

Railway Engineering

There are various modes of Transportation, which are major modes and minor modes.

Major modes :- Land Transport, Air Transportation, Water Transportation

Minor modes :- Elevator, pipelines, conveyor belts, Hyperloop.

- Rail transportation is a Land Transportation mode.
- Rail transportation includes trains of wagon in which wheels are made up of steel and they travel along rails which are also made up of steel.
- Hence the frictional losses during transportation comes out to be very less.
- The cost of Rail transportation is comparatively very less but it is not very flexible mode of transportation.

(I) Rails

- Rails are the steel girder (Beam) which are designed to carry the train load and further it transfers the train load to soil subgrade via sleeper and Ballast.
- The load which acts over the Rail is moving load and these rails converts the moving load into point load and transfer it to sleepers.
- During motion of the train the rails are subjected to high amount of wear and tear. Hence it should be hard enough with High Carbon Content.
- There are various methods of manufacturing of steel :-
 - ① Triplex Process
 - ② Duplex process

③ Bessemer's method ④ Open Hearth method etc.

→ In India most commonly we use Duplex process
(a) open hearth process

→ Earlier Triplex method was commonly used which consist of :-

(a) Acid Bessemer's converter

(b) Acid Openhearth ~~converter~~ furnace

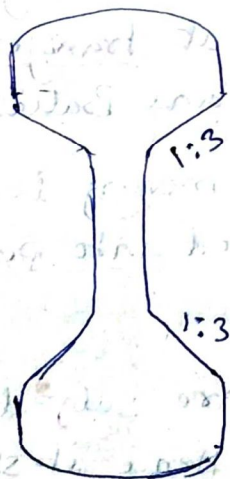
(c) Normal (or) Basic Open hearth furnace.

→ In Duplex Method, we have hot molten metal and Scrap material which is placed in Acid Bessemer's Converter

→ The final refining is done in Basic open hearth furnace.

Note:- ① Duplex method is common in today's time.
② Since Scrap is also used it proves to be economical.

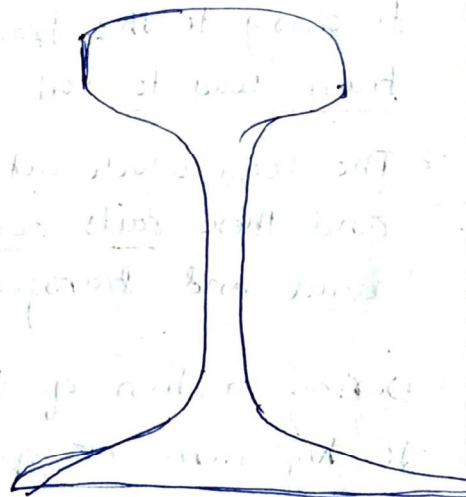
Types of Rails.



Double Headed.



Bull Headed



Flat footed.

(or)
Vignoles Rail.

(a) Double Headed Rails

- These were the early rails being used.
- The Basic Idea of developing these rails was, if the upper head of the rail gets worn out due to train movement, the rails can be inverted for further use.
- In the meanwhile, the lower part of the Rail are continuously subjected to loading action by Ballast, Hence Inundation marks can be observed which doesnot provides a smooth Riding surface.

(b) Bull Headed Rails

- It is the slight modification over double headed rails in which the upper head is made comparatively wider and thicker than lower head.

(c) Flat Footed Rails

- These are also known as Vignoles Rail and they consist of flat Bearing plate @ Bottom.
- They are Reported in terms of weight of the Rail per meter length like $\left\{ \begin{array}{l} 52 \text{ MR} = 52 \text{ kg/m} \Rightarrow V \leq 130 \text{ km/hr} \\ 60 \text{ MR} = 60 \text{ kg/m} \Rightarrow V \leq 160 \text{ km/hr} \end{array} \right.$
- As compared to other Rails, flat footed Rails are stiff, strong, easy to maintain and easy to lay.

Requirements of Rails.

- An Ideal rail should be capable enough to resist the load and accordingly dimensions are decided.
- * - The maximum permissible wear and Tear (vertical) should be 10mm (a) it should not exceed 5% of total weight of Rail.
- The maximum tensile strength should be 72 Kg/m²

- Before laying, the Rail should pass Tup test / Falling Weight Test.

{ Over a Rail of 1.5m length, a weight of 1ton (1000g) is made to fall from a height of 7.2m }

- The ratio of weight of Rail to that of locomotive (axle) should be 1: 510

$$\frac{\text{Weight of Rail}}{\text{Weight of locomotive (axle)}} = \frac{1}{510}$$

- Especially over the curved path check rails provided parallel to inner rails.
- Check rails prevents the wears and tears of outer rails and also prevents derailment.

Note :-

In case of Broad gauge (BG) and Degree of curve more than 8° and for Meters gauge (MG) with degree of curve more than 14° check rails are needed.

Length of Rails

- Generally it is desirable to provide large length of Rails as if small rails are joined to form large rails then there will be requirement of Joints.

- Joints are the weakest portion of entire Rail section and for larger length more number of joints will be required.

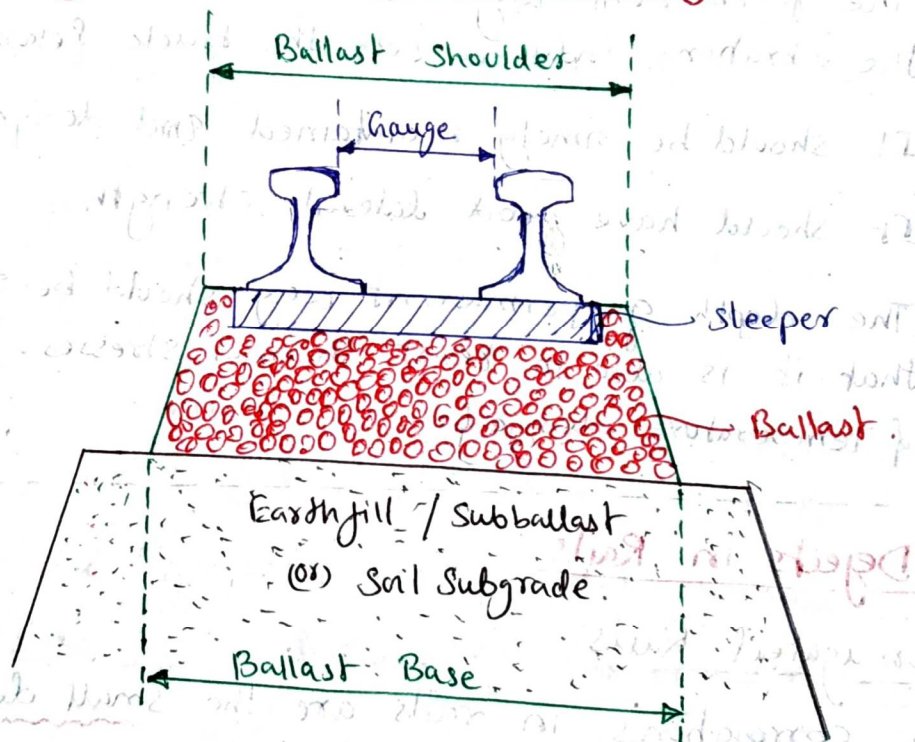
- To strengthen the joint fasteners are required, and more number of joints means more will be the requirement of fasteners which will be uneconomical.
- Hence length of the rail is restricted.
- If length is too large, it will be difficult to transport and also there will be limitation in providing spacing ~~from~~ for expansion joint.

Note :-

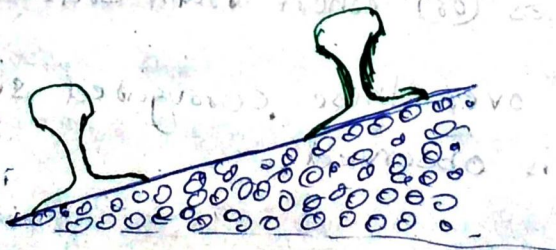
• For Broad Gauge :- $L = 12.8 \text{ m} (\approx 13 \text{ m})$

• For Meter Gauge :- $L = 11.89 \text{ m} (\approx 12 \text{ m})$

Railway Track (or) Permanent Way.



- Combination of Rails which are fixed over sleepers, which are further resting on Ballast and soil subgrade is termed as permanent way.



- on the curved path the Superelevation is maintained by ballast.
 - Rails are further joined by fish plates and it is Bolted.
 - The permanent way is observed to be Semi-elastic in nature.
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Requirement of Ideal / Good Permanent Way.

- ① There should be good drainage facility.
 - ② The gauge should be correct as per requirement and also uniform.
 - ③ The permanent way should be able to resist all the vibrations induced over the track. {elastic}
 - ④ It should be timely maintained and designed.
 - ⑤ It should have good lateral strength.
 - ⑥ The depth of permanent way should be such that it is able to resist thermal stresses. {Temperature change}
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Defects in Rails.

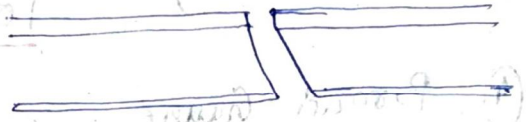
① Corrugated Rails :-

The corrugations in rails are the small depressions which are observed over the surface of the Rails.

- These defects generally arises when there are application of brakes (or) when train starts.
- When train moves over these corrugated surface, a roaring sound is observed.

② Kinks :- Whenever the rails moves slightly out of position then kinks are formed.

- These are generally formed when the joints are loose (or) gauges are non-uniform.
- Because of kink formation, Derailment may take place (or) it may lead to permanent curvature in rails.



③ Hogged Rails

If the rail gets bend down because of the continuous impact of train over the rails.



④ Buckling in Rails

- This defect arises in rails due to thermal stress induced because of temperature change.
- To allow resistance, expansion should be permitted and for that gap is provided ($\propto \Delta T$).
- In case if it is not provided because of thermal stress Buckling of rails takes place.
- Excessive tightening of Bolts in fish plate may also lead to Buckling.

Gauges in Railway Track.

- Gauge is the clear distance available on the inner face (or) running face of track rails.

Types of Gauges

- ① Narrow Gauge - 762 mm { 2 ft 6 inches }
- ② Standard Gauge - 1435 mm { 4 ft, 8.5 inches }
{ Not commonly used in India, most common in US & UK }
- ③ Metre Gauge - 1000 mm { 3 ft 3³/₈ inch }
- ④ Broad Gauge - 1676 mm { 5 ft 6 inch }

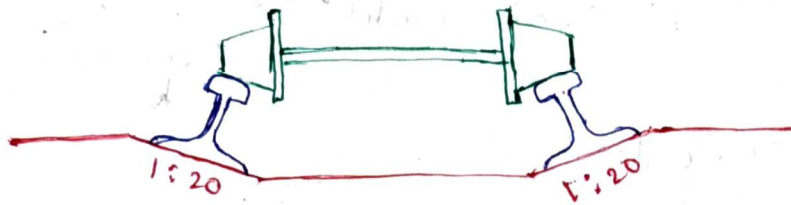
• Broad Gauge is commonly preferred -

- ① It gives higher stability against all the train operation.
- ② It gives higher speed.
- ③ It can bear higher load.
- ④ It is comparatively more Economical { cost per meter length }

Coning of Wheels

- + The wheels of the train are made @ the slope of 1:20 and this is known as Coning of wheels.
- Over a Straight path coning of wheels helps to keep the train in central position, such that distance travelled by outer wheel and inner wheel is same. { There will be no lateral movement }.
- Over Curved Path, coning of wheels also provides Resistance against impact of centrifugal force.
- For every 1° curve 0.029 m skid is permitted.

Adzing of Sleepers :- For effective use of coning of wheels, the Rails are never placed horizontal over the sleepers, they are laid at a slope of $1:20$.

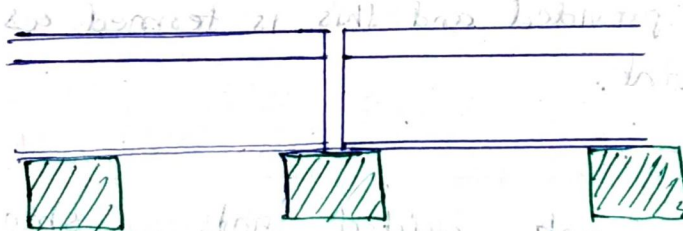


Rail Joints

Whenever, two adjoining rails are to be joined to prevent vertical and horizontal displacement of rails, Joints are provided.

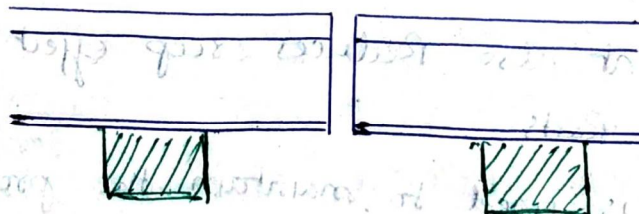
Types of Rail Joints

① Supported Rail joint When the ends of the rails are supported by single sleepers (Joint sleepers), then the joint is termed as supported Rail joint.

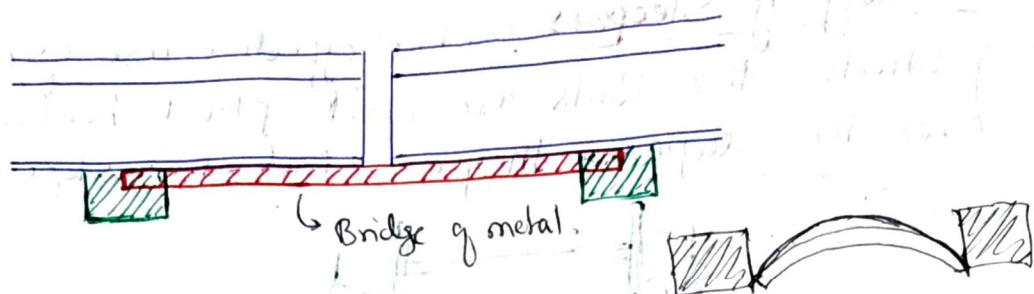


② Suspended Rail Joint

When the ends of the rails are projected beyond the sleeper (shoulder, sleeper), then the Joint is termed as suspended Rail joint.

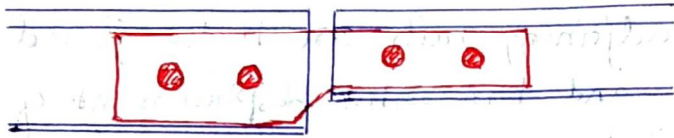


③ Bridge Rail Joint When the ends of the rail are supported over the Bridge, Bridge may be of metal plate (or) of corrugated plate.



④ Compromise Joints

When two different Rail sections are joined by using a fish plate, then joint is termed as compromise joint.



⑤ Expansion Joint

When there will be temperature change it will introduce thermal stress and Rise of temp^r will lead to expansion of Rails.

- To prevent this thermal expansion, at the end joint, gap is provided and this is termed as expansion joint.

⑥ Welded Joint

- Among all the joints, welded joints are strongest. welded joints are generally Required. :-

(a) To Increase the length of Rails by joining two or more Rails.

(b) The maintenance cost comes out to be less.

- Welded joint also Reduces creep effect and Buckling of Rails.

- Hence, it is used to maintain the proper alignment of Rails and uniform gauges.

- It also increases the life of Rails.