

# RAILWAY ENGINEERING

by

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**(EX IES)**

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# RAILS & RAIL JOINTS

## Rails :

- These are steel girders used for carrying the axle load (train load) and transfer it to the subgrade through sleeper and ballast.
- Rail convert the moving wheel load of train into point load, which acts on the sleepers.
- Since it has to resist high wear & tear, it is made of high carbon steel.
- In India, its manufacturing is done by 'open hearth/duplex process.'

## NOTE :

- Steel is manufactured by two processes :

### (i) Triplex Process :

- It has three main production facilities :
  - (a) Acid Bessemer Converter
  - (b) Basic Open Hearth Furnace
  - (c) Acidic Open Hearth Furnace
- It is outdated.
  - ↳ 1950's में बन्द हो गया था।

### (ii) Duplex Process : (or, Open Hearth Process)

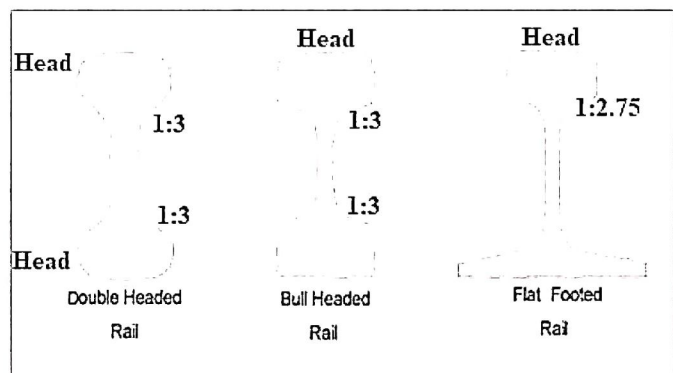
- It consists of blowing hot metal & scrap in the Acid Bessemer Converter and finally refining them in Basic Open Hearth
- Here, scrap is also utilized.
- Used in today's time



Lec-1

## Types of Rails :

- (1) Double Headed Rails (DH Rails)
- (2) Bull Headed Rails (BH Rails)
- (3) Flat Footed Rails (FF Rails)  
OR, Vignales Rails



### (1) Double Headed Rails :

- These rails were used in beginning.
- The idea behind providing two heads was, if one head will worn out, the rail can be inverted and re-used.
- But in lower part due to indentations, smooth running surface was not obtained.

### (2) Bull Headed Rails :

- In these rails, head was made a little thicker and stronger than lower part.

### (3) Flat Footed Rail / Vignole's Rail :

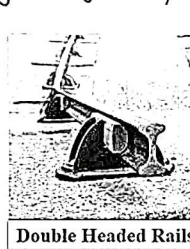
- Here, bearing plate / flat plate is used at bottom.
- These rails are designated by weight of rail per unit length

eg: 52 kg/m or 52 MR

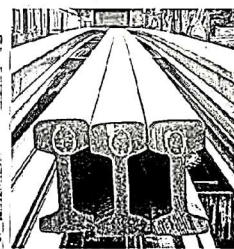
60 kg/m or 60 MR

- 52 MR :  $V \leq 130$  kmph

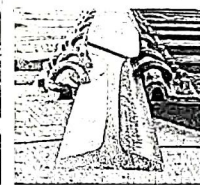
60 MR :  $V \leq 160$  kmph



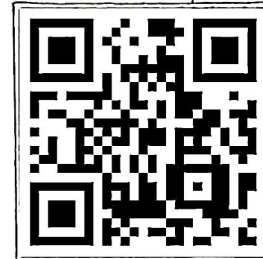
Double Headed Rails



Bull Headed Rails



Flat Footed Rails



Lec-1 (20:35)

- Flat footed rails are more stronger, stiffer, easy to lay, cheaper and easy to maintain in comparison to double head / bull headed rails.

### Requirement of Rails :

- These must be capable of withstanding the lateral forces.

(Hence, width of head and foot is increased.)

- To allow for vertical wear of 10 mm on its head.

↳ अगर 10 mm से ज्यादा wear & tear हो रही है तो उस rail को change करना पड़ेगा

- Minimum tensile strength is  $72 \text{ kg/m}^2$ .

- Must pass weight / tup test.

↳ इसमें 1.5 m की rail लेते हैं और इसके ऊपर 1000 kg (1 tonne) का weight fall कराया जाता है, 7.2 m की height से। ऐसा करने से concerned rail fail नहीं होनी चाहिए।

- Ratio of weight of rails to weight of locomotive (axle load) is 1:510.

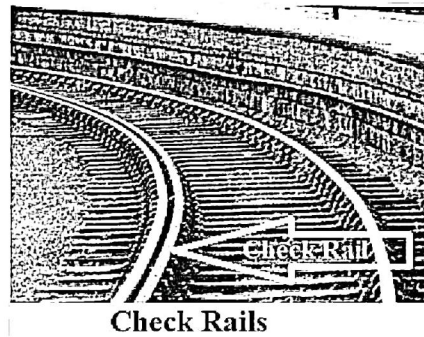
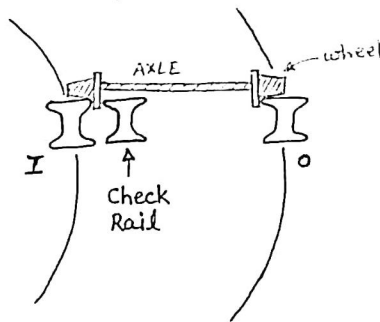
↳ rails का weight निकाला per unit length, और locomotive का weight निकाला per unit length 1:510 उन weight per unit length का ratio है।

- When wear of head exceeds 5% to total weight, it must be replaced.

- On curves, check rail parallel to inner rails is introduced to control wear & tear of outer rail and to avoid the derailment

- Check rail is used, if curve is more than  $8^\circ$  for BG and more than  $14^\circ$  for MG.

↳ जब train, circular path के around चलेगी तो इस पर centrifugal force लगेगा। इस force की वजह से train के wheel, outer rail के inner side के contact में आएँगे और outer rail के inner side की wear & tear start हो जाएगी। इसको रोकने के लिए curve की inner side पर rail लगा दी जिससे train बाहर निकल ही नहीं पाएगी। So, एक फायदा तो ये हुआ कि outer rail की wear & tear बच गई। दूसरा फायदा ये हुआ कि centrifugal force की वजह से train की derailment हो सकती थी, वो बच गई।



Lec-2

### Length of the Rails :

- Since joints are weakest points of railway track and they require fasteners also, so number of joints are required to be reduced.

- Hence, larger rails are preferred to smaller rails, as they would give strong rails and economical rails.

- Rails length is restricted by transportation limitations & due to gap required for expansion joints.

- Rail length for BG tracks is  $12.8 \text{ m} \approx 13 \text{ m}$

for MG tracks is  $11.89 \text{ m} \approx 12 \text{ m}$

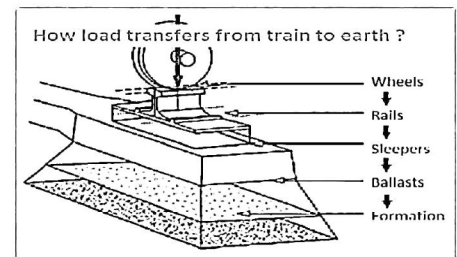
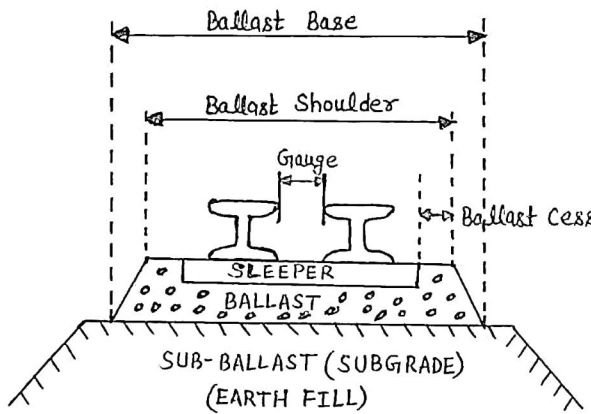
↳ Rails की बड़ी length prefer की जाती हैं, in comparison to smaller length, bcoz joints पूरे railway track में weakest point होते हैं, तो अगर rail length छोटी होगी तो number of joints ज्यादा लगेंगे जिससे पूरे track की strength कम निकल कर आएगी। Moreover, joints ज्यादा होंगे तो fasteners ज्यादा लगेंगे जिससे cost ज्यादा आएगी। इसलिए long rail prefer की जाती हैं। पर ये भी possible नहीं है कि 100 km की एक ही rail बनाकर use कर लें, due to transportation limitations. Also, long rails होंगी तो expansion joints में भी gap ज्यादा चाहिए (due to temp. deformation  $L\alpha\Delta T$ ), मतलब लम्बी rails हो गईं तो gap ज्यादा आएगा जिसमें wheel ही फंस जाएगा।  
So, length of rail is restricted. [Joint की strength  $\approx 50\%$  of rail की strength]

### Permanent Way/ Railway Track :

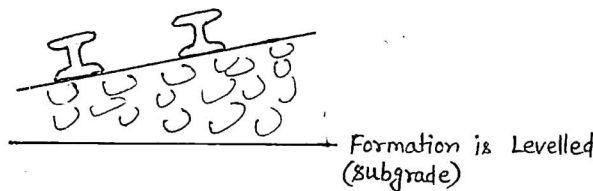
— Combination of rails, fitted on sleepers, resting on ballast & subgrade is called permanent way.



Lec-2 (12:20)



— On curve, superelevation is maintained by ballast and formation is levelled.



— On this way, rails are joined by fish plates & bolts.

— Permanent way is regarded as semi-elastic in nature.

↳ कई बार material transportation के point of view से temporary tracks भी बनाए जाते हैं, तो यहाँ ये 'permanent' word से signify करता है कि ये track हमेशा यहीं रहेगा, ये permanent है।

## Requirements of an Ideal Permanent Way :

- The gauge should be correct and uniform.
- It should be elastic to absorb the vibrations of track.
- Drainage should be perfect otherwise settlement will occur.
- It should be properly maintained and designed.
- It should have sufficient lateral strength.



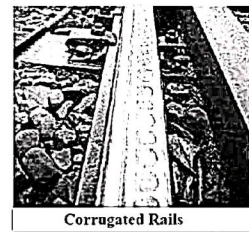
Lec-2 (18:30)

→ Uniform sleeper space, proper depth of ballast, sustain temp. stresses etc.

## # Defects in Rails :

### (1) Corrugated Rail :

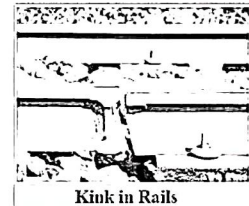
- The corrugation of rails are minute depressions on the surface of the rails.
- These are created at the place where either brakes are applied (i.e., on curves) or, where trains starts.
- When train passes over it, it makes roaring sound.



Corrugated Rails

### (2) Kink in Rails :

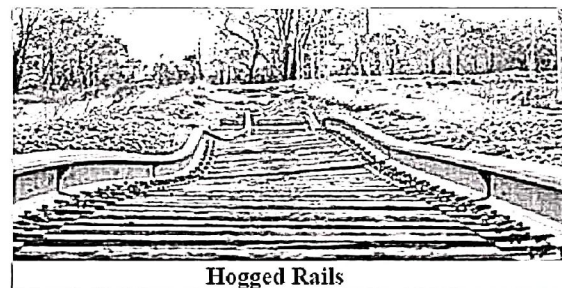
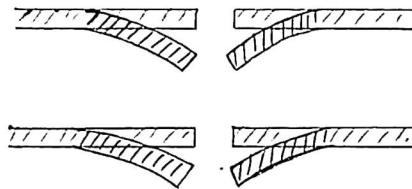
- When ends of the adjoining rails move slightly out of position, kinks are formed.
- These occur due to loose packing of joints.



Kink in Rails

### (3) Hogged Rails :

- If head of the rail gets bend down due to impact action of rail, it is termed as hogged rails.

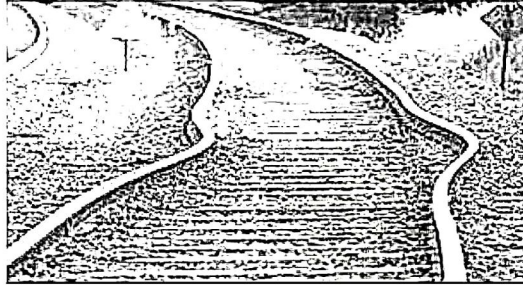


Hogged Rails

#### (4) Buckling of Rail :

- During summers, due to rise in temp., the expansion of rails occur.
- To allow this expansion, certain gap in b/w two rails is provided at the end joints.
- If gap is not sufficient or not available, the thermal expansion would cause thermal stresses, that leads to buckling.

- Buckling may also take place if fish plates are tightly bolted due to which rails are not allowed to slip.



**Buckling of Rails**



Lec-2 (32:30)

#### Gauges in Railway Track :

- It is defined as clear distance b/w inner or running faces of two tracks rails.

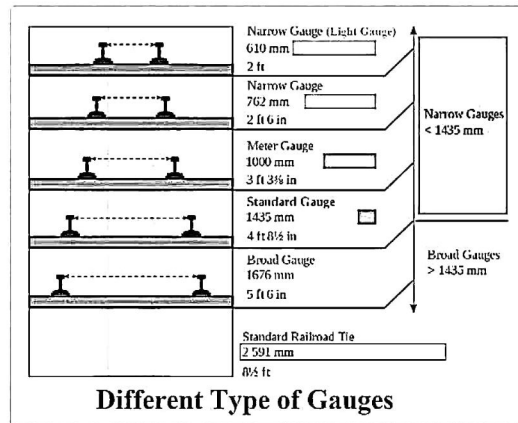
#### Different Types of Gauge :

- (1) Narrow Gauge : 762 mm (2 ft. 6 in)
- (2) Meter Gauge : 1000 mm (3 ft. 3  $\frac{3}{8}$  in)
- (3) Standard Gauge : 1435 mm (4 ft. 8  $\frac{1}{2}$  in)
- (4) Broad Gauge : 1676 mm (5 ft. 6 in)

- Standard gauge is not used in India.

- BG is preferred over MG and NG, as :

- (a) It gives more stability.
- (b) It offers higher speed.
- (c) It can take more load.
- (d) It is more economical.



**Different Type of Gauges**



BG gives more stability, means:

→ stability in train operations such as moving on crossings, switching tracks, providing joints etc. is more in BG.



Lec-3

## # Coning of Wheels :

- The wheels of the train are made at a slope of 1:20, this is known as coning of wheels.
- Coning is done on a straight track to keep the train just in central position during movement, so that distance travelled by two wheels is always same.
- Coning on curved track is also done to overcome the effect of centrifugal force.
- Here, skid permitted is 0.029m per 1° of central angle.

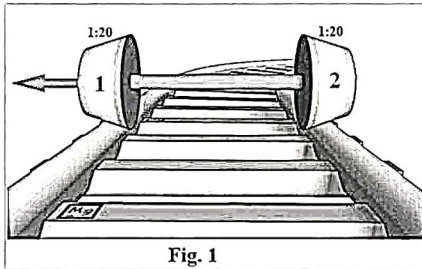
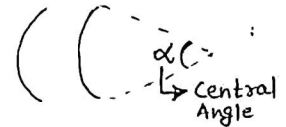


Fig. 1

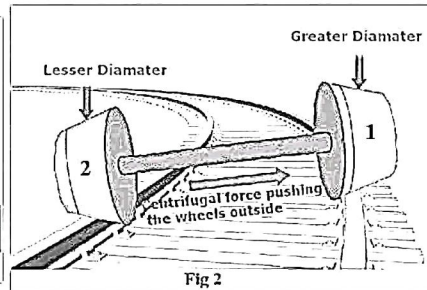
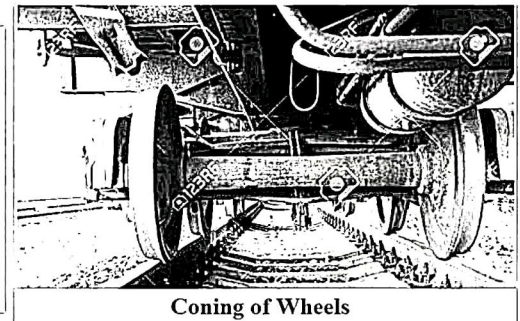
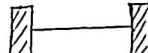


Fig. 2



Coning of Wheels

① Wheels of train are never made straight. 

② Purpose of coning on both straight track and curved track is same. Coning of wheels always keeps the train in central position. How??

Train में bogies की lateral movement इसी coning of wheels की वजह से ही मिलती है। Suppose, train की movement (lateral movement) left side में हुई (refer fig. 1) तो wheel ① का बड़ा diameter, track के contact में आया और wheel ② का छोटा diameter, track के contact में आया। अगर wheel ① का बड़ा dia, track के contact में आया तो wheel ① ज्यादा distance चलेगा, wheel ② का छोटा dia, track के contact में आया तो wheel ② कम distance चलेगा। ऐसा practically possible नहीं है कि एक wheel कम distance चले और दूसरा wheel ज्यादा distance चले। जैसे ही wheel ① ज्यादा distance

चलता है तो wheel ② उसको अपनी तरफ pull करता है जिससे कि दोनों wheel की चली हुई distance same आए। ये तो बात हुई straight track पर।

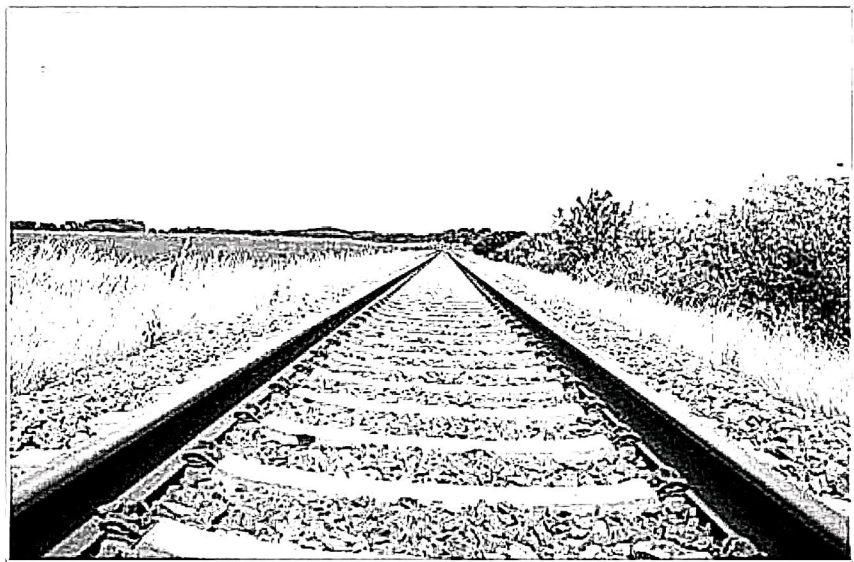
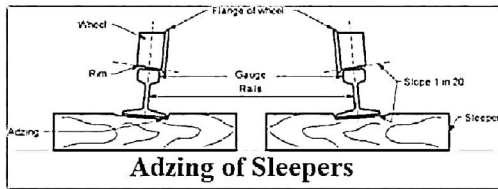
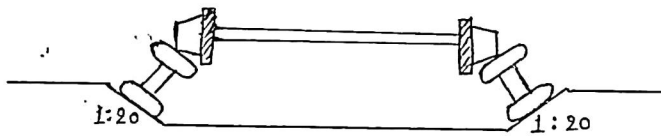
- Curved track पर (refer fig. 2) centrifugal force का role आएगा जिससे train की movement, outward side में होगी जिससे wheel ① का बड़ा dia, track के contact में आएगा और wheel ② का छोटा dia, track के contact में आएगा जिससे wheel ① ज्यादा distance travel करने लगेगा और wheel ② कम distance travel करने लगेगा। So, wheel ②, wheel ① को अन्दर की तरफ pull करेगा so that दोनों wheels same distance travel करें क्योंकि दोनों अलग-अलग distance travel नहीं कर सकते, axle से connected हैं।
- अगर coning of wheels ना हो तो train का derailment हो जाएगा।



Lec-3 (17:40)

### # Adzing of Sleepers :

- For the effective use of coning of wheels, the rails are not laid horizontally. These are laid at an slope 1:20 on sleeper, termed as Adzing of Sleepers.



Adzing of Sleepers