadvantages of Steel of Sleepers

1. The steel sleepers possess the following disadvantages:
2. They get easily rusted and corroded.
3. They develop cracks at rail seats or near lugs.
4. Their lugs get broken easily.
5. The steel sleepers do not provide effective track circuiting.
6. The steel sleepers can only be for the type of rails for which theses are manufactured.
7. These develop the tendency to become center bound because of slope at both ends.
8. The overall cost of steel sleepers is more than that of timber sleepers.

Comparison of different types of sleepers

Characteristics	Type of sleeper			
	Wooden	**Steel**	**'CI**	**Concrete**
Service life (years)	12-15	40-50	40-50	50-60
Weight of sleeper for BG (kg)	83	79	87	267
Handling	Manual handling; no damage to sleeper while handling	Manual handling; no damage to sleeper while handling	Manual handling; liable to break by rough handling	No manual handling; gets damaged by rough handling
Type of maintenance	Manual or mechanized	Manual or mechanized	Manual	Mechanized only
Cost of maintenance	High	Medium	Medium	Low
Gauge adjustment	Difficult	Easy	Easy	No gauge adjustment possible
Track circuiting	Best	Difficult; insulatin	Difficult; insulati	Easy

		g pads are necessary	ng pads are necessary	
Damage by white ants and corrosion	Can be damaged by white ants	No damage by white ants but corrosion is possible	Can be damaged by corrosion	No damage by white ants or corrosion
Suitability for fastening	Suitable for CF* and EF[f]	Suitable for CF and EF	Suitable for CF only	Suitable for EF only
Track elasticity	Good	Good	Good	Best
Creep	Excessive	Less	Less	Minimum
Scrap value	Low	Higher than wooden	High	None

Ballast

Definition:

It is a layer of broken stones, gravel or any other such gritty material laid and packed below and around sleepers.

Functions of ballast:

- To distribute the loads uniformly over the subgrade.
- To provide good drainage for the track structure.
- To provide elasticity and resilience to track for getting proper riding comfort.
- To held the track structure to line and grade.
- To reduce dust.
- To prevent growth of brush and weeds.

Requirements of Good Ballast

1. It should be tough and should not crumble under heavy loads.
2. It should not make the track dusty or muddy.
3. It should offer resistance to abrasion and weathering.
4. It should not produce any chemical reaction with rails and sleepers.
5. The materials should be easily workable.
6. It should retain its position and should not be distributed.

Materials used as Ballast

1. Broken Stone - Broken stone is one of the best materials for railway ballast to be used on the railway tracks. Almost all the important railway tracks are provided with broken stone. The stone to be used as railway ballast should be hard, tough nonporous and should not decompose when exposed to air and light. Igneous rocks like quartzite and granite forms the excellent ballast materials. When these are not available then lime stone and sand stone can also be used as good ballast material.

1. Gravel - Gravel ranks next in its suitability for use as materials for ballast and is used in many countries of the world in very large quantities. Gravel consists of worn fragments of rocks occurring in natural deposits. Gravel or shingle may be obtained from river bed or it may be dug out from gravel pits.

Advantages of Gravel

1. It is cheaper in its cost as it has not to be broken as like stone ballast

2. It has got excellent drainage properties, if properly cleaned Disadvantages of Gravel

1. It easily rolls down under the vibrations and packing under the sleepers get tense

2. The variation in size is considerable and hence requires screening before use

3. Grovel as obtained from gravel pits, is full of earth and hence requires proper cleaning if proper drainage of the track is to be done.

3. Cinders Or Ashes- The residue from the coal in locomotives or other furnaces is called cinder or ashes. It is one of the universal forms of ballast as it is a byproduct of all the railway which uses coal as a fuel.

Advantages of Cinders or Ashes

1. Handling of the material is not cumbersome this material can be handle easily

2. Cost is very low and hence can also be used for sidings

3. It has got fairly good drainage properties

4. Large quantities of this material can be made available at short notice.

5. In case of emergence such as caused by the destruction of portion of railway track during floods. This material proves to be very useful and is used in the formation repairing as well as for packing of track.

Disadvantages of Cinders or Ashes

1. It is highly corrosive and cannot be used where steel sleepers are fixed

2. The foot of the rails get affected due to use of this type of material as ballast

3. It is very soft and can easily be reduced to powder under vibrations and hence the track becomes very dusty. This is objectionable particularly in dry weather.

4. Sand- Sand is another good materials for railway ballast , coarser sand is to be preferred to finer sand and the best sand is that which contains a quantity of fine gravel varying in size from 1/8 upwards.

Advantages of Sand

1. If the sand is free from earth and vegetation then it has good excellent properties to drain off water immediately

2. It is cheaper if available in nearby locality

3. It produces very silent track and hence are suitable for packing cast iron pot sleepers. Disadvantages of Sand

1. It gets easily disturbed under vibrations and hence its maintenance is very difficult

2. The sand can be easily washed off or blown away and hence requires frequent renewal.

3. The sand particles may get into the moving parts of the vehicles and produces friction.

This leads to heavy wear of vehicles.

5. Kankar- Kankar a lime agglomerate is found in many places in the form of nodules of varying sizes.

Advantages of Kankar:

i. Kankar is suitable Materials for ballast when other good material for ballast is not available

ii. Kankar is good for light traffic on metre and narrowgauge

Disadvantages of Kankar

1. It is very soft and can be reduced to powder form easily, hence, making the track dusty.
2. The maintenance of track is very difficult

6. Moorum-The decomposition of laterite results into the formation of moorum. It has red and sometimes yellow color. The best moorum is that which contains large quantities of small laterite stones.

Advantages of Moorum

1. Moorum is good materials for ballast when other material for ballast is not available.
2. Moorum can be safely used on newly laid track and acts as a soling when broken stones are laid afterwards.
3. Moorum has got good drainage properties

Disadvantages of Moorum

1. Moorum is very soft and reduces to powder and hence to dust form in short time.
2. Maintenance of tracks laid with this material is difficult

7. Brick Ballast Or Brick Bats-Sometimes the broken pieces of over burnt bricks, called brickbats, are used as materials for ballast.

Advantages of Brick Ballast

1. It has got excellent drainage properties
2. They can be used as good ballast material where suitable material for ballast is either unavailable or uneconomical

Disadvantages of Brick Ballast

1. Brickbats turn down into powder form easily and hence the track becomes dusty
2. Maintenance of the track laid with this material as ballast is very difficult.
3. Rails are often corrugated on the tracks laid with this material as ballast

8. Selected Earth-Selected earth may be used as material for railway ballast for sidings and also for newly laid tracks.

Track fixtures for BG

Rail joints – Fish plates – Fish bolts- Fang bolts- Hook bolts – Rail chairs and keys – Bearing plates – Blocks – Spikes-Elastic fastenings- Anchors & Anti creepers

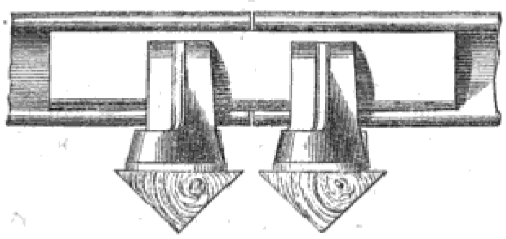
Fastening

A rail fastening system is a means of fixing rails to railroad ties. The terms rail anchors, tie plates, chairs and track fasteners are used to refer to parts or all of a rail fastening system. Various types of fastening have been used over the years.

Fish Plates

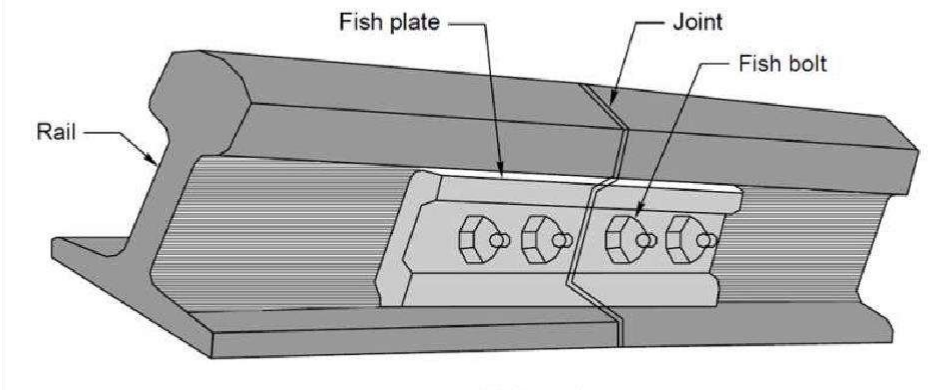
In rail terminology, a fishplate, splice bar or joint bar is a metal bar that is bolted to the ends of two rails to join them together in a track. The name is derived from fish, a wooden bar with a curved profile used to strengthen a ship's mast. The top and bottom edges are tapered inwards so the device wedges itself between the top and bottom of the rail when it is bolted into place. In rail transport modelling, a fishplate is often a small copper or nickel silver plate that slips onto both rails to provide the functions of maintaining alignment and electrical continuity.

Fig. 1.

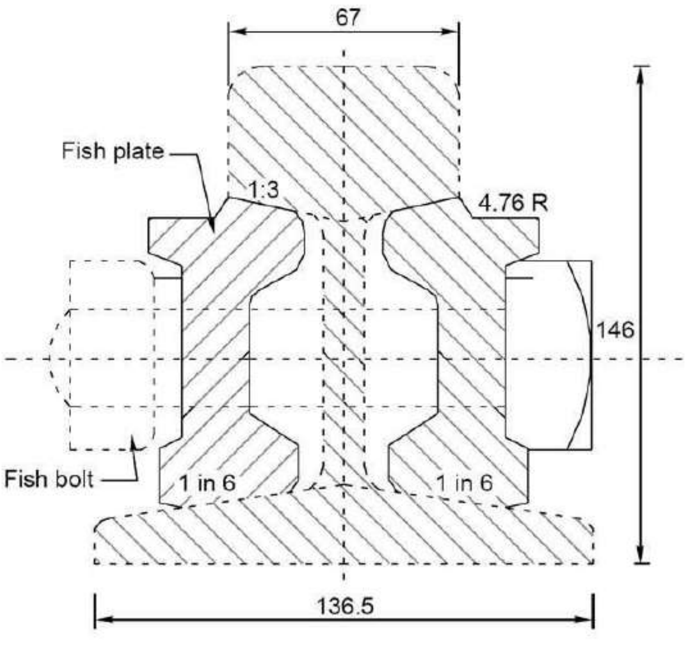


Fish as specified.

RAIL-TO-RAIL Fastenings

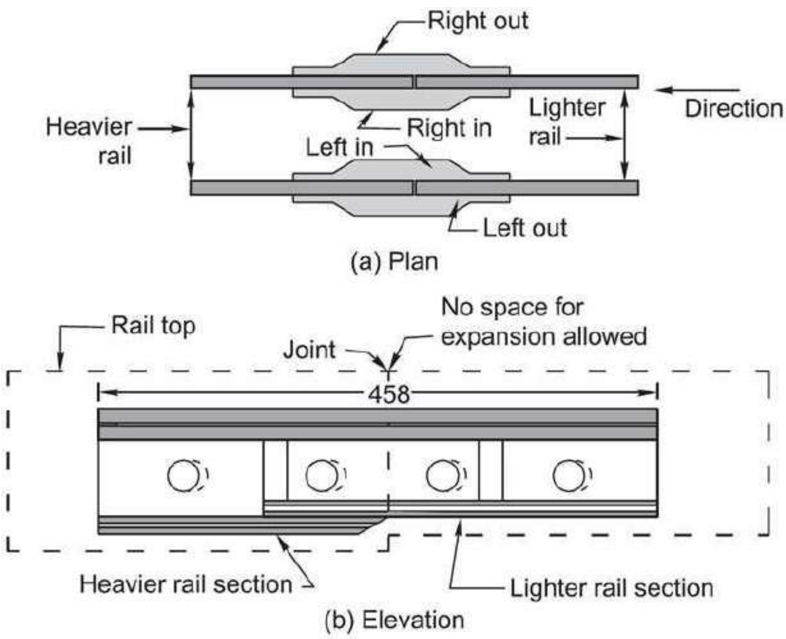


Fish plate

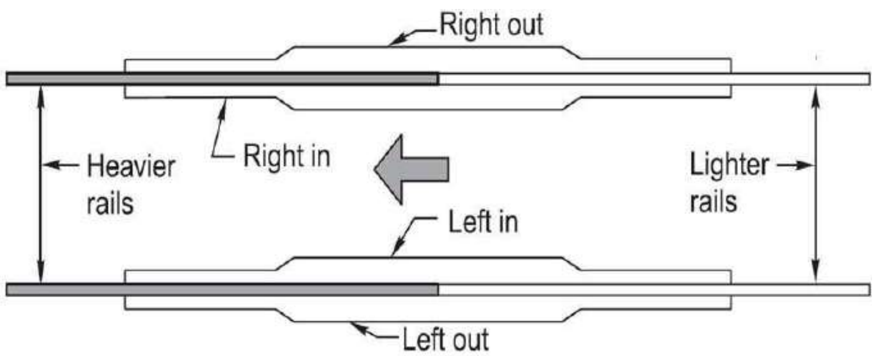


Fish plate for 90 R rails

Combination Fish Plates

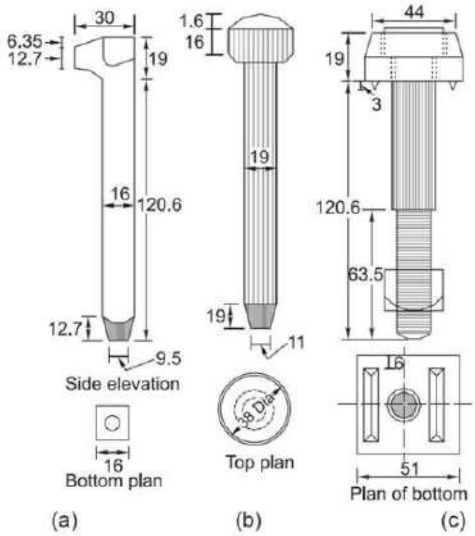


Combination fish plate (dimensions in mm)



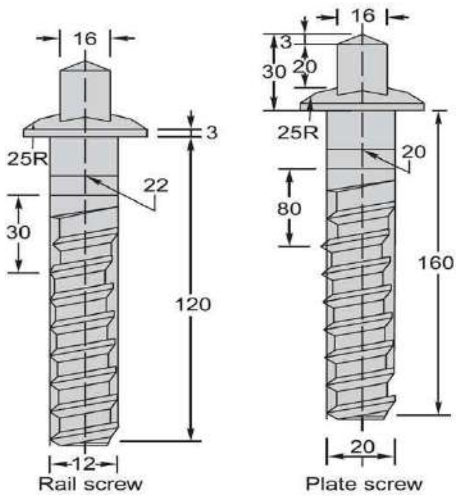
Marking of combination fish plates

Fang Bolts



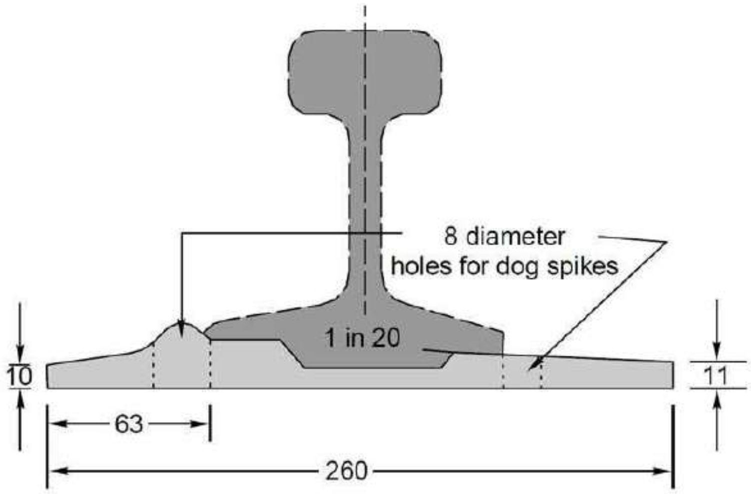
(a) Dog spike, (b) round spike, (c) fang bolt

Screw Spikes

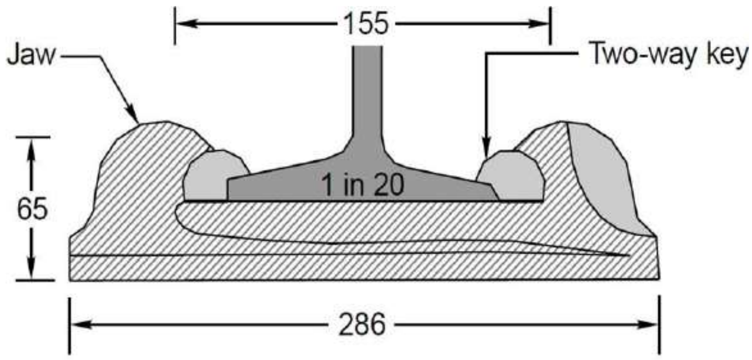


Screw spikes

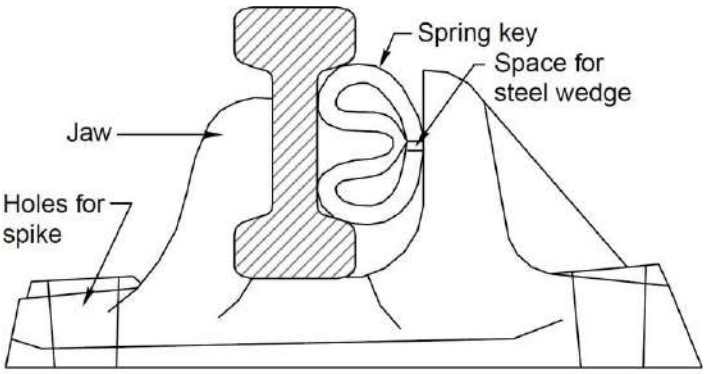
Bearing Plates



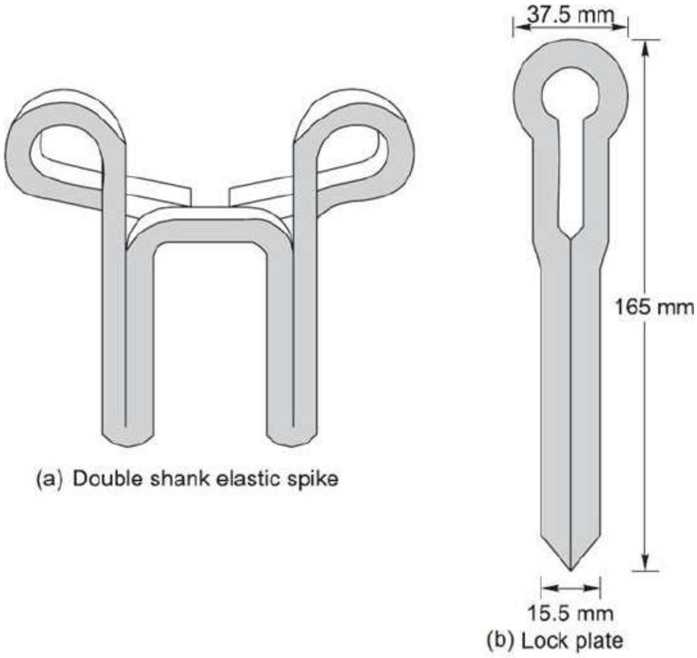
Canted MS bearing plate for 90 R (dimensions in mm)



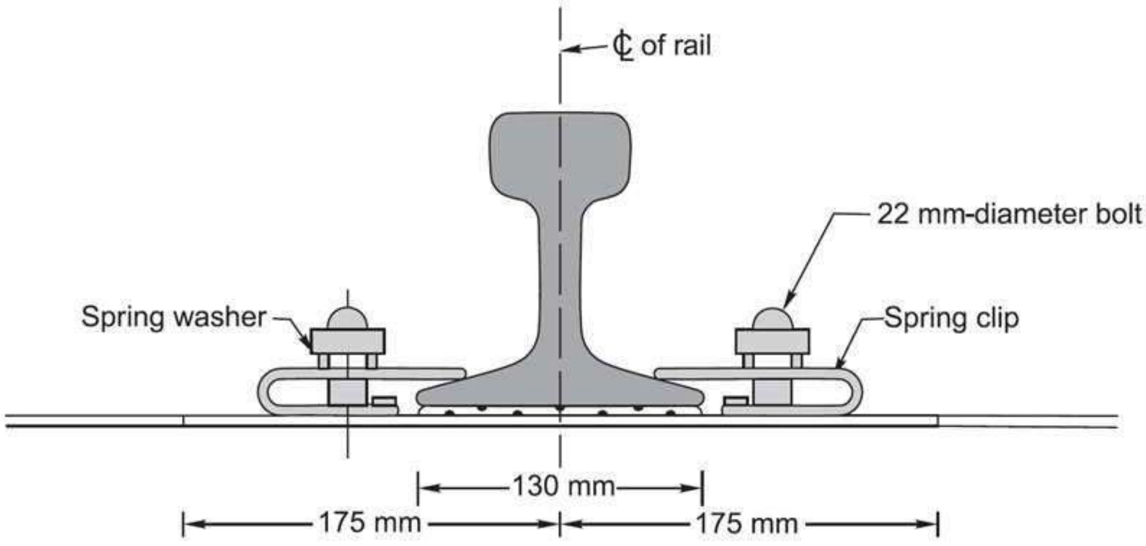
CI anticreep bearing plate



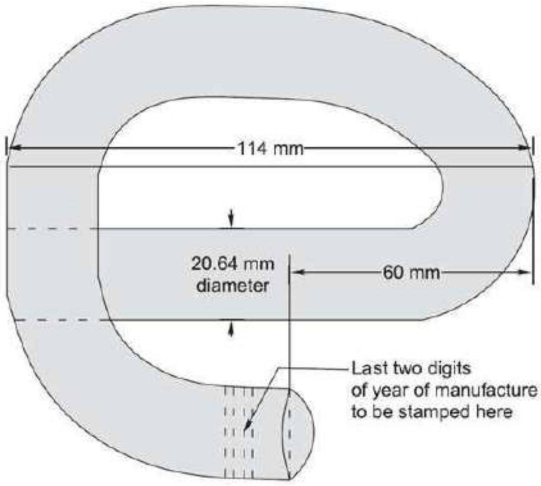
CI bearing plate for BH rail



Lock spike

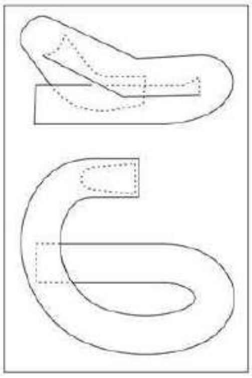


Spring steel clip



Pandrol clip (ERC rail clip) MK III

New Elastic Fastening (G Clip)

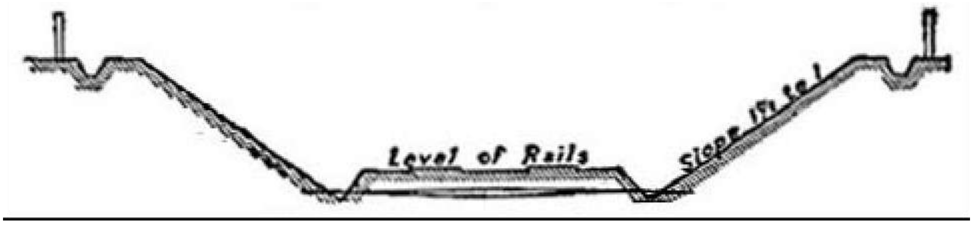


Logwell G clip

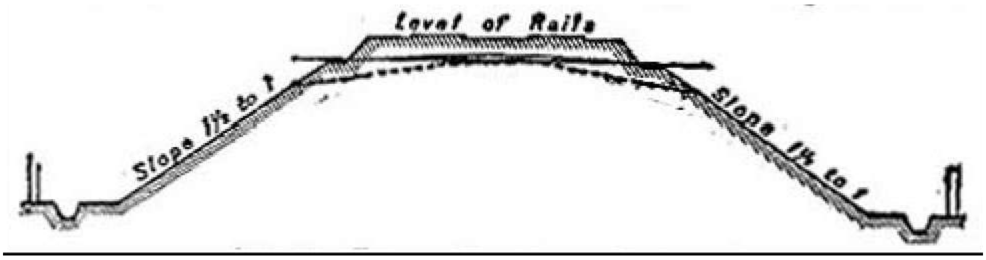
Isometric view of G clip assembly

CHAPTER-4

Geometric for Broad gauge



Typical Section of Railway in Cutting.



Typical Section of an embankment.

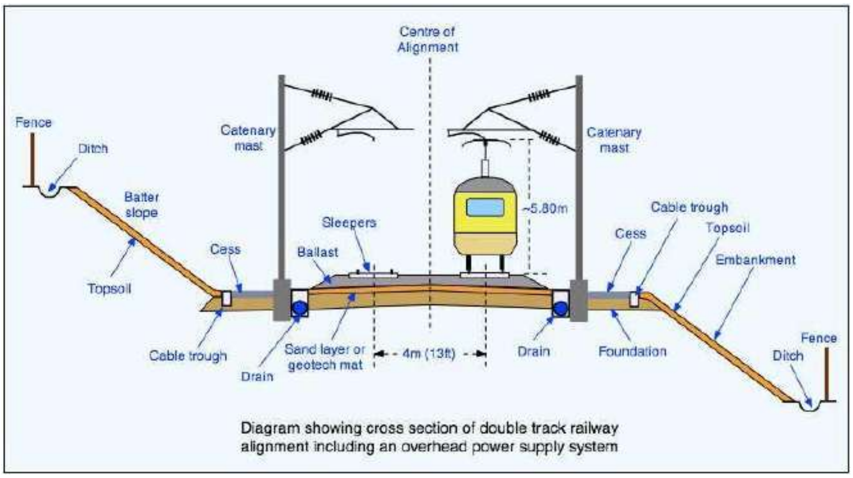


Diagram showing cross section of double track railway alignment including an overhead power supply system

Classification of Railway Land. With a view to determine what the disposition of the land will probably be on the completion of the work for which it had been acquired, the classification given in paragraph 818 etc. should be adopted.

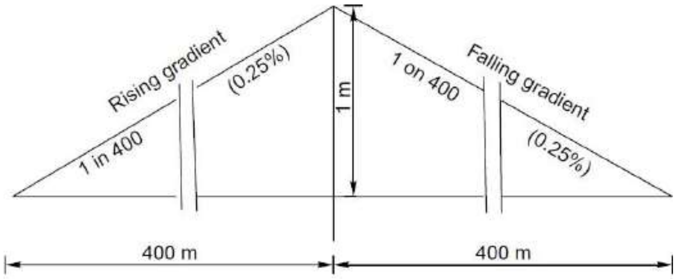
On railways, land is divided into two classes, viz.,

- (i) permanent land width
- (ii) temporary land width

Permanent land width is land which will be required permanently after the railway is open for traffic and the work of construction is complete. Under this head will be included all land to be occupied by the formation of the permanent line of railway with side slopes of banks and cuttings, and the berms connected therewith; catchwater drains and borrow pits or such parts of them as it is necessary to retain; the entrances to tunnels and shafts belonging to them; the sites of bridges, and protection or training works; station yards; landing places for railway ferries; ground to be occupied by works belonging to the railway such as gas works, arrangements for water supply, septic tanks, collecting pits, filter beds and pumping installations, & c., ground for the storage manufacture or acquisition of materials; land for sanitary zones, cemeteries, churches, plantations; gardens, and recreation grounds, sites for stations, offices, workshops; dwelling houses and other buildings required for the purposes of the railway, or the accommodation of the staff, with the grounds, yards, roads, & c., appertaining thereto. Under this head will also be included land outside the permanent railway boundary, which will be required for the permanent diversion of roads or rivers, or for other works incidental to the construction of the railway, which are made for public purposes and will not on completion of the works be maintained by the railway authorities.

Temporary land width is land which is acquired for temporary purposes only, and which is disposed of after the work of construction is completed.

Gradients for drainage



Rising and falling gradient

Drainage is defined as interception, collection and disposal of water away from track. Drainage is the most important factor in track maintenance and for stability of banks/cuttings. When water seeps into the formation, it weakens the bonds between the soil particles, softens the soil and results in creation of ballast pockets. On one hand, ingress of water into bank/cutting adds to weight of soil mass trying to slide, thereby increasing propensity for slope-slide, on the other hand, it reduces shear strength of soil, thereby decreasing factor of safety for stability of slope. Therefore, quick disposal of water from formation top/slopes is very essential. Drainage system should be effective in preventing the stagnation of water and allow quick disposal of water. At present, drainage is not being given its due importance in field. Provisions relating to drainage have been detailed in various guidelines issued by RDSO from time to time, however, the present Guidelines highlight the salient features of drainage arrangement in embankment as well as cuttings.

CONVENTIONAL DRAINAGE SYSTEMS

- SURFACE DRAINAGE
- SIDE DRAINS
- CATCH WATER DRAINS
- SUB SURFACE DRAINS

SUPER ELEVATION

(1) **Cant or super elevation** is the amount by which one rail is raised above the other rail. It is positive when the outer rail on a curved track is raised above inner rail and is negative when the inner rail on a curved track is raised above the outer rail.

(2) **Equilibrium speed** is the speed at which the centrifugal force developed during the movement of the vehicle on a curved track is exactly balanced by the cant provided.

(3) **Cant deficiency**- Cant deficiency occurs when a train travels around a curve at a speed higher than the equilibrium speed. It is the difference between the theoretical cant required for such higher speed and actual cant provided.

(4) **Cant excess** - Cant excess occurs when a train travels around a curve at a speed lower than the equilibrium speed. It is the difference between the actual cant and the theoretical cant required for such a lower speed.

(5) Maximum permissible speed of the curve-It is the highest speed which may be permitted on a curve taking into consideration the radius of the curvature, actual cant, cant deficiency, cant excess and the length of transition. When the maximum permissible speed on a curve is less than the maximum sectional speed of the section of a line, permanent speed restriction becomes necessary.

(6) **Cant gradient** and cant deficiency gradient indicate the amount by which cant or deficiency of cant is increased or reduced in a given length of transition e.g., 1 in 1000 means that cant or deficiency of cant of 1 mm. is gained or lost in every 1000mm. of transition length.

(7) **Rate of change of cant** or rate of change of cant deficiency is the rate at which cant or cant deficiency is increased or reduced per second, at the maximum permissible speed of the vehicle passing over the transition curve, e.g., 35 mm. per second means that a vehicle when traveling at a maximum speed permitted will experience a change in cant or deficiency of cant of 35mm. in each second of travel over the transition.

(8) Transition curve is an easement curve, in which the change of radius is progressive

throughout its length and is usually provided in a shape of a cubic parabola at each end of the circular curve. It affords a gradual increase of curvature from zero at the tangent point to the specified radius of circular are and permits a gradual increase of super elevation, so that the full superelevation is attained simultaneously with the curvature of the circular arc.

Superelevation, Cant deficiency and Cant excess

(1) Superelevation/cant

(a) The equilibrium superelevation/cant necessary for any speed is calculated from the formula

$$C = \frac{GV^2}{127R}$$

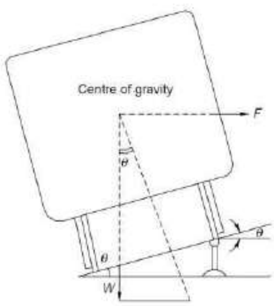
Where C is cant/superelevation in mm. G is the gauge of track width of rail head in mm. R is the radius of the curve in metres.

Necessity of SuperElevation

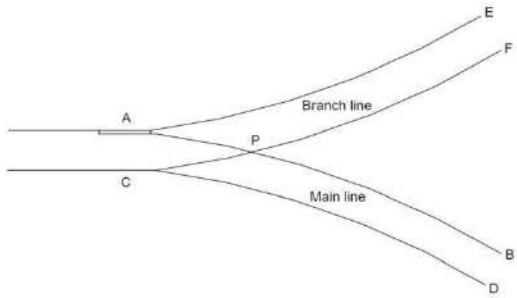
In order to counteract the effect of centrifugal force the outside rail of the curve may be elevated above the inside rail effectively moving the centre of gravity of the rolling stock laterally toward the inside rail. This procedure is generally referred to as super elevation.

If the combination of lateral displacement of the centre of gravity provided by the super elevation, velocity of the rolling stock and radius of curve is such that resulting force becomes centered between and perpendicular to a line across the running rails the downward pressure on the outside and inside rails of the curve will be the same.

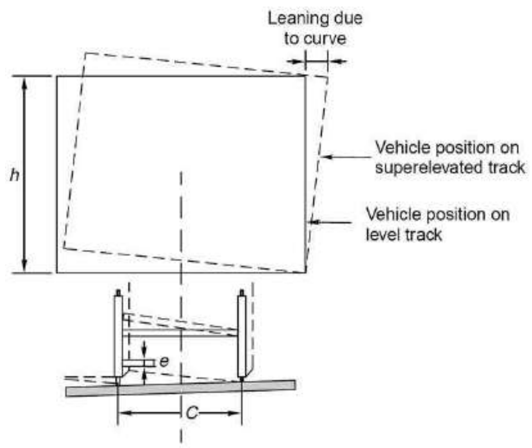
The super elevation that produces this condition for a given velocity and radius of curve is known as the balanced or equilibrium elevation.



Equilibrium superelevation



Negative superelevation



Effect of lean due to superelevation

Limitation of Super elevation

For Mixed Passenger & Freight Routes

Typical early railway operation resulted in rolling stock being operated at less than equilibrium velocity (all wheels equally sharing the rolling stock weight), or coming to a complete stop on curves. Under such circumstances excess super elevation may lead to a downward force sufficient to damage the inside rail of the curve, or cause derailment of rolling stock toward the centre of the curve when draft force is applied to a train. Routine operation of loaded freight trains at low velocity on a curve super elevated to permit operation of higher velocity passenger trains will result in excess wear of the inside rail of the curve by the freight trains.

Thus on these types of routes, super elevation is generally limited to not more than 6 inches. For High Speed Passenger Routes

Modern high speed passenger routes, do not carry slower speed trains, nor expect trains to stop on curves, so it is possible to operate these routes with higher track super elevation values. Curves on these types of route are also designed to be relatively gentle radius, and are typically in excess of 2000m (2km) or 7000m (7km) depending on the speed limit of the route.

CHAPTER -5

POINTS AND CROSSING

Necessity:-

I. Points and crossing are provided to help transfer railway vehicle from one track to another.

II. The track may be parallel to diverging from or converging with each other point and crossing are necessary because the wheels of railway vehicles are provided with inside flange and therefore they require this in special arrangement in order to navigate their way on the rail.

III. The points or switches aid in diverting the vehicles and the crossing provide gaps in the rails so as to help the flanged wheels to roll over them.

IV. A complete set of points and crossings, along with lead rails, is called a turnout.

Points or Switches

A pair of tongue rail and stock rail with necessary connection and fitting forms a switch

Crossing: - it is a device introduced at the junction where two rails cross each other to permit the wheel flanges of a railway vehicle to pass from one track to another

Switches

- A pair of stock rail, AB and CD made of medium-manganese steel.
- A pair of tongue rails, PCS and RS also known as switch rails made withstand wear. The tongue rails are machined to very thin section to obtain a snug fit with the stock rail is called 'toe' and thicker end is called the 'heel'
- A no. of slide chairs to support the tongue rail and enable from stock rail.
- Two or more stretcher bars connecting both the tongue rails close to the toe for the purpose of holding them at a fixed distance from each other.
- A gauge ties plate to fix gauges and ensure correct gauge at the points.

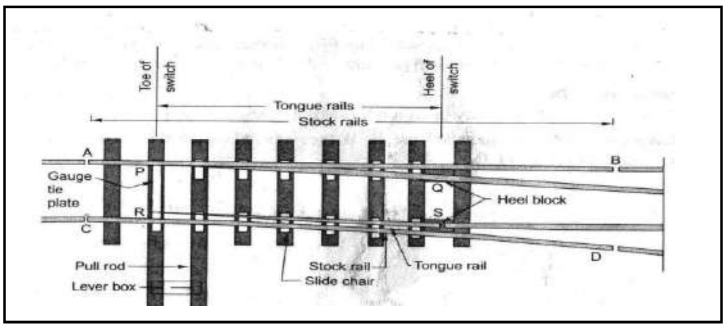


FIGURE: DETAILS OF SWITCH

Types of Switches

Switches are of two types, namely 'stud switches' and 'split switch'.

In 'stud switch' no separate tongue rail is provided and some portion of the track is moved from one side to the other side.

In 'split switch' a pair of stock rail and pair of tongue rails are present, split switches are two types:-

1) **Loose Heel type:-**

- In this type of split switch, the switch or tongue rail finishes at the heel of the switch to enable movement of the free end of the tongue rail.
- The fish plates holding the tongue rail may be straight or hightly bent.
- The tongue rail is fastened to the stock rail with the help of a fishing fit block and four bolts.
- All the fish bolts in the lead rail are tightened while those in the tongue rail are kept loose or snug to allow free movement of the tongue.
- As the discontinuity of the track at the heel is a weakness in the structure, the use of these switches is structures, the use of these switches is not preferred.

(2) Fixed Heel Type:-

In this type of split switch the tongue rail does not end at the heel of the switch, but extends further and is rigidly connected. The movement at the toe of the switch is made possible on account of flexibility of tongue rail.

Crossing:-

A crossing or Frog is a device introduced at the point/junction where two gauge faces / rails cross each other to permit the wheel flanges of a railway vehicle to pass from one track to each other.

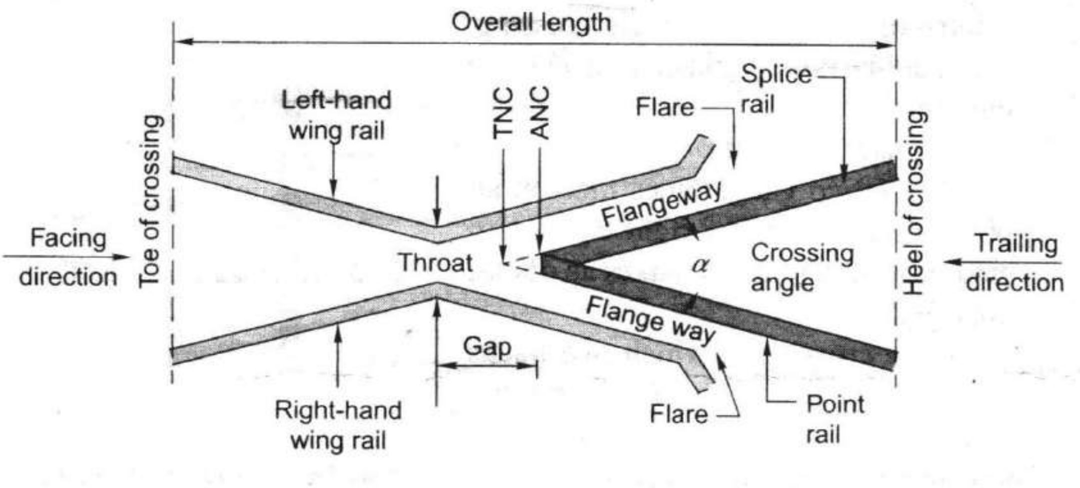


Figure :- Details of Crossing

A crossing consists of the following components.

(i) Two rails, ***point rails and splice rails***, which are machined to form a nose. The point rail ends at the nose whereas the splice rail joins it a little behind the nose. Theoretically, the point rail should end in a point and be made as thin as possible, but a knife edge of point rail would break off under the movement of traffic. The point rail therefore, has its fine end slightly cut off to form a blunt nose, with a thickness of 6mm. The toe of the blunt nose is called the ***actual nose of crossing (ANC)*** and the theoretical point where the gauge faces form both sides intersect is called the ***theoretical nose of crossing (TNC).***The 'V' rail is planed to a depth of 6mm (1/4'') at the nose and runs out in 89mm to stop a wheel running in the facing direction from hitting the nose.

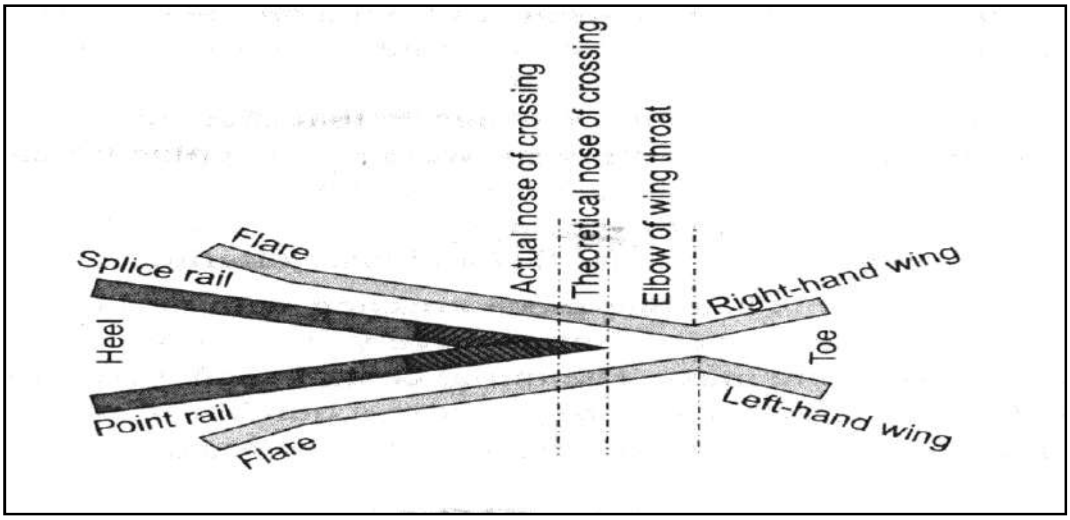


Figure: - Point Rail and Splice Rail

(ii) Two wing rails consisting of a right hand and a left hand wing rail that converge to from a throat and diverge again on either side of the nose. Wing rails are flared at the ends to facilitate the entry and exit of the flanged wheel in the gap.

(iii) A pair o f check rails to guide the wheel flanges preventing them from moving sideways which would otherwise may result in the wheel hitting the nose of the crossing as it moves in the facing direction.

<u>TYPES OF CROSSING:</u>

A crossing may be of the following types:-

(a) **<u>An acute angle crossing or 'V' crossing</u>** in which the intersection of two gauge faces forms on acute angle, For example when a right rail crosses a left rail, it makes an acute crossing. So unlike rail crossing from an acute crossing.

(b) **<u>An obtuse or diamond crossing</u>** in which the two gauge faces meet at an obtuse angle. When a right on left rail crosses a similar rail, it makes an obtuse crossing.

(c) **<u>A square crossing</u>** in which two tracks crossing at right angles, such crossings are rarely used in actual practice. For manufacturing purposes, crossing is of following types.

According to manufacture, the crossing may be classified as mentioned under:- (a) Built up crossing:-

In a built-up crossing two wing rails and a V-section consisting of splice and point rails are assembled together by means of bolts and distance blocks to form a crossing.

Advantages:-

(a) Initial cost is low.

(b) Repair can be carried out by welding.

(b) Cast steel crossing:-

This is one piece crossing with no bolts and therefore requiring very little maintenance.

Comparatively

Advantages:-

(a) Longer life.

Disadvantages:-

(a) Initial cost is high.

(b) Repair and maintenance causes a no of problem.

(c)Combined rail and cast crossing:-.

is a combination of a built-up and cast steel crossing and consists of a cast steel nose finished to ordinary rail faces to form the two legs of the crossing.

Through it allows the welding of worn-out wing rails, the nose is still liable to fracture suddenly.

CMS Crossing:- Due to increase in traffic and the use of heavier axle loads, the ordinary built-up crossing manufacturer from medium –manganese rails subjected to vary heavy wear and tear, especially in fast lines and suburban sections with electric traction. Past experience has shown that life of such crossings varies six months to two years, depending on their location and service conditions. CMS crossings possese higher strength, offer more resistance to wear and consequently have a longer life.

Advantages:-

- Less wear and tear.
- Longer life.
- Free from bolts as wheel as other components that normally to get loose as a result of movement of traffic.

Spring or Movable Crossing:-

In a spring crossing, one wing rail is movable and held against the V of the crossing with a strong helical spring while the other wing rail is kept fixed. When a vehicle passes on the main track, the movable wing rail is snug with crossing and the vehicle does not need to negotiate any gap at the crossing. In case the vehicle has to pass over a turnout track, the movable wing is forced out by the wheel flanges and the vehicle has to negotiate a gap as in normal turnout.This type of crossing is useful when there is high-speed traffic on the main track and slow-speed traffic on the turnout track

CHAPTER 6

METHODS OF LYING & MAINTENANCE OF TRACK:-

Essential of Track Maintenance:-

1. The gauge should be correct or within the specified limits.
2. There should be no difference in cross levels except on curves, where cross levels vary in order to provide superelevation.
3. Longitudinal levels should be uniform.
4. The alignment should be straight and kink-free.
5. The ballast should be adequate and sleepers should be well packed.
6. The tack drainage should be good and formation should be well trained.

Railway track can be maintained either conventionally by manually labour or by the application of modern methods of track maintenance, such as mechanical tamping or measured shovel packing. The major maintenance operations performed in a calendar year (12-months) are as follows for achieving the above mentioned standards:-

1) **Through Packing-:**
2) **Systematic Overhauling**
3) **Picking up slacks**

1) Through Packing

Through Packing is carried out in a systematic and sequential manner as described as follows:

-

- **Opening of road:-**

The ballast is dug out on either side of the rail seat for a depth of 50mm (2”) below the bottom of the sleeper with the help of a shovel with a wire claw .On the outside, the width of the opening should extend up to the end of the sleeper.

On the inside it should extend from the rail seat to a distance of 450mm (18”) in case of BG, 350mm (14”) in case of MG, and 250mm (10”) in case of NG.

- **Examination of rails, sleepers and fastening:-**

The rails, sleepers and fastening to be used are thoroughly examined. Defective sleepers are removed and loose fastening are tightened. Any kinks in rails are removed.

- **Squaring of sleepers:-**

(a) To do this one of the rails is taken as the sighting rail and the correct sleeper spacing is marked on it.
(b) The position of the sleeper is checked with reference to the second rail with the help of a T- square.

(c) The sleeper attended to after this defects have been established, which may include their being out of square or at incorrect spacing.

- **Aligning the track:-**

(a) The alignment of the track is normally checked visually, where in the rail is visually assessed form a distance of about four rail lengths or so.
(b) Small errors in the alignment are corrected by slewing the track after loosening the cores at the ends and drawing out sufficient ballast at the ends of the sleeper.
(c) Slewing is carried out by planting crowbar deep into the ballast at an angle not more than 30 form the vertical.

Advantages of Track Maintenance:-

1. If the track is suitably maintained, the life of the track as well as that of the rolling stock increases since there is lesser wear and tear of their components.
2. Regular track maintenance helps in reducing operating costs and fuel consumption.
3. Small maintenance jobs done at the appropriate time, such as tightening a bolt or key, hammering the dog spike, etc., help in avoiding loss of concerned fitting and thus saving on the associated expenditure.
4. When track maintenance is neglected for along time, it may render the track beyond repair, calling for heavy track renewals that entail huge expenses

Gauging:-

The gauge should be checked and an attempt should be made to provide a uniform gauge within permissible tolerance limits.

2. <u>Systematic overhauling:-</u>

The systematic overhauling of the track should normally commence after the completion of one cycle of through packing. It involves the following operations in sequence:-

(a) Shallow screening and making up of ballast section.

(b) Replacing damaged or brother fittings.

(c) Including all items in through packing.

(d) Making up the cess.

3. <u>Picking up stacks:-</u>

Stacks are those points in the track where the running of trains is faculty. Slacks generally occur in the following cases:-

(a) Stretches of yielding formation.

(b) Improperly aligned curves.

(c) Portions of track with poor drainage.

(d) Approaches to level crossing, girder bridges etc.

(e) Section with an inadequate or unclean ballast cushion.

No through packing is done during the raining season and slacks are only picked up in order to keep the track safe and in good running condition.

Duties of a permanent way Inspector (PWI)

The PWI is generally responsible for the following:-

(a) Maintenance and inspection of the track to ensure satisfactory and safe performance.

(b) Efficient execution of all works incidental to track maintenance, including track relaying work.

(c) Accounts and periodical verification of the stores and tools in his or her charge.

(d) Maintenance of land boundaries between stations and at important stations as may be specified by the administration.

The PWI also carries out inspection of the following facts of a track.

(a) Testing the track.

(b) Inspection of track and gauge.

(c) Level crossing inspection.

(d) Point and crossing inspection.

(e) Curve inspection.

(f) Safety of track.

In addition to the inspections, a PWI also carries out following duties:-

(a) Check the proximity of trees that are likely to damage the track and get them removed.

(b) Check night patrolling at last once a month by train as well as by trolley.

(c) Takes the necessary safety measures wile executing maintenance work that affects the safety of the track.

(d) Periodically inspects and respective LWR tacks to ensure their safety.

(e) Ensures the cleanliness of station yards.

(f) Keeps proper records of the training out of ballast.

(g) Looks after all establishment work, including the welfare of the staff working under his charge and maintenance their service records.

(h) Ensures the safety of the track during the execution of work that affects the track.