

RAILWAYS

CHAP-1 INTRODUCTION

Advantages of Railway

- Railways are an important source of employment in India.
- It provides greater employment opportunities for both skilled and unskilled labour.
- It is a cheaper mode of transport as compared to other modes of transport.
- It provides a comfortable and safe means of transportation.
- It is the fastest way of transportation.
- It covers large distance at high speed.
- Railways carry people and goods over long distances quickly and cheaply.
- The chances of accidents and breakdowns of railways are minimum as compared to other modes of transport.
- It has an efficient system of rail traffic, signalling and communication system.

→ It helps in the industrialization process of a country by easy transportation of coal and raw materials at a cheaper rate.

→ Uniform rates

→ Least pollution.

→ The carrying capacity of the railway is extremely large. Moreover, its capacity is elastic which can easily be increased by adding more wagons.

Classification of Indian Railway

The railway board has classified the railway lines in India based on the importance of the route, the traffic carried and the maximum permissible speed on the route.

(1) Broad Gauge

(2) Metro Gauge

(i) Broad Gauge :- All the B.G routes of Indian railways have been classified into 5 different groups based on speed.

(a) Group A lines :- These lines are meant for sanctioned speed of 160 kmph.

(b) Group B lines:- Under this group these routes have been classified on which the maximum permissible speed is 130 kmph allowed.

(c) Group C lines:- These lines for suburban sections of Bombay, Kolkata and Delhi.

(d) Group D lines:- All routes where the maximum sanctioned speed is 100 kmph comes under this group.

(e) Group E lines:- The branch lines where maximum speed is less than 100 kmph.

(2) Metro Gauge:- Based on routes it is classified into 3 main groups:
(i) Trunk route
(ii) Main line
(iii) Branch line



PERMANENT WAY

The track on a railway or railroad also known as the permanent way.

→ It is the combination of rails, sleepers, ballast, fixturers, fasteners, plus the under lying subgrade.

→ The purpose of a permanent way is to provide the permanent facility for safety and quick movement of normal commercial traffic between the starting and destination stations.

→ Permanent way costs nearly 40% of the total investment to the railways.

Component of Permanent Way

The main components of permanent way are as follows:-

- (i) Subgrade
- (ii) Ballast
- (iii) Sleepers
- (iv) Rails
- (v) Fixturers & Fasteners

In a permanent way, rails are joined either by welding or by using fishplates and are fixed with sleepers by using different types of fasteners.

→ Sleepers are properly placed and packed with ballast.

→ Ballast is placed on the prepared subgrade called formation.

Gauge

The distance between two rails of track is known as gauge.

→ The gauge of the railway track is a clear minimum vertical distance between the inner sides of two tracks is called railway gauge.

There are two types of gauges are mainly used in India:

① Broad gauge

→ It is also called wide gauge or large line.

→ It is mainly used in main cities and routes.

→ The distance between the two tracks in these gauges is 1676 mm.

→ This gives better stability and they are even better than thinner gauges.

② Metre Gauge

→ It is mainly used in underdeveloped and interior areas.

→ The distance between the two tracks is 1,000 mm.

→ The metre gauge lines were made of reduce the cost.

CHAP-3 TRACK MATERIALS

Rails

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.

Functions of Rails

→ To provide continuous and level surface for movement of train.

→ To provide a smooth pathway so that friction between rail and wheel become less.

→ Serve as a lateral guide for the running of wheels.

→ Transferring the load into the sleeper.

→ To bear the stresses developed in the track due to temperature changes and loading patterns.

→ To resist breaking forces caused

due to stoppage of trains

Requirement of Rails

- The section of the rail should be such that the load of each wheel is transferred to the sleepers without exceeding the permissible stresses.
- The section of the rail should be able to withstand the lateral forces caused due to fast moving trains.
- The web of the rail section should be such that it can safely bear the vertical load without buckling.
- The head of the rail should be sufficiently thick for adequate margin of vertical wear.
- The section of the rails should be such that the ends of two adjacent rails can be efficiently jointed with a pair of fishplates.
- The foot of the rail should be wide enough so that the rail is stable against overturning.

Types of Rail Section

The rails used in the construction of railway track are of following type :-

- ① Double headed rails
- ② Bull headed rails
- ③ Flat footed rails

① Double headed Rails :- Both the upper and lower tables were identical and they were interlocked with the hope of doubling the life of rails.

② Bull headed Rails :- 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.

③ Flat footed Rails :- These rails were first of all invented by Charles Vignole in 1836 and hence these rails are also called Vignole rails.

→ The rail section having their foot rolled to flat are called flat footed rails.

→ They don't need any chain and can be directly spiked or keyed to the sleepers.

→ Thus they are economical.

Rail Joints

Rail joints are necessary to hold together the adjoining ends of the rails in the correct position.

→ It forms the weakest part of the track.

Types of Rail Joint

According to position of joints rail joints are classified into 2 categories such as:

① Square Joints:- When a joint in one rail is exactly opposite to the joint in the parallel rail it is called as square joint.

→ It is very common type of joint in straight track and most preferred.

② Staggered Joints:- When a joint in one rail is exactly opposite to the center of the parallel rail length it is called as staggered

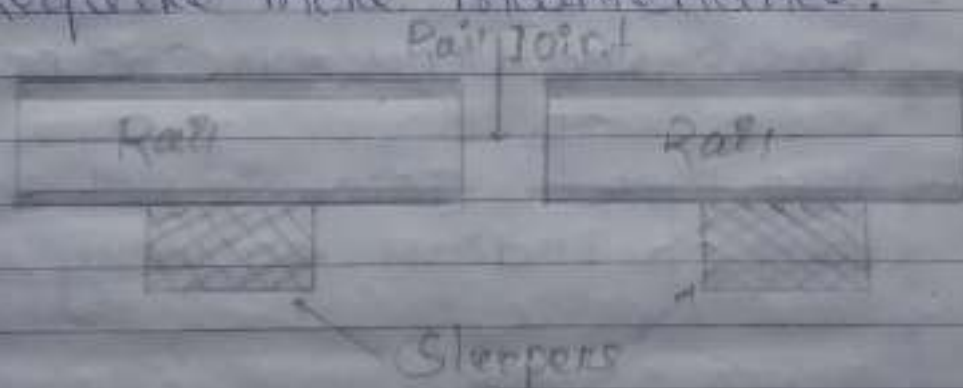
Joints.

According to position of sleepers:-

① Suspended Joints

The rail joint, when placed at the center of two consecutive sleepers is known as suspended joint.

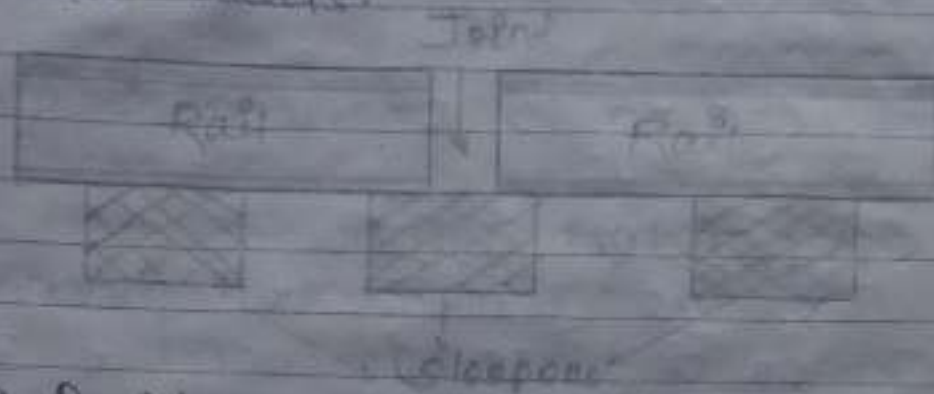
- Load is equally distributed on sleepers.
- More commonly adopted.
- Provide greater elasticity to the track.
- Require more maintenance.



② Supported Joints:- Sleeper is placed exactly below the joint.

- It appears like rails are supported weakest part.
- These are not used at present.
- Supported joint did not give sufficient support to the heavy

axle loads.

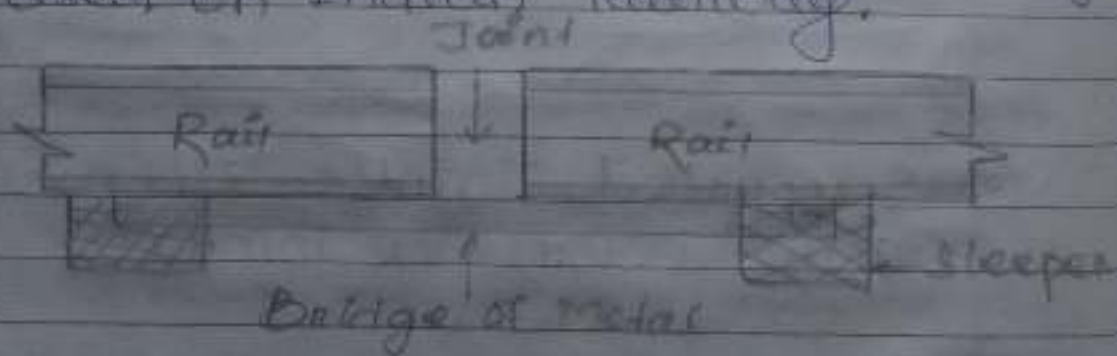


③ Bridge Joints :- It is similar to suspended joint.

→ Difference is here, a sufficient length of metal is used to connect the ends of two rails, so that there is no bending stress in the rails.

→ Bridge is placed at bottom of rails and rests on sleepers.

→ This type of joint is not commonly used on Indian railway.



Requirement of an Ideal Joints
An ideal or perfect rail joint is one which provides the same strength and stiffness as the other rail section of the track.

The following requirements should be met by an ideal joint:

→ The two rail ends should remain true in line both laterally and vertically when trains move on the track.

→ This is necessary to avoid wheel jumping or changing its correct path of movement.

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

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

→ A good joint should be easily disconnectable so that it can be easily taken out without disturbing the whole track for the purposes of changing rails on a fishplate, and lubricating the contact faces.

→ The joint should fulfil the above requirements with the minimum of

initial and maintenance cost (i.e., it should be economical).

Purpose of Welding of Rails
Welding of rails is done for the following purposes:-

- Welding is done to increase the rail length by joining two or more rails.
- It reduces the number of joints and requirements of fishplates and thereby increases the strength joint and makes the track economical.
- It is done to prepare the damaged rails and thus increase their life.
- The welding process is used to bridge the bent portion of rail head.

Advantages of Welding of Rails
Following are the advantages of welding of rails:-

- It satisfies the condition of the perfect joint and thus increases the life of the rail and reduces

maintenance cost.

- It reduces the amount of creep.
- It minimizes the wear of rails at joints.
- By eliminating joints, it provides a good riding quality.
- The cost of track construction by welding of rails decreases due to less the number of rail joints.
- The welded rail offers more lateral longitudinal and vertical stability to the track.

Creep

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

- It is common to all railway tracks.
- Its value changes from 0 to 150 mm per month.

Causes of Creep in rail

Following are some causes of

Creep :-

- Rails not properly fixed to sleepers.

- Bad drainage of ballast.
- Bad quality of sleepers used.
- Improper consolidation of formation bed.
- Gauge fixed too tight or too slack.
- Rails fixed too high to carry the traffic.
- Incorrect adjustment of super-elevation on outer rails at curves.
- Incorrect allowance for rails expansion.
- Rail joints maintained in bad condition.

Prevention of Creep

Following are some prevention of creep in rails:-

- Use of steel sleepers on a track to minimize creep.
- Use higher melting point metals

→ To use materials with greater grain size and less alloying.

Sleepers

Railway sleepers also called railroad ties, railway ties or cross ties are important railway component.

→ The rail sleeper is always lying between two railheads to keep the correct space of gauge.

→ The sleeper supports two rails to form the railway.

→ These sleepers generally rests on ballast.

→ The load from rails when train passed, is taken by these sleepers and is distributed it to the ballast.

Functions of sleepers

Following are the basic functions of railway sleepers:-

→ It hold the rails strongly and maintain uniform gauge.

→ Transfer the load from rails to

-the ballast or ground.

→ Reduce the vibrations coming from rails.

→ Provide strength, durability, longitudinal and lateral stability to the track.

Requirements of Sleepers

Following are the requirements of an Ideal Sleeper :-

→ It should be economical.

→ The fittings of the sleepers should be such that they can be easily adjusted during maintenance.

→ They should have long life.

→ They should be quite durable.

→ They should not be too heavy or light in weight.

→ They should be able to maintain the correct gauge.

→ They should facilitate easy removal and replacement of ballast.

→ They should be capable of resisting shocks and vibrations due to heavy moving loads.

Classification of Sleepers

Based on material used, railway sleepers are classified into following types:-

(i) Wooden Sleepers

These sleepers are made of wood. Either hardwood or softwood can be used to make wooden sleepers.

→ Advantages of Wooden Sleepers

→ Wood sleepers are cheaper than others and easy to manufacture.

→ They are light in weight so, they can be easily transported and handle without damage.

→ Fasteners can be easily installed to wooden sleepers.

→ They are good insulators (sb), rails are well protected.

→ Any type of gauge can be maintained by wooden sleepers.

→ They are suitable for all types of rail section.

→ They are well suitable for tracks in coastal areas.

Disadvantages of wooden sleepers

→ Life of wooden sleepers is very less compared to others (12 to 15 years).

→ They are susceptible to fire.

→ They are easily liable to attack by vermin and weather.

→ Provide poor creep resistance.

→ Good attention is required even after laying.

(a) Concrete Sleepers

Concrete sleepers are manufactured by concrete with internal mesh reinforcement.

→ It is used in many countries due to its high stability and small maintenance.

→ These are more suitable for high speed rails.

Advantages of concrete sleepers

→ Concrete sleepers are heavier than all other types hence, gives good stability and more strength to the track.

→ They have long lifespan probably 40-50 years so, economically preferable.

→ They have good fire resistance.

→ Corrosion is not occurred in concrete sleepers.

→ Breeking strength is more.

→ Concrete sleepers holds the track strongly and maintains gauge.

→ Vermin attack, decay etc. are not occurred.

→ Hence, they are suitable for all types of soil and moisture conditions.

Disadvantages of concrete sleepers

→ Because of heavy weight, handling is difficult.

→ Damage may occur while transporting

→ They are heavily damaged at time of derailment.

→ For tracks on bridges and at crossings concrete sleepers are not suitable.

③ Steel sleepers

Steel sleepers are more often used because of stronger than wood and economical than concrete.

Advantages of Steel sleepers

→ It is more durable.

→ They are light in weight so, easy to transport, to place and to install.

→ They cannot be attacked by vermin etc.

→ Lifespan of steel sleepers is more and is about 30-35 years.

→ They are recyclable hence possess good scrap value.

→ They are good resistant against fire and creep.

→ Lesser damage during handling & transporting.

→ They are well suitable for tracks of high speeds and larger loads.

→ They hold the rail strongly and easily connect rail to the sleeper.

Disadvantages of steel sleepers

→ Steel can be affected by chemical easily.

→ It requires high maintenance.

→ These are not suitable for all type of rail sections and gauges.

→ If derailment is happened, they damaged very badly and not suitable for reusing.

→ They are not suitable for all types of ballast which is provided as bed for sleepers.

④ Cast Iron Sleepers

Cast iron sleepers are widely used in the world especially in Indian railways.

Advantages of Cast Iron Sleepers

- Cast iron sleepers can be used for long period up to 60 years.
- Easy to manufacture.
- Higher scrap value.
- They provide strong seat to the rail.
- Vermin attack is impossible in case of cast iron sleepers.
- Creep of rail can be prevented by cast iron sleepers.

Disadvantages of Cast Iron Sleepers

- proper maintenance is required.
- Cast iron is expensive in market when compared to other sleeper material. Hence it is uneconomical.
- So many fastening materials are required to fix the rail to the sleeper.
- They are damaged badly when derailment happened.

→ Cast iron sleepers can be easily damaged and corroded by salt water.

→ They are brittle in nature and can be damaged easily while handling.

→ So, transportation, placing is difficult to deal.

⑤ Composite Sleepers

Composite sleepers are modern type sleepers which are made from waste plastic and rubber.

→ Hence, it is also called as plastic sleepers.

→ They have many combined properties of all other types.

Advantages of Composite Sleepers

→ Composite sleepers are serviceable for longer spans about 50 years.

→ They are light in weight but possess great strength.

→ They have good scrap value.

→ They can be used for any type of rail section.

→ Vibrations received from rails are reduced well by these composite sleepers.

Disadvantages of composite sleepers

→ They are not much good against fire.

→ High cost for large scale production.

Ballast

The ballast is a layer of broken stones, gravel, marbles or any other granular material placed and packed below and around sleepers for distributing load from the sleepers to the formation.

→ It provides drainage as well as longitudinal and lateral stability to the track.

Function of Ballast

The ballast serves the following functions in a railway track.

→ Provides a level and hard bed for the sleepers to rest on.

- To drain off the water quickly and to keep the sleepers in dry conditions.
- To protect the surface of formation and to form an elastic bed.
- To hold the sleepers in position during the passage of trains.
- To transmit and distribute the loads from the sleepers to the formation.
- To provide lateral stability to the track as a whole.

Requirements of Ballast

The ideal materials for ballast should fulfill the following requirements:-

- It should be tough and wear resistant.
- It should be hard so it does not get crushed under the moving loads.
- It should be non-porous and should not absorb water.
- It should be durable and should not get pulverized or disintegrated under adverse weather conditions.

- It should allow for good drainage of water.
- It should be cheap and economical.

Materials for Ballast

The following materials are used for ballast on the railway track:-

- ① Broken stone
- ② Gravel
- ③ Clinders / Ashes
- ④ Sand
- ⑤ Kankar
- ⑥ Moorum
- ⑦ Breck Ballast
- ⑧ Selected Earth

Types of Ballast

The different types of ballast used on Indian Railways are described in the following:-

* Sand ballast

Sand ballast is used primarily for cast iron posts. It is also used with wooden and steel trough sleepers in areas where traffic density is very low.

* Moorum ballast

The decomposition of laterite results in the formation of moorum. It is

red, and sometimes yellow, in color.

* Coal ash or clinker

This type of ballast is normally used in yards and sidings since it is very cheap and easily available.

→ It is harmful for steel sleepers and fittings because of its corrosive action.

* Broken stone ballast

This type of ballast is used the most on Indian Railways. A good stone ballast is generally produced from hard stones such as granite, quartzite and hard trap.

* Other types of ballast

There are other types of ballast also such as the brickbat ballast, gravel ballast, kankar stone ballast and earth ballast.

→ These types of ballast are used only in special circumstances.

Subgrade and formation

Subgrade is the naturally occurring soil which is prepared to receive the ballast.

→ The prepared flat surface, which is ready to receive the ballast, sleepers,

and rails, so called -the formation.

Functions of formation

It has the following functions:

- To provide a smooth and uniform bed for laying the track.
- To bear the load transmitted to it from the moving load through the ballast.
- To facilitate drainage.
- To provide stability to the track.

POINT & CROSSINGS

(Points and crossings are provided to help transfer railway vehicles from one track to another.)

- The tracks may be parallel to diverging from, or converging with each other.

Necessity of point & crossing

- points and crossings are necessary because the wheels of railway vehicles are provided with inside

Flangers and therefore, they require this special arrangement in order to navigate their way on the rails.

→ The point ^{or switch} and crossing aid in diverting the vehicles and the crossing provide gap in the rails so as to help the flanged wheels to roll over them.

Important Terms

The following terms are often used in the design of points & crossings.

Turnout: It is an arrangement of points and crossings with lead rails by means of which the rolling stock may be diverted from one track to another.

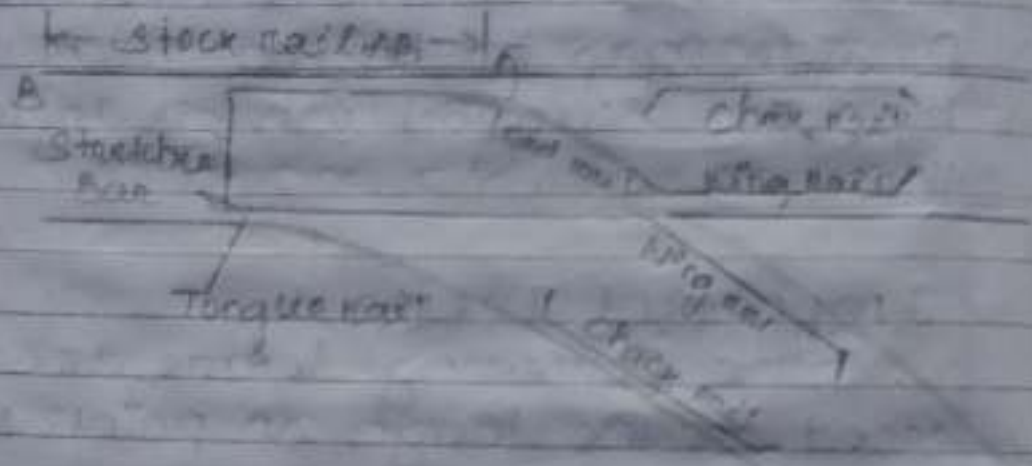
→ A turnout is designated as a right-hand or a left-hand turnout depending on whether it diverts the traffic to the right or to the left.

Tongue rail: It is a tapered movable rail, made of high-carbon or manganese steel to withstand wear.

→ At its thicker end, it is attached to a running rail.

→ A tongue rail is also called a switch rail.

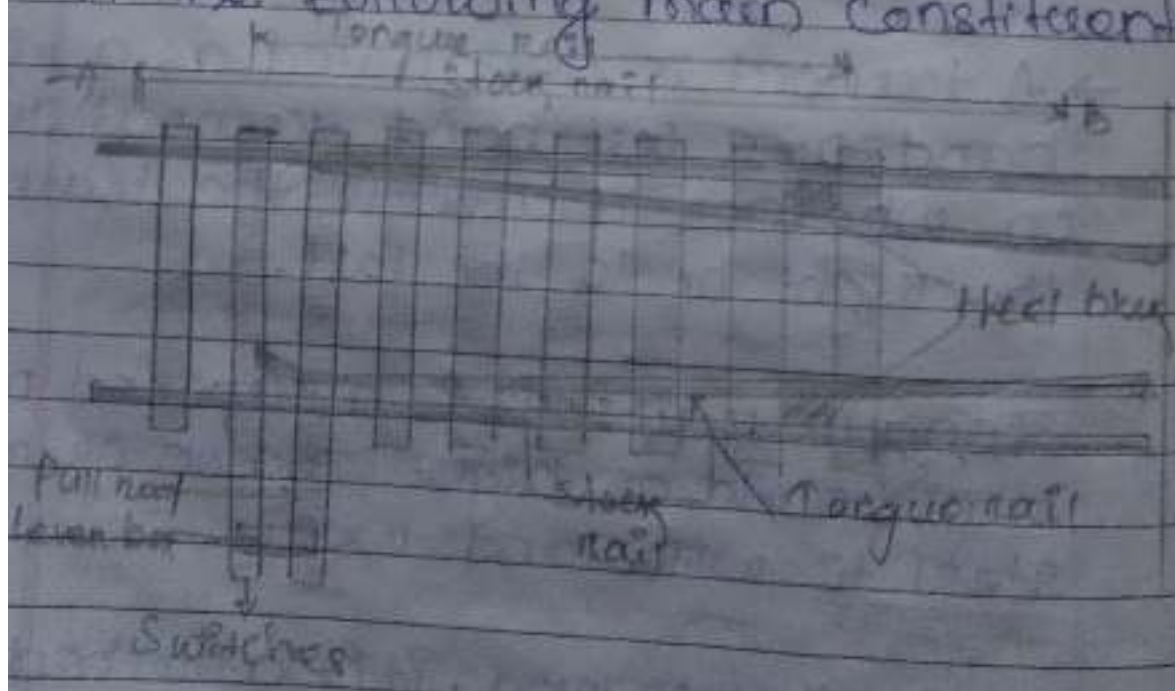
Stock rail: It is the running rail against which a tongue rail operates.



Points or switch: A pair of tongue and stock rails with the necessary connections and fittings from a switch.

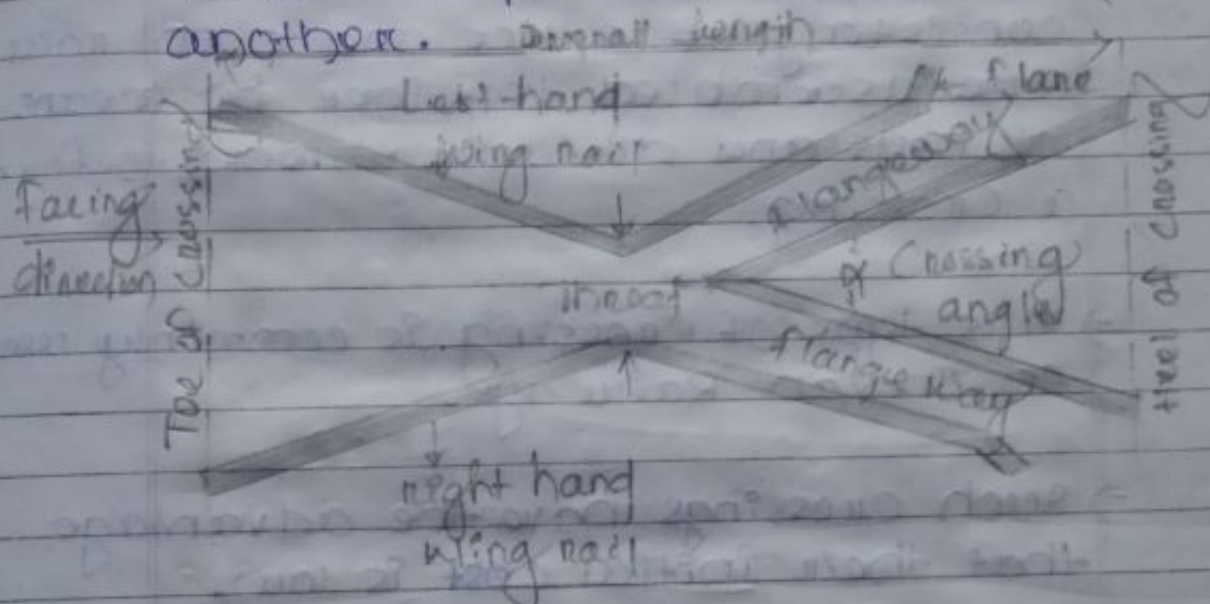
Switches

A set of points or switches consist of the following main constituents.



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.



Types of crossings

A crossing may be of the following types:

(a) An acute angle crossing or 'V' crossing in which the intersection of the two gauge faces forms an acute crossing.

(b) An obtuse or diamond crossing in which the two gauge faces meet at an obtuse angle.

(c) A square crossing in which two tracks cross at right angles. Such crossings are rarely used in actual practice.

For manufacturing purposes, crossings can also be classified as follows:

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

→ This type of crossing is commonly used on Indian Railways.

→ Such crossings have the advantage that their initial cost is low.

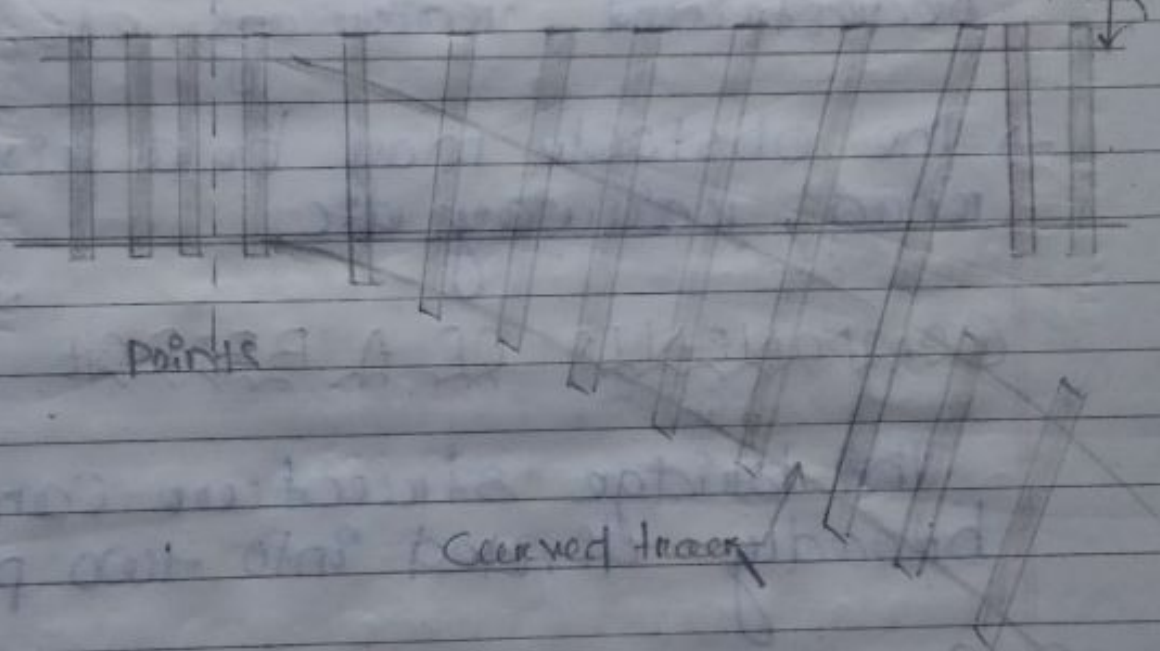
Cast steel crossing: - This is a one-piece crossing with no bolts and, therefore, requiring very little maintenance.

→ They have longer life, have also been adopted.

Combined rail and cast crossing
This 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.

Position of sleepers at points & crossings
Sleepers are normally perpendicular
to the track.

→ At points and crossings, a situation
arises where the sleepers have to
cross to the main line as well as to the
transverse portion of the track. ^{straight}
track



Sleepers for points and crossings:

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