---UNIT 1—

Introduction to Indian railway

Indian Railways (IR) is India's national railway system operated by the Ministry of Railways. It manages the fourth-largest railway network in the world by size, with 121,407 kilometres (75,439 mi) of total track over a 67,368-kilometre (41,861 mi) route[3]. Thirty eight percent of the routes are electrified with 25 KV AC electric traction while thirty-three percent of them are double or multi-tracked [3][4].IR runs more than 13,000 passenger trains daily, on both long-distance and suburban routes, from 7,349 stations across India[3]. The trains have a five-digit numbering system. Mail or express trains, the most common types, run at an average speed of 50.6 kilometres per hour (31.4 mph).[5] In the freight segment, IR runs more than 9,200 trains daily. The average speed of freight trains is around 24 kilometres per hour (15 mph).[6]

As of March 2017, IR's rolling stock consisted of 277,987 freight wagons, 70,937 passenger coaches and 11,452 locomotives[3]. IR owns locomotive and coach-production facilities at several locations in India.

The Indian railway came into existence in the period of Lord Dalhousie , who is considered as the father of Indian Railway.

The first rail in India ran in Indian in the year of 1853 from Mumbai to Thane (32 km).

In 1856 – following 4 railway companies were established in India.

- GREAT INDIAN PENINSULAR RAILWAY
- THE EAST INDIAN RAILWAY
- THE MADRAS RAILWAY
- THE BOMBAY BORODA AND CHENNAI INDIAN RAILWAY
- THE SCINDIA RAILWAY
- THE EASTERN BENGAL RAILWAY
- THE SOUTH INDIAN RAILWAY
- THE CALCUTTA AND SOUTH EASTERN RAILWAY.

List of IR Zones

Railway Zone	Code	Zone Headquarters	Operational Statistics[4](in FY2011-12)				Railway Divisions
			Route length (km)	Number of Stations	Revenue	Passenger Carried (million)	
01. Northern Railway	NR	Delhi	6,968	1142	₹ 89,246 million(US$1.4 billion)	685	Delhi,[5] Ambala,[6] Firozpur,[7] Lucknow NR,[8]Moradabad[9]
02. North Eastern Railway	NER	Gorakhpur	3,667	537	₹ 17,667 million(US$270 million)	250	Izzatnagar,[10] Lucknow NER,[11] Varanasi[12]
03. Northeast Frontier	NFR	Guwahati	3,907	690	₹ 21,079 million(US$320	88	Alipurduar, Katihar, Rangiya, Lumding, Tinsukia[13]

List of IR Zones							
Railway Zone	Code	Zone Headquarters	Operational Statistics[4](in FY2011-12)				Railway Divisions
			Route length (km)	Number of Stations	Revenue	Passenger Carried (million)	
Railway					million)		
04. Eastern Railway	ER	Sealdah	2,414	576	₹ 37,254 million(US$570 million)	1,173	Howrah,[14] Sealdah,[15] Asansol,[16] Malda [17]
05. South Eastern Railway	SER	Howrah	2,631	353	₹ 73,721 million(US$1.1 billion)	263	Adra,[18] Chakradharpur,[19] Kharagpur,[20] Ranchi[21]
06. South Central Railway	SCR	Secunderabad	6,137	883	₹ 89,114 million(US$1.4 billion)	378	Secunderabad,[22] Hyderabad,[23]Vijayawada,[24]Guntakal,[25] Guntur,[26] Nanded[27]
07. Southern Railway	SR	Chennai	6,844	890	₹ 81,820 million(US$1.3 billion)	406	Chennai,[28] Tiruchirappalli,[29] Madurai,[30] Palakkad,[31]Salem,[32] Thiruvananthapuram[33]
08. Central Railway	CR	Mumbai	3,905	612	₹ 75,447 million(US$1.2 billion)	1,675	Mumbai,[34] Bhusawal,[35] Pune,[36] Solapur,[37] Nagpur[38]
09. Western Railway	WR	Mumbai	6,182	1046	₹ 82,167 million(US$1.3 billion)	1,654	Mumbai WR,[39] Ratlam,[40] Ahmedabad, Rajkot,[41]Bhavnagar,[42] Vadodara[43]
10. South Western Railway	SWR	Hubballi	3,177	456	₹ 26,384 million(US$400 million)	181	Hubballi,[44] Bengaluru,[45] Mysuru,[46]

List of IR Zones							
Railway Zone	Code	Zone Headquarters	Operational Statistics[4](in FY2011-12)				Railway Divisions
			Route length (km)	Number of Stations	Revenue	Passenger Carried (million)	
11. North Western Railway	NWR	Jaipur	5,459	663	₹ 36,240 million(US$560 million)	157	Jaipur,[47] Ajmer,[48] Bikaner,[49] Jodhpur [50]
12. West Central Railway	WCR	Jabalpur	2,965	372	₹ 65,135 million(US$1.0 billion)	138	Jabalpur,[51] Bhopal,[52] Kota[53]
13. North Central Railway	NCR	Allahabad	3,151	435	₹ 87,796 million(US$1.3 billion)	182	Allahabad,[54] Agra,[55] Jhansi [56]
14. South East Central Railway	SECR	Bilaspur	2,447	358	₹ 63,402 million(US$970 million)	126	Bilaspur,[57] Raipur,[58] Nagpur SEC[59]
15. East Coast Railway	ECoR	Bhubaneswar	2,572	342	₹ 87,884 million(US$1.3 billion)	86	Khurda Road,[60] Sambalpur,[61] Waltair[62]
16. East Central Railway	ECR	Hajipur	3,628	800	₹ 59,386 million(US$910 million)	222	Danapur,[63] Dhanbad,[64] Mughalsarai,[65] Samastipur,[66]Sonpur[67]
17. Metro Railway	MTP	Kolkata	130	75	₹ 348 million(US$5.3 million)[68]	183[69]	NA
18. Konkan Railway	KR	Navi Mumbai					None

UNIT 2

RAILWAY SURVEY

Introduction

In order to have a proper and satisfactory new route , the various surveys are carried out. Before the actual survey starts , the study of available maps is made. Aerial surveys maps of India are generally used for this purpose.

Classification of Surveys. The various kinds of Surveys which are carried out as a part of investigation of Railway projects are indicated below :

(i) Traffic Surveys. This is a detailed study to make a forecast of the traffic prospects to facilitate the projection of the most promising route and the category of line (cf. Para 210 and 211) to be constructed in the case of new lines and to assess the quantum of traffic to determine the traffic facilities to be provided on an existing line. These surveys are to be under-taken in conjunction with Reconnaissance or Preliminary Engineering surveys so that the Technical feasibility and costs of the alternative proposals can be taken into account while formulating the recommendations.

(ii) Reconnaissance Survey :

- (a) This term should apply to all rough and rapid investigations of an area with a view to determine the technical feasibility and approximate cost of one or more routes for a projected Railway line from a general examination with the help of contoured Survey of India maps and other available material without a more careful investigation of the field and with the use of only those instruments that will repidly give approximate distances and heights such as prismatic compass, clinometer and similar instruments.
- (b) Where suitable aerial Photographs are available, field investigations by instruments can be considerably avoided/dispensed with by Steroscopic studies of the Photographs and site inspections as may be required.

(iii) Preliminary Survey :

- (a) This consists of a detailed instrumental examination of the rout / or routes selected as a result of "Reconnaissance" in order to obtain a close estimate of the probable cost of the projected line, under this survey. However, staking out of the alignment with a theodolite is not required. Whether a line is to be built or not will usually be decided on the result of the survey considered in conjunction with Traffic survey. The Railway Board may, however, require the submission of an estimate based on Final Location Survey before sanctioning the commencement of construction.
- (b) Whether suitable aerial photographs are available, detailed instrumental examinations of the route/ routes selected as a result of "Reconnaissance Survey" could be considerably avoided dispensed with by using photogrammetric methods which involve plotting of contoured strip maps.

From aerial Photographs on 1: 10,000 scale or 5 times the scale of the available photographs for obtaining an optimum alignment.

(iv) location survey: A Final Location Survey will generally be a post investment decision investigation to prepare working details and to make accurate costing in certain cases. The principal differences between the work required in a Final Location Survey and that in a Preliminary Survey is that the alignment finally selected during a survey should be fully staked on the ground with a theodolite and/or **Electronic Distance MeasuringInstruments,** the report should be fuller and detailed plans and sections should be submitted.

Unit 3

Classification of permanent way describing its component parts

Introduction –

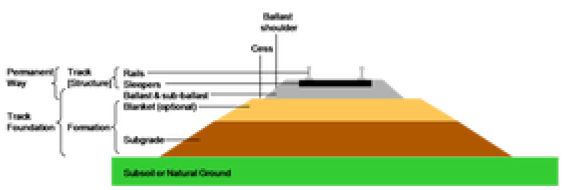
The **permanent way** is the elements of railway lines: generally the pairs of rails typically laid on the sleepers embedded in ballast, intended to carry the ordinary trains of a railway. It is described as permanent way because in the earlier days of railway construction, contractors often laid a temporary track to transport spoil and materials about the site; when this work was substantially completed, the temporary track was taken up and the permanent way installed.

The earliest tracks consisted of wooden rails on transverse wooden sleepers, which helped maintain the spacing of the rails. Various developments followed, with cast iron plates laid on top of the wooden rails and later wrought iron plates or wrought iron angle plates.

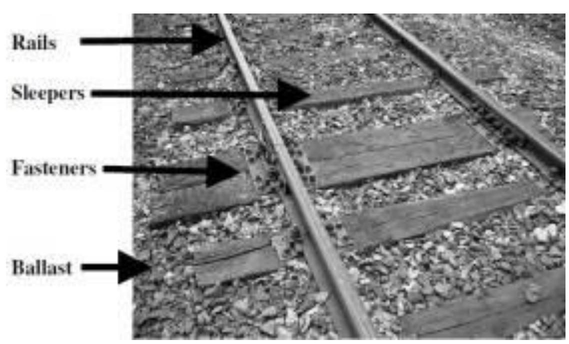
Component Parts Of Permanent Way

Railway Track is also known as Permanent Way.

-The Main Components of Permanent Way are as Follows:



- Rails
- Sleepers (or Ties)
- Fasteners
- Ballast (or Slab Track)
- Subgrade



Description of component parts of permanent way.

1- **Rails :** rail is a main part of permanent way. Rolling stocks are move on the rails. Rails are made up of steel. These are rest on sleepers. Rails are connected end to end by means of fish plate, fish bolt or by welding. There must have a uniform horizontal distance between two rails which classifies it into different categories.
2- **Sleepers :** sleepers are made up of wood, concrete or steel, which are generally used beneath the rails to transfer the live load of the rails to the ballasts.
3- **Ballast :** sand stones irregular pieces of size 40 to 80

Track Cross-section

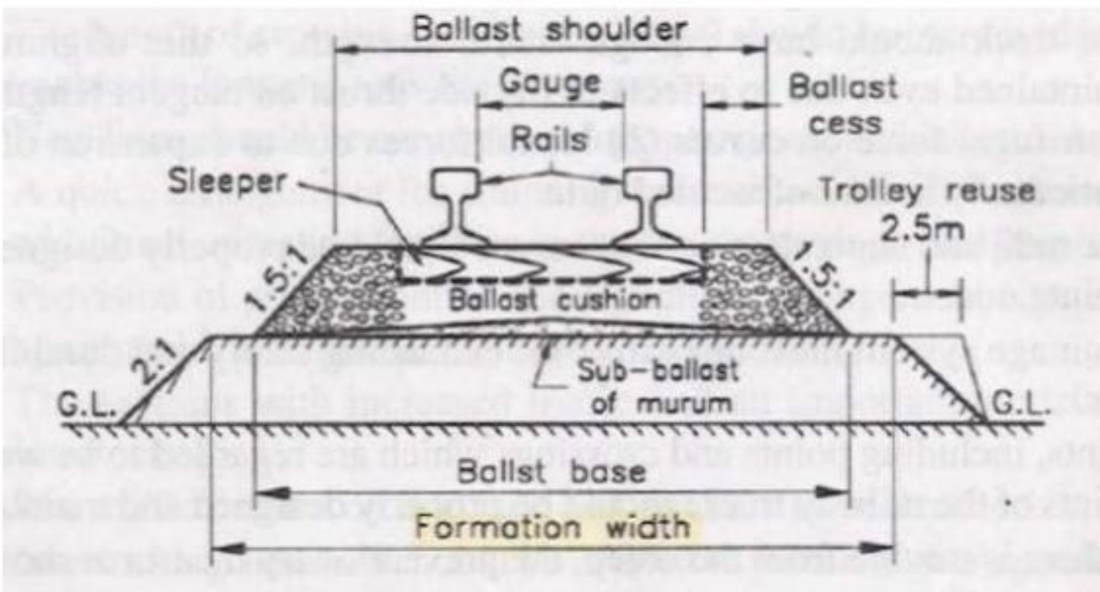


Fig. 3.1 Typical Cross-section of a Permanent Way on Embankment.

UNIT 4

RAIL GAUGE

DEFINATION-

The clear horizontal distance between the inner (running) faces of the two rails forming a track is known as Gauge. (see in fig given below)
This gauge of 1435 mm has been universally used in Great Britain, France, Germany, U.S.A., Canada and most other countries of Europe and is thus known as the world standard gauge.
In India broad gauge used which has standard size 1676 mm.

TYPES OF GAUGES PREVALENT IN INDIA

The different gauges prevalent in ***India*** are of the following these types :-

1. ***Broad gauge (1676),***
2. ***Metre gauge (1000),***
3. ***Narrow gauge (762 mm & 610 mm).***

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.

METRE GAUGE

- When the clear horizontal distance between the inner faces of twoparallel 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.

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.

UNIT 5

RAIL AND TYPES OF RAIL

Definition of Rail **rail is a main part of permanent way. Rolling stocks are move on the rails. Rails are made up of steel. These are rest on sleepers. Rails are connected end to end by means of fish plate, fish bolt or by welding. There must have a uniform horizontal distance between two rails which classifies it into different categories.**

Types of Rails

Rails can be divided in three types

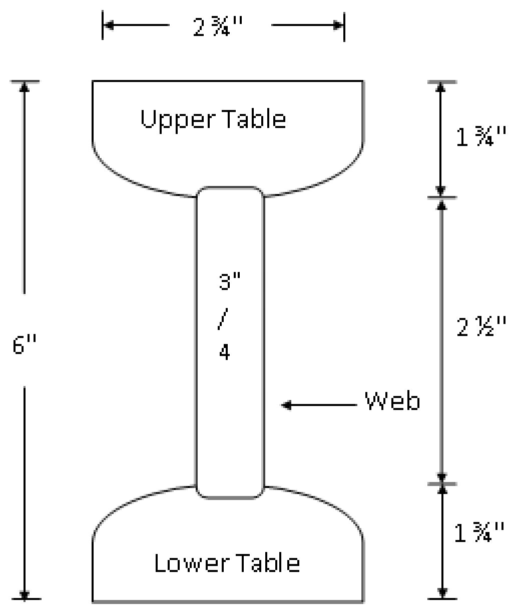
1. Double Headed Rails
2. Bull Headed Rails
3. Flat Footed Rails

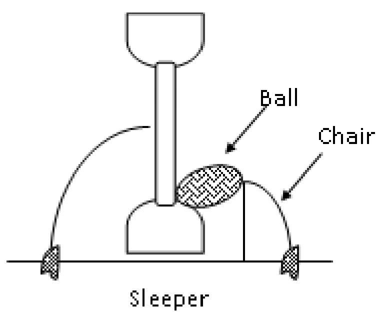
1. Double Headed Rails

These rails indicate the early stage of development. It essentially consists of three parts,

- Upper Table
- Web
- Lower Table

Both the upper and lower tables were identical and they were introduced with the hope of double doubling the life of rails. When the upper table is worn out then the rails can be placed upside down reversed on the chair and so the lower table can be brought into use. But this idea soon turned out to b wrong because due to continuous contract of lower table with the chair made the surface of lower table rough and hence the smooth running of the train was impossible. Therefore, this type of rail is practically out of use. Nowadays, these rails vary in lengths from 20 – 24. A 100 lb double headed rail is shown in the figure.



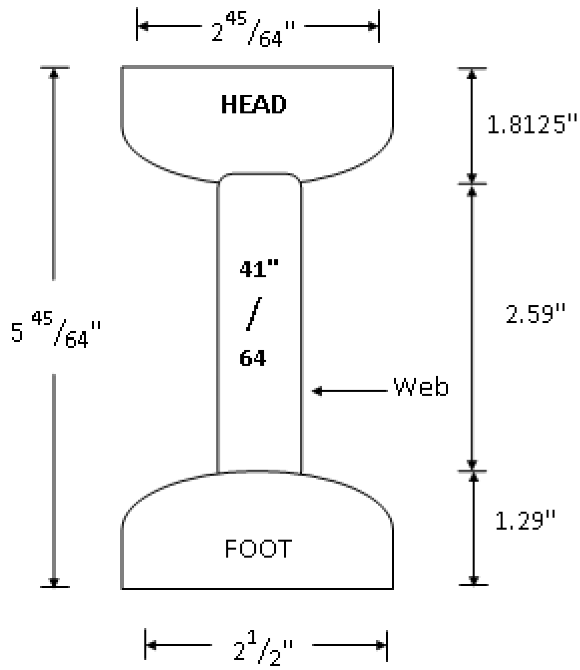


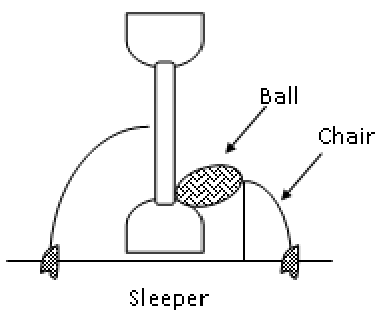
2. Bull Headed Rails

This type of rail also consists of three parts,

- The Head
- The Web
- The Foot

These rails were made of steel. The head is of larger size than foot and the foot is designed only to hold up properly the wooden keys with which rails are secured. Thus, the foot is designed only to furnish necessary strength and stiffness to rails. Two cast iron chairs are required per each sleeper when these rails are adopted. Their weight ranges from 85lb to 95lb and their length is up to 60 ft.



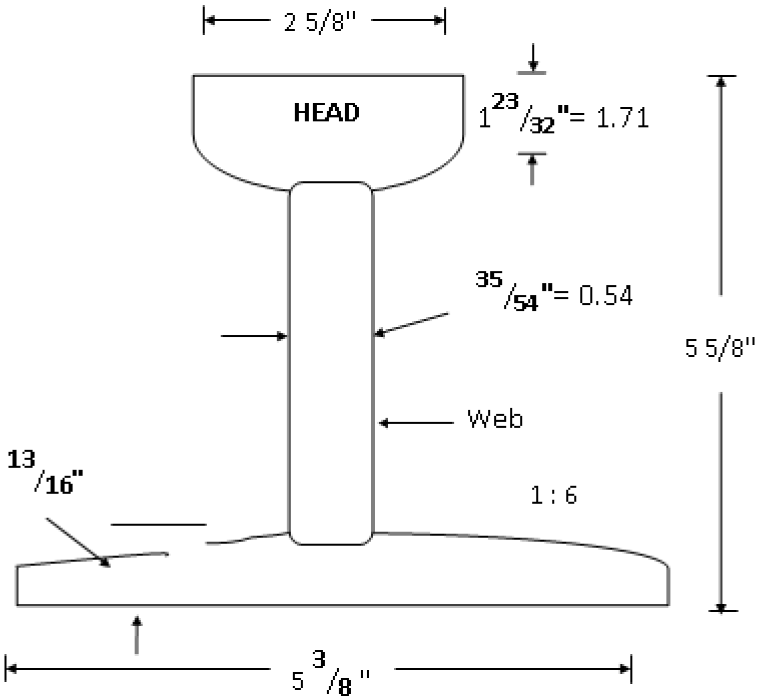


3. Flat Footed Rails

These rails were first of all invented by Charles Vignoles in 1836 and hence these rails are also called vignols rails. It consist of three parts

- The Head
- The Web
- The Foot

The foot is spread out to form a base. This form of rail has become so much popular that about 90% of railway tracks in the world are laid with this form of rails.



Flat footed rails has the following advantages

1. They do not need any chair and can be directly spiked or keyed to the sleepers. Thus they are economical.
2. They are much stiffer both vertically and laterally. The lateral stiffness is important for curves.
3. They are less liable to develop kinks and maintain a more regular top surface than bull headed rails.
4. They are cheaper than bull headed rails.
5. The loads from wheels of trains are distributed over large number of sleepers and hence larger area which results in greater track stability, longer life of rails and sleepers, reduced maintenance, costs, less rail failure and few interruptions to traffic.

Wear of Rails

The separation or cutting of rail due to friction and abnormal heavy load is called wear. There are three types of wears of rail.

1. Wear of Rails on top OR Head of Rail
2. Wear at the End of Rails
3. Wear at the side of head of Rails

Methods for Reducing Wear of Rails

The following methods are adopted for reducing wear of rails.

1. Use of Special Alloy Steel
2. Good Maintenance of Track
3. Reduction of Expansion Gap
4. Exchange of Inner and Outer Rails on Curves
5. Use of Lubricating Oil

Coning of Wheels

The rim or flanges of the wheels are never made flat but they are in the shape of a cone with a slope of about 1 to 20. This is known as coning of wheels. The coning of wheels is manly done to maintain the vehicle in the central position with respect to the track. When the vehicle is moving on leveled track then the flanges of wheels have equal circumference.

But when the vehicle is moving along a curved path then in this case the outer wheel has to cover a greater distance then that of inner wheel. Also as the vehicle has a tendency to move sideways towards the outer rail, the circumferences of the flanges of the inner wheel and this will help the outer wheel to cover a longer distance than the inner wheel. In this ways smooth riding is produced by means of coning of wheels.

Coning Wheels Disadvantages

Coning wheels has the following disadvantages:

1. In order to minimize the above below disadvantages the tilting of rails is done. i.e. the rails are not laid flat but tilted inwards by using inclined base plates sloped at 1 in 20 which is also the slope of coned surface of wheels.
2. The pressure of the horizontal component near the inner edge of the rail has a tendency to wear the rail quickly.
3. The horizontal components tend to turn the rail outwardly and hence the gauge is widened sometimes.
4. If no base plates are provided, sleepers under the outer edge of the rails are damaged.
5. In order to minimize the above mentioned disadvantages the tilting of rails is done. i.e. the rails are not laid flat but tilted inwards by using inclined base plates sloped at 1 in 20 which is also the slope of coned surface of wheels.

Advantages of Tilting of Rails

1. It maintains the gauge properly.
2. The wear at the head of rail is uniform.
3. It increases the life of sleepers and the rails

Unit 6

Rail Fastenings

Any device used to secure running rails into chairs or baseplates or directly to sleepers, bearers or other rail supports. Rail fastenings keeps rails fastened to sleepers (transfer of forces), provides a proper slope of rail foot (1:20, 1:40) in the transverse plane, prevents the rail from longitudinal movement, damps noise and vibration coming from rails.

General Requirements for Rail Fastenings

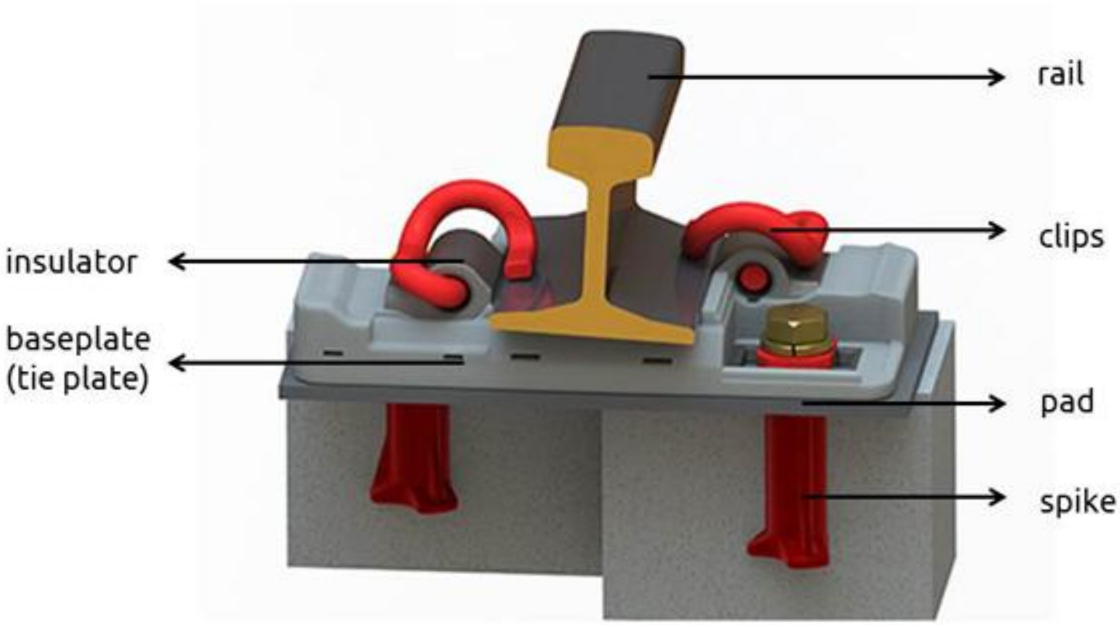
Rail fastenings shall:

1. hold rails securely in the rail seat.
2. limit the rotation of the rail about the outer edges of the rail foot.
3. minimise longitudinal movement of rails through creep and thermal forces.
4. assist in retention of track gauge.
5. not cause damage to the rail.

Where practicable, rail fastenings shall either be self-tensioning or permit tightening of the fastening to a predetermined load.

Where existing rail fastenings are not effective in minimising longitudinal movement of rails, it is permissible to fit rail anchors as a method of meeting this requirement.

Rail Fastenings Components



Clips

Clips are used to fasten the rails to the underlying baseplate.

Spike

Rail screw is a large (~6 in or 152 mm length, slightly under 1 in or 25 mm) metal screw used to fix a tie plate or fasten rail.

Tie Plate

A tie plate is also called a baseplate or sole plate. Rail tie plate is used in rail construction to support the rails. Tie plates are generally used to take the load of rail and distribute the load to the sleepers offering proven economies.

Insulator

Rail insulator is used to adjust rail gauge and insulate the rail from ties and clips.

Pad

The rail pad, originally called sole plate, is used when rail is attached to concrete, rather than timber, ties or sleepers. Rail pads function to reduce fatigue cracking of the concrete ties, believed to be driven by impact and vibration from the passing train.

The raid pad prevents rail-sleeper abrasion and the crushing of the sleeper under the rail foot. Rubber rail pads are normally designed to a specified load-deflection characteristic. The initial stiffness of the rail pad is designed to be low so that that their deformations under the springs toe loads is quite substantial. This ensures that the rail pad remains in intimate contact with the rail despite any vertical movements of the latter. When the wheel is over the pad, the latter's stiffness must be high to prevent large movements which can result in the metal spring becoming loose. Such a load-deflection characteristic can be obtained by introducing grooves in the rubber rail pads. Rubber pad or grooved rubber rail pad are made up of rubber or plastic to dampen the shocks of vibrations of a passing train.

Railway fish plate, It is also called **rail joint** or **joint bar**. As one of the rail components, rail joint's function is different from other rail components. Rail joint is a flat metal plate usually used to connect adjacent two rails by a number of rail bolts or railroad spikes. Traditionally, railway fish plate is drilled with some holes on the ends of the sections to be connected. There are some holes in the end of railway track, which are used to be lined up with the holes in the railway fish plate and jointed with rail bolt. In general, railway fish plates are made of steel, but plastics and composites are alternative raw materials for rail joint.

Typical railway fish plate types

According to different applications, rail joint can be classified into many types. Typical rail joint types include **ordinary rail joint, insulated rail joint, non-standard rail joint and compromise rail joint**.

Common rail joint

Common rail fish plate is made of the general material Q235 steel, this kind of rail fish plate can be used in various types of rail tracks. Appearance and weight of ordinary rail joint has some differences with the different weight of railway track. Main types of ordinary railway fish plate are *4hole and 6hole*.

Insulated rail joint

Unit 7

Railway Sleepers –

Definition

It is a component of permanent way laid transversely under the rails and performing the following functions.

1. To support the rails firmly and evenly
2. To maintain the gauge of the back correctly
3. To distribute the weight common on the rails over a sufficiently large areas of the ballast
4. To act as an elastic medium between the rail and the ballast and to absorb the vibrations of the trains.
5. To maintain the track at proper grads
6. To align the rail properly

Characteristics of Ideal Railway Sleepers

1. Initial cost and maintenance cost should be low
2. They should resist weathering, corrosion, decay and other deterioration
3. They should bear the wheel load efficiently and satisfactorily
4. They should maintain the correct gauge
5. They should absorb shocks or vibrations due to moving vehicles
6. It should distribute the load properly and uniformly over the ballast
7. Fastenings of rail with sleepers should be strong and simple
8. They should not break while packing of ballast
9. Weight should not be low or high

Types of Sleepers.

May 22, 2015

Depending upon the position in a railway track, railway sleepers may be classified as:

1. Longitudinal Sleepers
2. Transverse Sleepers

1. Longitudinal Sleepers

These are the early form of sleepers which are not commonly used nowadays. It consists of slabs of stones or pieces of woods placed parallel to and underneath the rails. To maintain correct gauge of the track, cross pieces are provided at regular intervals.

At present this type of sleepers are discarded mainly because of the following reasons.

- Running of the train is not smooth when this type of sleepers is used.
- Noise created by the track is considerable.
- Cost is high.

2. Transverse Sleepers

Transverse sleepers introduced in 1835 and since then they are universally used. They remove the drawbacks of longitudinal sleepers i.e. the transverse sleepers are economical, silent in operation and running of the train over these sleepers is smooth. Depending upon the material, the transverse sleepers may be classified as:

- Timber/wooden sleepers
- Steel sleepers
- Cast Iron Sleepers
- Concrete Sleepers

Timber or Wooden Sleepers

The timber sleepers nearly fulfilled all the requirements of ideal sleepers and hence they are universally used. The wood used may be like teak, sal etc or it may be coniferous like pine.

The salient features of timber/wooden sleepers with advantages and disadvantages.

Advantages of Timber Sleepers

1. They are much useful for heavy loads and high speeds
2. They have long life of 10-12 years depending upon the climate, condition, rain, intensity, nature of traffic, quality of wood etc
3. Good insulators and hence good for track circuited railway tracks
4. They are able to accommodate any gauge
5. Suitable for salty regions and coastal areas
6. Can be used with any section of rail
7. Can be handled and placed easily
8. They are not badly damaged in case of derailment
9. They are not corroded
10. Cheaper than any other types of sleepers

Disadvantages of Timber Sleepers

1. Liable to be attacked by vermin so, they must be properly treated before use
2. Liable to catch fire
3. They do not resist creep
4. They are affected by dry and wet rot
5. Become expensive day by day
6. Life is shorter compare to others

Steel sleepers

They are in the form of steel trough inverted on which rails are fixed directly by keys or nuts and bolts and used along sufficient length of tracks.

Advantages of Steel Sleepers

1. Have a useful life of 20-25 years.
2. Free from decay and are not attacked by vermins
3. Connection between rail and sleeper is stronger
4. Connection between rail and sleeper is simple
5. More attention is not required after laying

6. Having better lateral rigidity
7. Good scrap value
8. Suitable for high speeds and load
9. Easy to handle
10. Good resistance against creep

Disadvantages of Steel sleepers

1. Liable to corrosion by moisture and should not because in salty regions
2. Good insulators and hence cannot be used in track circuited regions
3. Cannot be used for all sections of rails and gauges
4. Should not be laid with any other types of ballast except store
5. Very costly
6. Can badly damaged under derailments
7. Way gauge is obtained if the keys are over driven
8. The rail seat is weaker
9. Having good shock absorber as there is not cushion between rail foot and ballast

Cast Iron Sleepers

They consist of two pots or plates with rib and connected by wrought iron tie bar of section of about 2″ ½”   each pot or plate is placed below each rail. The pot is oval in shape with larger diameter 2′-0″ and smaller diameter 1′-8″ is preferred. Plate sleepers consist of rectangular plates of size about 2′ – 10′ x 1′ – 0″.

The relative advantages and disadvantages are given below.

Advantages of Cast Iron Sleepers

1. Long life upto 50-60 years
2. High scrape value as they can be remolded
3. Can be manufactured locally
4. Provided sufficient bearing area
5. Much stronger at the rail seat
6. Prevent and check creep of rail
7. They are not attacked by vermin

Disadvantages Cast Iron Sleepers

1. They are prone to corrosion and cannot be used in salty formations and coastal areas
2. Not suitable for track circuited portions of railways
3. Can badly damage under derailment
4. Difficult to maintain the gauge as the two pots are independent
5. Require a large number of fastening materials
6. Difficult to handle and may be easily damaged
7. Lack of good shock absorber
8. They are expensive

Concrete sleepers

R.C.C and pre-stressed concrete sleepers are now replacing all other types of sleepers except to some special circumstances such as crossing bridges etc here timber sleepers are used. They were first of all used in France round about in 1914 but are common since 1950. They may be a twin block sleepers joined by an angle iron. It may be a single block pre-stressed type.

Advantages Concrete Sleeprs

1. Durable with life range from 40-50 years
2. They can be produced on large quantities locally by installing a plant
3. Heavier than all other types thus giving better lateral stability to the track
4. Good insulators and thus suitable for use in track circuited lines
5. Efficient in controlling creep
6. They are not attacked by corrosion
7. Free from attacks of vermin and decay, suitable for all types of soils
8. Most suitable for welded tracks
9. Prevent buckling more efficiently
10. Initial cost is high but proves to be economical in long run
11. Effectively and strongly hold the track to gauge
12. Inflammable and fire resistant

Disadvantages Concrete Sleepers

1. Difficult to be handled
2. Difficult to be manufactured in different sizes thus cannot be used in bridges and crossing
3. Can be damaged easily while loading and unloading

UNIT 8

BALLAST

What is Ballast

Railway Ballast is the foundation of railway track and provide just below the sleepers. The loads from the wheels of trains ultimately come on the ballast through rails and sleepers.

Functions of Ballast

Some of the important functions of railway ballast are:

1. To provide firm and level bed for the sleepers to rest on
2. To allow for maintaining correct track level without disturbing the rail road bed
3. To drain off the water quickly and to keep the sleepers in dry conditions
4. To discourage the growth of vegetation
5. To protect the surface of formation and to form an elastic bed
6. To hold the sleepers in position during the passage of trains
7. To transmit and distribute the loads from the sleepers to the formation
8. To provide lateral stability to the track as a whole

Requirements for Ideal Ballast

The ideal material for ballast should fulfill the following requirements

1. It should be possible to maintain the required depth of the material in order to distribute the load of passing train on the formation ground
2. The material to be used for ballast should not be too rigid but it should be elastic in nature
3. The material for ballast should be of such nature that it grips the sleepers in position and prevent their horizontal movement during passage of train
4. It should not allow the rain water to accumulate but should be able to drain off the water immediately without percolating
5. It should be strong enough a resistance to abrasion

Materials for Ballast

The following materials are used for ballast on the railway track.

1. Broken Stone
2. Gravel
3. Cinders / Ashes
4. Sand
5. Kankar
6. Moorum
7. Brick Ballast
8. Selected Earth

UNIT 9

CROSSING AND SIGNALLING

Crossing- A crossing or frog is a device introduced at the point where two gauge faces cross each other to permit the flanges of a railway vehicle to pass from one track to another.

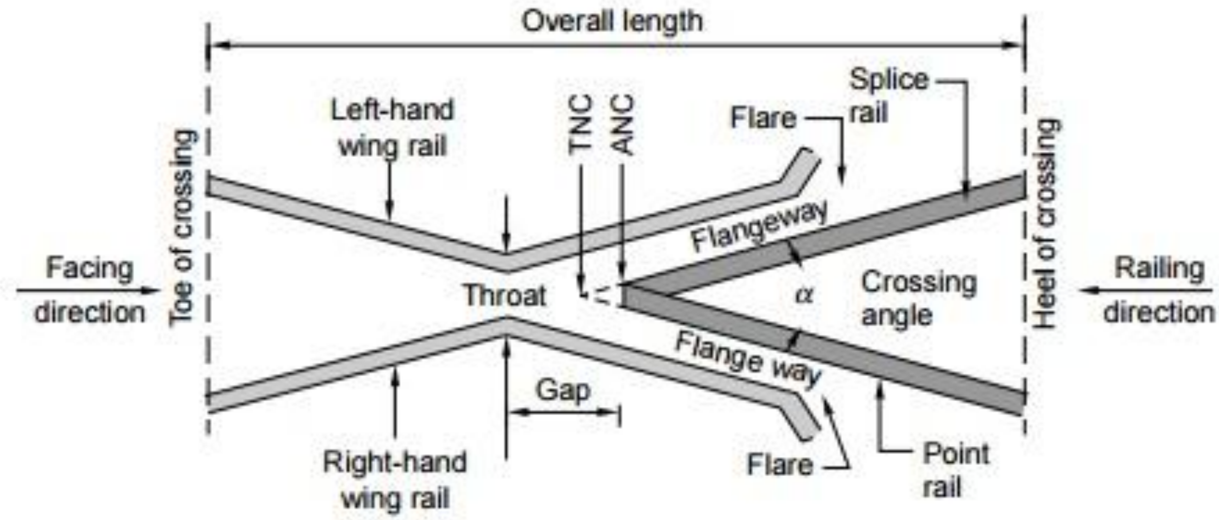


Fig. 14.5 Details of a crossing

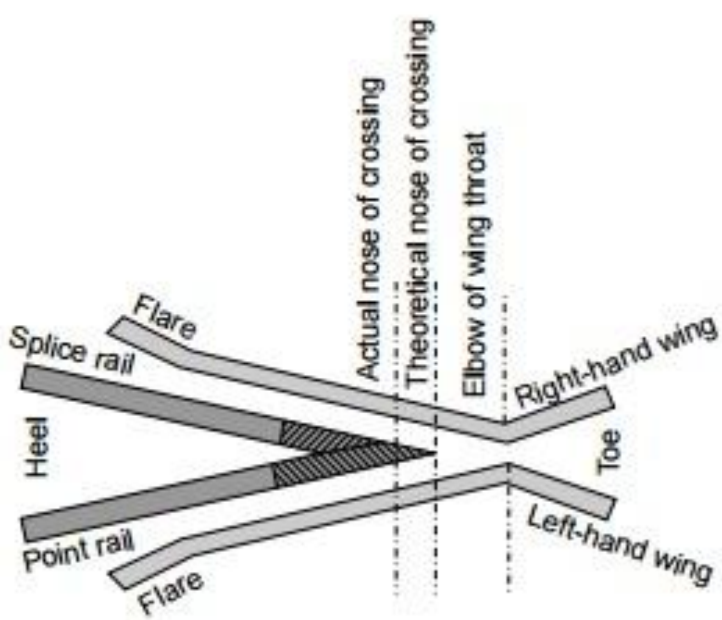


Fig. 14.6 Point rail and splice rail

TYPES OF CROSSING

1. Acute crossing
2. Obtuse crossing
3. Square crossing

Sinalling in railway :

A **signal** is a mechanical or electrical device erected beside a railway line to pass information relating to the state of the line ahead to engine drivers . The driver interprets the signal's indication and acts accordingly. Typically, a signal might inform the driver of the speed at which the train may safely proceed or it may instruct the driver to stop.

Funtions :

Signals are used to indicate one or more of the following:

- That the line ahead is clear (free of any obstruction) or blocked
- That the driver has permission to proceed
- That points (also called *switch* or *turnout* in the US) are set correctly
- Which way points are set
- The speed the train may travel
- The state of the next signal

Various Types of Fixed Signals used on railway

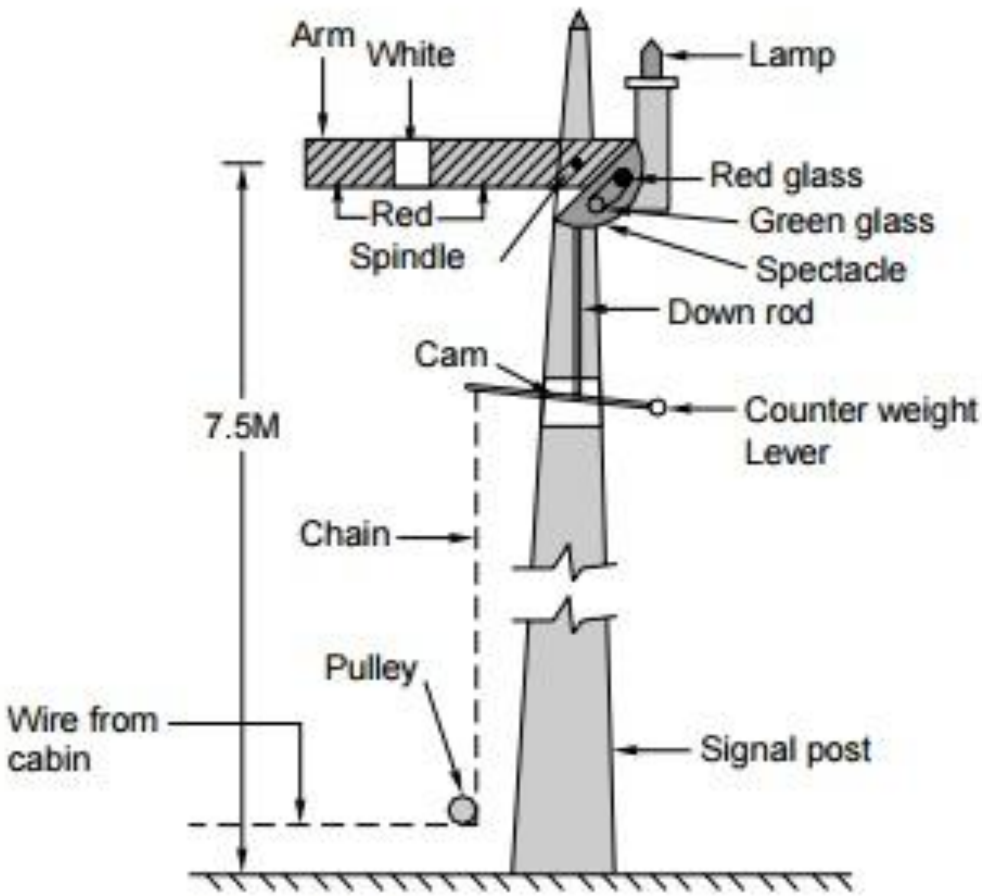


Fig. 31.2 Semaphore signal

The various types of fixed signals used on railways are as follows.

Fixed Signals

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The various types of fixed signals used on railways are as follows.

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Semaphore signals

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The word 'semaphore' was first used by a Greek historian. 'Sema' means sign and 'phor' means to bear. A semaphore signal consists of a movable arm pivoted on a vertical post through a horizontal pin as shown in Fig. 31.2.

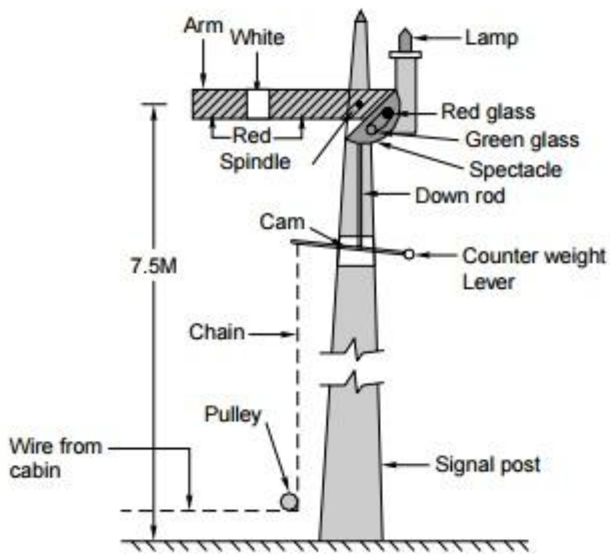

Fig. 31.2 Semaphore signal

The arm of the semaphore signal on the side facing the driver is painted red with a vertical white stripe. The other side of the signal is painted white with a black vertical stripe. The complete mechanical assembly of the signal consists of an arm, a pivot, a counterweight spring stop, etc., and is housed on top of a tubular or lattice post. In order for the signal to also be visible at night, a kerosene oil or electric lamp, operated through a twilight switch, is fixed to the post. A spectacle is also attached to the moving signal arm, which contains green and red coloured glasses. The red glass is positioned at the upper end and the green glass is positioned at the lower end of the spectacle so that the red light is visible to the driver when the arm is horizontal and the green light is visible when the arm is lowered. The semaphore signal can be used as a stop signal as well as a warner signal.

-

With reference to lower quadrant signalling, the colour aspects of a semaphore signal and their corresponding indications when the arm of the signal is in two distinct positions are shown in Fig. 31.3 and also Table 31.3.

-

Lower quadrant semaphore signals move only in the fourth quadrant of a circle and have only two colour aspects. In order to provide the drivers with further information, upper quadrant signalling is sometimes used on busy routes. In this system, the arms of the semaphore signals rest in three positions and the signals have three colour aspects, namely, red, yellow, and green associated with the horizontal, 45 o above horizontal, and vertical directions, respectively.

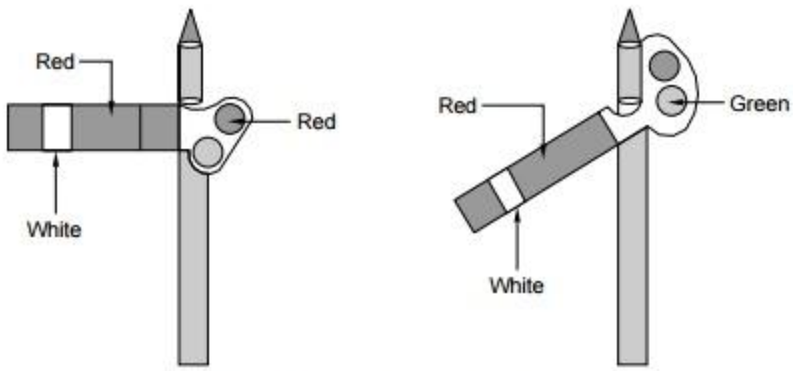

Fig. 31.3 Positions of semaphore signals

Table 31.3 Indications give by a semaphore signal

Position of signal	*Position of arm*	*Colour during night*	*Indication*
On	Horizontal	Red	Stop or danger
Off	Inclined 45° to 60° below horizontal	Green	Proceed or line is clear

The signals are designed to be fail-safe so that if there is any failure in the working of the equipment, they will always be in the stop position. These signals are operated by hand levers or buttons located in a central cabin, which is normally provided near the station master's office. Semaphore signals are normally provided as outer signals, home signals, starter signals, advanced starter signals, and warner signals.

-

Permissive signal-warner or distant signal

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In order to ensure that trains speed up safely, it is considered necessary that warning be given to drivers before they approach a stop signal. This advance warning is considered necessary, otherwise the drivers may confront a 'stop signal' when they least expect it and take abrupt action, which can lead to perilous situations. A warner or distant signal has, therefore, been developed, which is to be used ahead of a stop signal and is in the form of a permissive signal that can be passed even in most restricted conditions. In the case of a stop signal, the driver has to stop the train when it is in the 'on' position, but in the case of a permissive signal, the driver can pass through even when it is in the 'on' position. The most restrictive aspect of a permissive or warner signal is that the driver is not supposed to stop at the signal even when it is in the 'on' position.

-

The warner signal is similar to a stop signal except that the movable arm is given the shape of fish tail by providing a V-shaped notch at the free end; the white strip is also V-shaped.

In the case of signalling using coloured light, the permissive signal is distinguished from the stop signal by the provision of a P marker disc on the signal post.

-

The warner signal is intended to warn the driver of a train regarding the following aspects as explained in Table 31.4.

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(a) That the driver is approaching a stop signal.

-

(b) To inform the diver as to whether the approach signal is in an 'on' or 'off' position.

-

Table 31.4 Position of warner arm or distant signal

Table 31.4 Position of warner arm or distant signal

Position	*Day indication for semaphore signal*	*Night indication for semaphore signal**	*Aspect*
On	Arm horizontal	Red light	Proceed with caution and be prepared to stop at the next stop
Caution	Arm inclined 45° in the upward direction	Yellow light	Proceed cautiously so as to pass the next stop signal at a restricted speed
Off	Arm inclined 90° is the upward or 45° is the downward direction	Green light	Proceed at full permissible speed, next stop signal is also green

* Also day and night indication for a coloured light signal.

* Also day and night indication for a coloured light signal.

-

The warner signal can be placed at either one of the following locations.

-

(a) Independently on a post with a fixed green light 1.5 m to 2 m above it for night indication.

-

(b) On the same post below the outer signal or the home signal.

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In case a warner is fixed below an outer signal the various positions of the outer and warner signals and their corresponding indications are given in Fig. 31.4.

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Coloured light signals

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These signals use coloured lights to indicate track conditions to the driver both during the day and the night. In order to ensure good visibility of these light signals, particularly during daytime, the light emission of an electric 12-V, 33-W lamp is passed through a combination of lenses in such a way that a parallel beam of focused light is emitted out. This light is protected by special lenses and hoods and can be distinctly seen even in the brightest sunlight. The lights are fixed on a vertical post in such a way that they are in line with the driver's eye level. The system of interlocking is so arranged that only one aspect is displayed at a time. Coloured light signals are normally used in suburban sections and sections with a high traffic density. Coloured light signals can be of the following types.

a) Two-aspect, namely, green and red

b) Three-aspect, namely, green, yellow, and red

c) Four-aspect, namely, green, yellow (twice), and red.

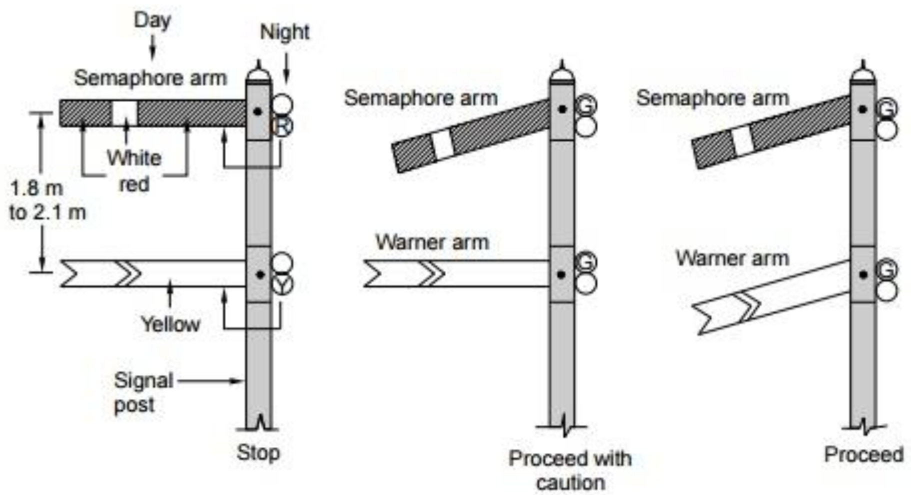

Fig. 31.4 Warner below an outer signal

In India, mostly three-aspect or four-aspect coloured light signalling is used. In the case of three-aspect signalling, green, yellow, and red lights are used. Green indicates 'proceed', yellow indicates 'proceed with caution', and red indicates 'stop' (Fig. 31.5).

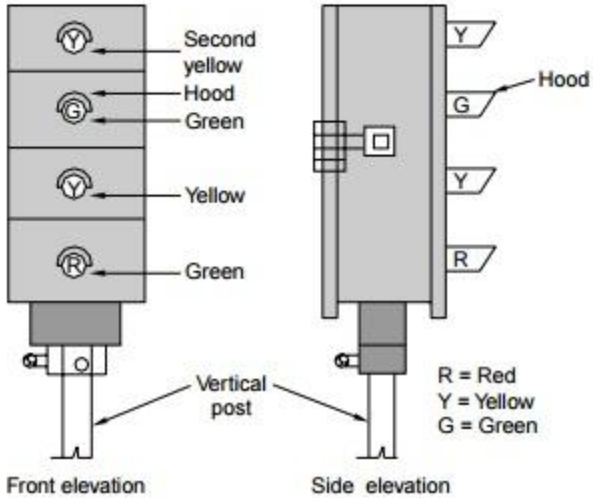

Fig. 31.5 Coloured light signals

In the case of four-aspect coloured light signalling, the interpretation of the colours are given in Table 31.5.

Table 31.5 Indications of coloured light signals

Table 31.5 Indications of coloured light signals

Colour of signal	*Interpretation*
Red	Stop dead, danger ahead
Yellow	Pass the signal cautiously and be prepared to stop at the next signal
Two yellow lights displayed together	Pass the signal at full speed but be prepared to pass the next signal, which is likely to be yellow, at a cautious speed
Green	Pass the signal at full speed, next signal is also off

In conventional semaphore signals, the 'on' position is the normal position of the signal and the signals are lowered to the 'off' position only when a train is due. In the case of coloured light signals placed in territories with automatic signalling, the signal is always green or in the 'proceed' position. As soon as a train enters a section, the signal changes to 'Red' or the 'stop' position, which is controlled automatically by the passage of the train itself. As the train passes through the block section, the signal turns yellow to instruct the driver to 'proceed with caution' and, finally, when the train moves onto the next block section, the signal turns green indicating to the driver to 'proceed at full permissible speed'.

-

Thus it can be seen that each aspect of the signal gives two pieces of information to the driver. The first is about the signal itself and the second is about the condition of the track ahead or of the next signal. This helps the driver to manoeuvre the train safely and with confidence even at the maximum permissible speed.

-

Calling-on signal

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This consists of a small arm fixed on a home signal post below the main semaphore arm (Fig. 31.6). When the main home signal is in the horizontal (on) position and the calling-on signal is in on inclined (off) position, it indicates that the train is permitted to proceed cautiously on the line till it comes across the next stop signal. Thus the calling-on signal is meant to 'call' the train, which is waiting beyond the home signal.

-

The calling-on signal is useful when the main signal fails, and in order to receive a train, an authority letter has to be sent to the driver of the waiting train to instruct him/her to proceed to the station against what is indicated by the signal. In big stations and yards, the stop signals may be situated far off from the cabin and the calling-on signal expedites the quick reception of the train even the when signal is defective.

-

Co-acting signal

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In case a signal is not visible to the driver due to the presence of some obstruction such as an overbridge or a high structure, another signal is used in its place, preferably on the same post. This signal, known as the co-acting signal, is an exact replica of the original signal and works in unison with it.

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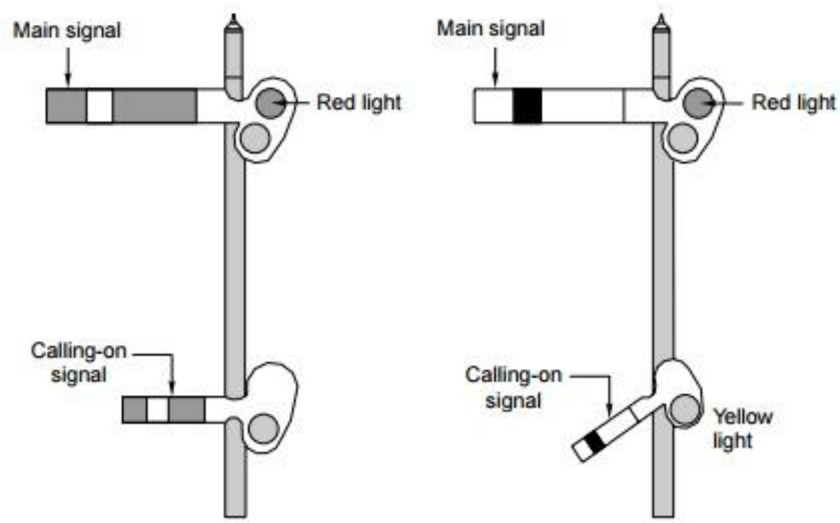

Fig. 31.6 Calling-on signal

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Repeater signal

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In cases where a signal is not visible to the driver from an adequate distance due to sharp curvature or any other reason or where the signal is not visible to the guard of the train from his position at the rear end of a platform, a repeater signal is provided at a suitable position at the rear of the main signal. A repeater signal is provided with an R marker and can be of the following types.

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(a) A square-ended semaphore arm with a yellow background and a black vertical band.

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(b) A coloured light repeater signal.

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(c) A rotary or disc banner type signal.

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The 'off' positions of these three types of repeater signals are depicted in Fig. 31.7.

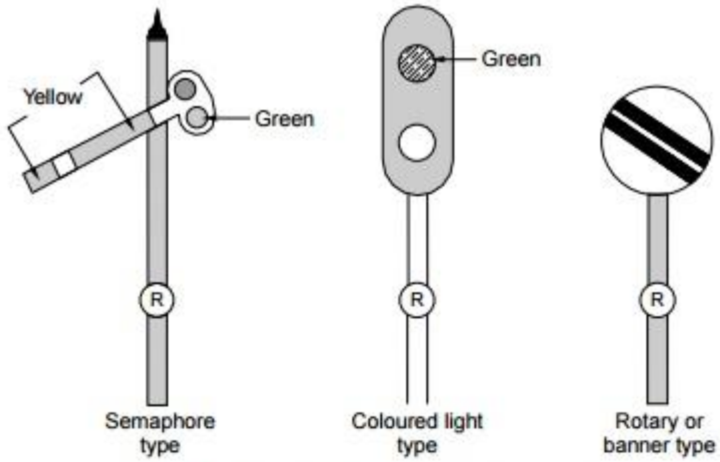

Fig. 31.7 Different Types of repeater signals

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