TRANSPORTATION ENGINEERING II

RAILWAY ENGINEERING

By

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MCET

COMPONENTS OF PERMANENT WAY

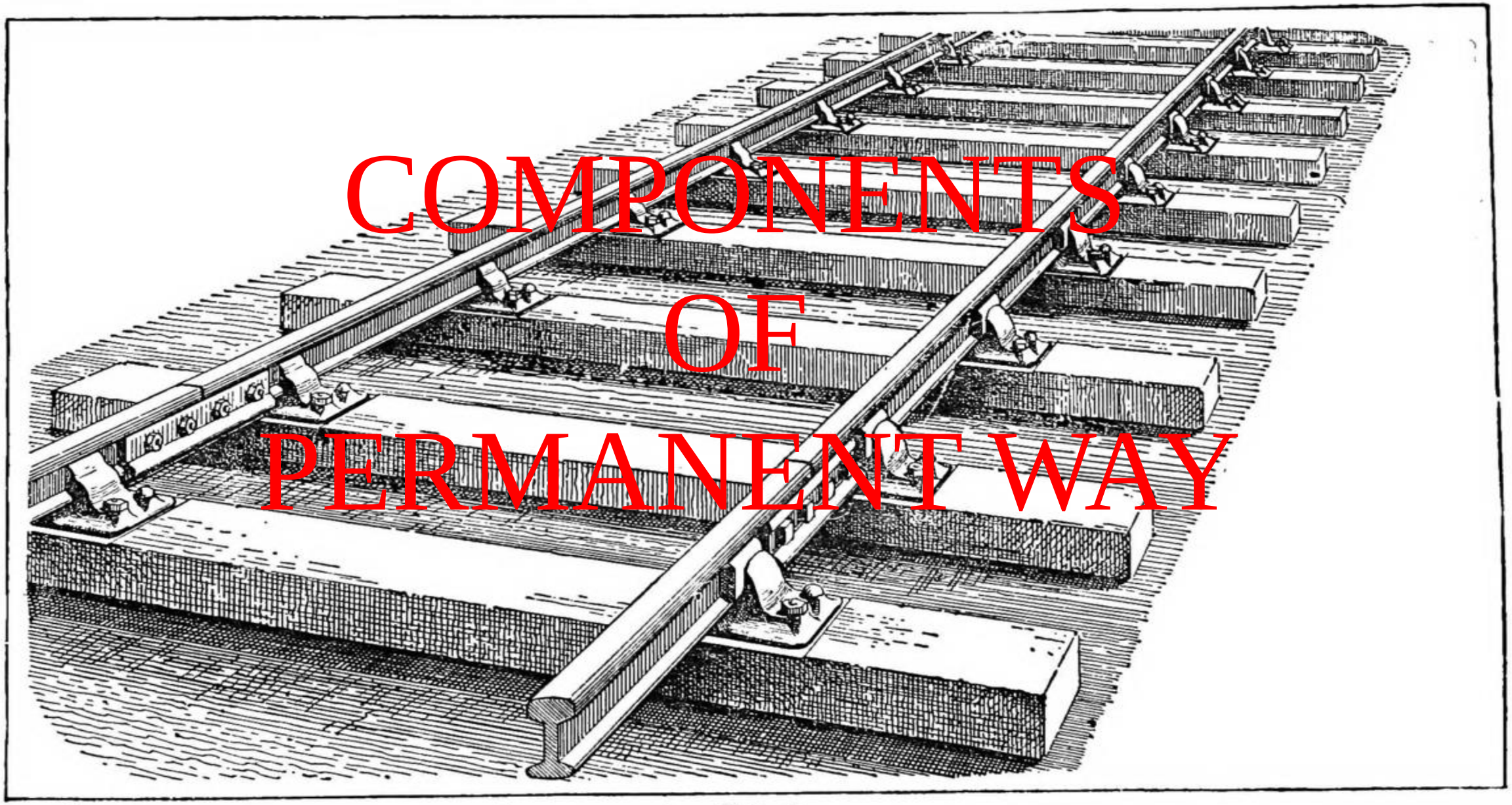
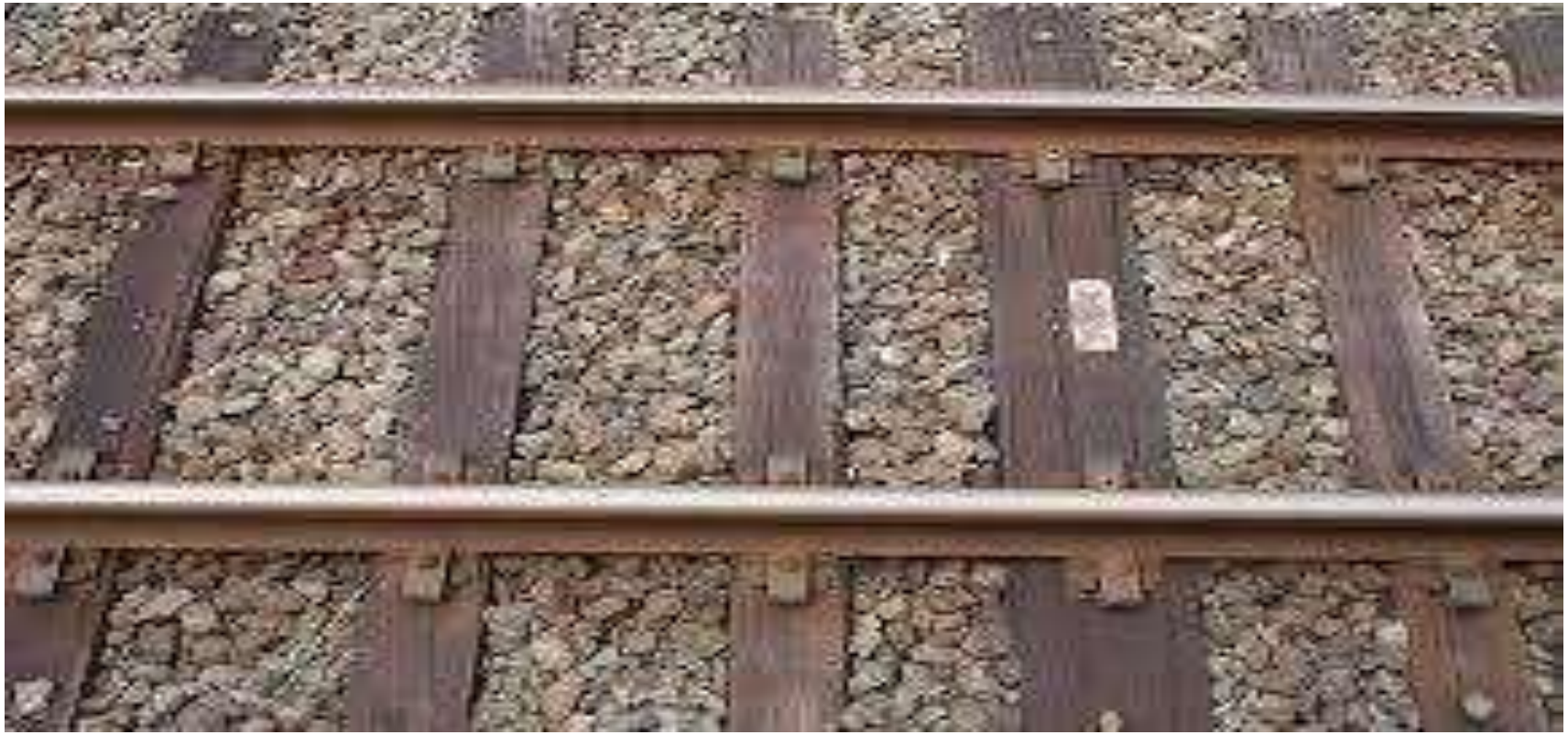


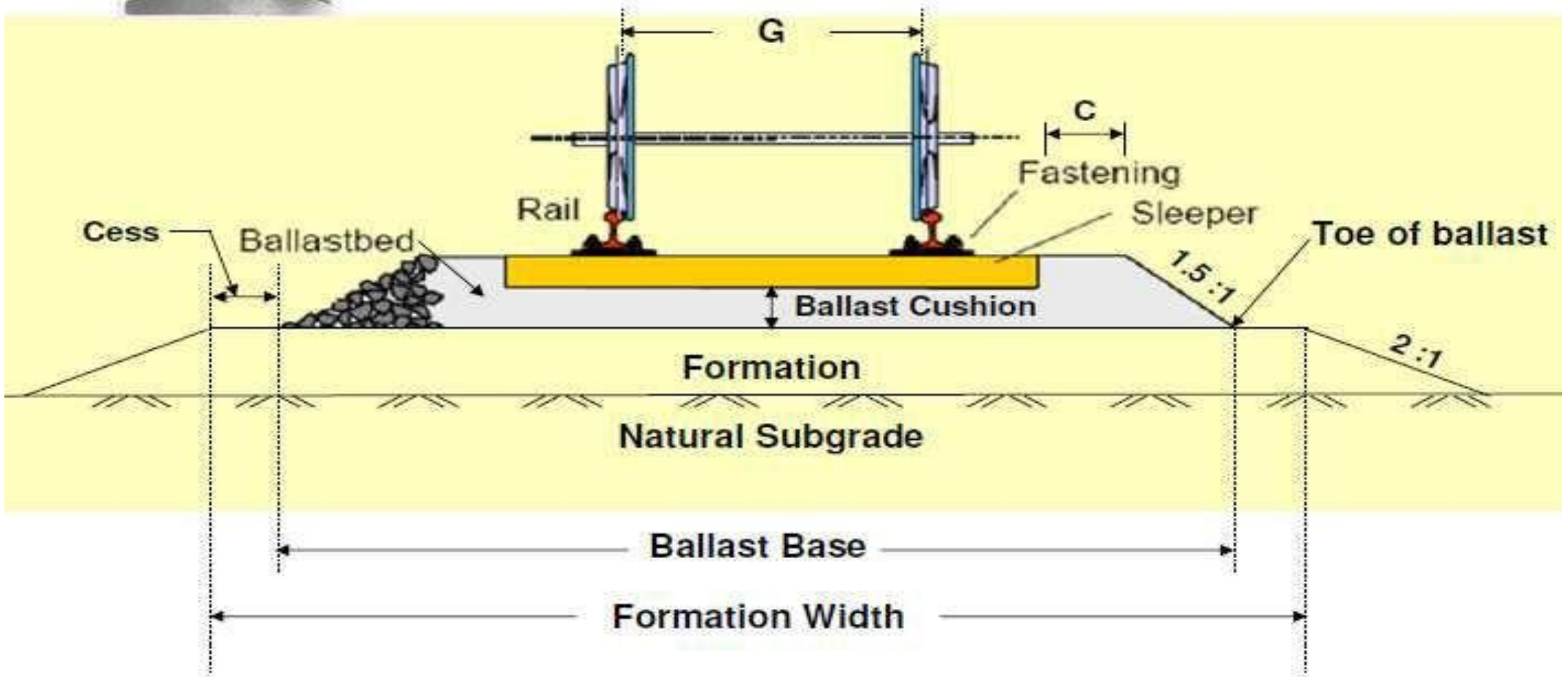
FIG. 6.
PERMANENT WAY OF THE LONDON AND NORTH-WESTERN RAILWAY, 1888.

Permanent Way

The combination of ***rails,*** fitted on ***sleepers*** with the help of ***fixtures*** and ***fastenings*** and resting on ***ballast*** and ***subgrade*** is called the railway track or permanent way.



Track Structure



Track Cross-section

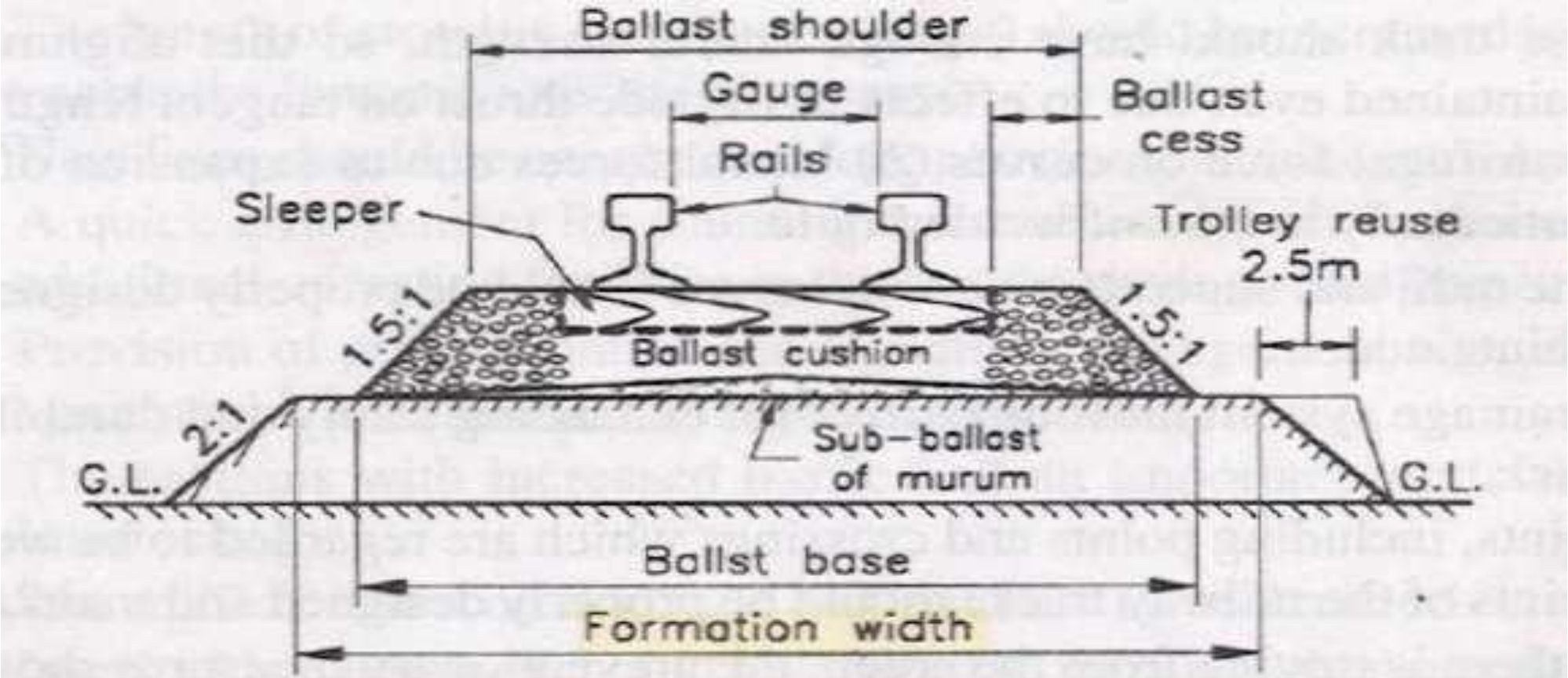


Fig. 3.1 Typical Cross-section of a Permanent Way on Embankment.

RAILS

- **General**

Rail is similar to steel girders. These are placed end to end to provide continuous and level surface for the trains to move

On Indian Railways the standard lengths are the following:

- Length = 12.80 meter for BG (say 13 m)
- Length = 11.89 meter for MG (say 12 m)

Functions of Rail

1. To provide continuous and level surface for movement of train.
2. To provide a smooth pathway so that friction between rail and wheel become less.
3. Serve as a lateral guide for the running of wheels.
4. Transferring the load into the sleeper.
5. To bear the stresses developed in the track due to temperature changes and loading patterns.
6. To resist breaking forces caused due to stoppage of trains.

Requirements of an ideal rail

The main requirements of an ideal rail section are as under

1. The section of the rail should be such that the load of eh wheels is transferred to the sleepers without exceeding the permissible stresses.
2. The section of the rail should be able to withstand the lateral forces caused due to fast moving trains.
3. The underside of the head and top of the foot of the rail section should be of such a slope that the fishplates fit snugly.
4. The center of gravity of the rail section should preferably coincide the center of the height of the rail so that maximum tensile and compressive stresses are nearly equal.

5. The web of the rail section should be such that it can safely bear the vertical load without buckling.

6. The head of the rail should be sufficiently thick for adequate margin of vertical wear.

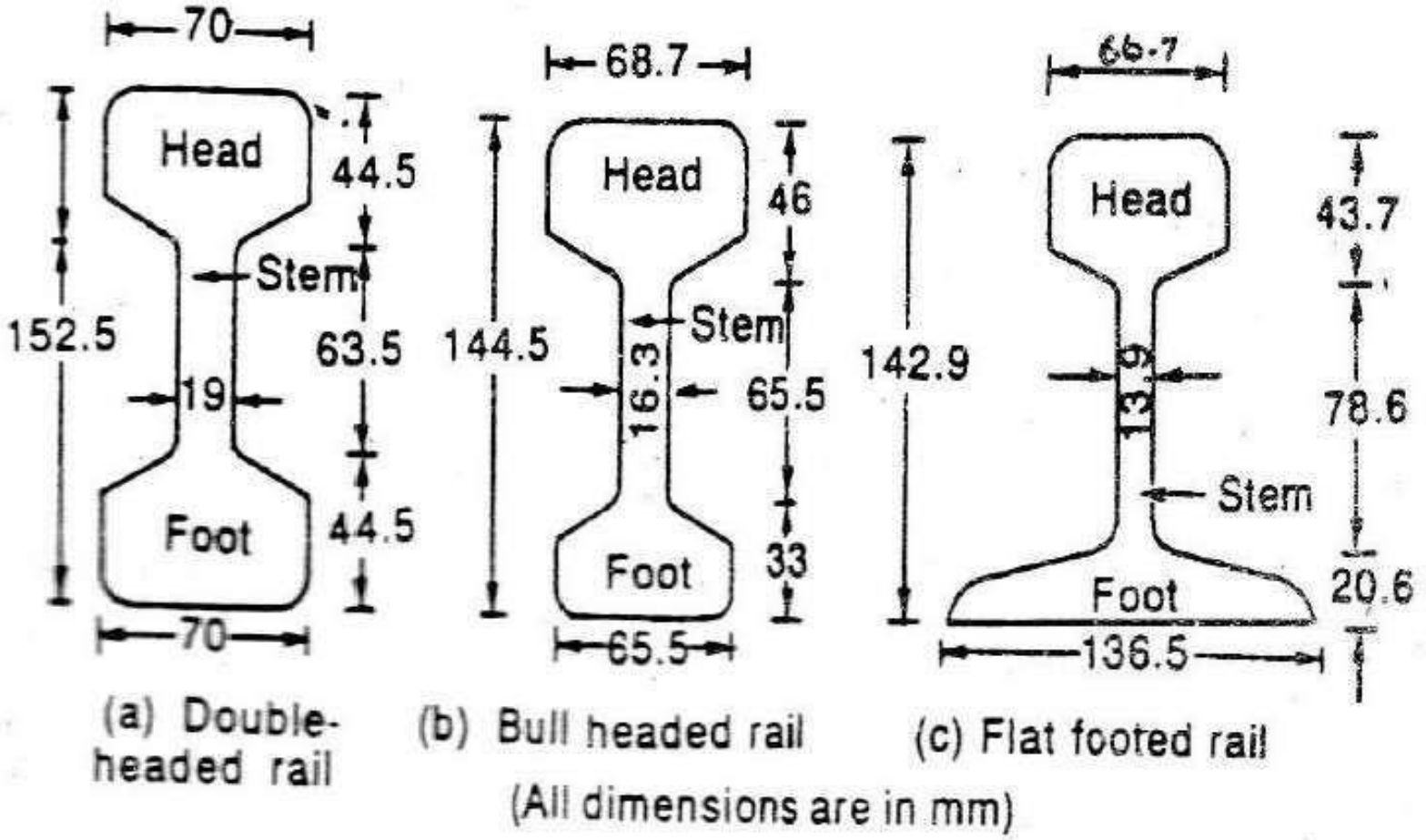
7. The foot of rail should provide sufficient bearing area on the underlying sleepers so that the compressive stresses on the timber sleeper remain within permissible limits.

8. The section of the rails should be such that the ends of two adjacent rails can be efficiently jointed with a pair of fish plates.

9. The surfaces for rail table and gauge face should be sufficiently hard to resist the wear.

Types of rail sections

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

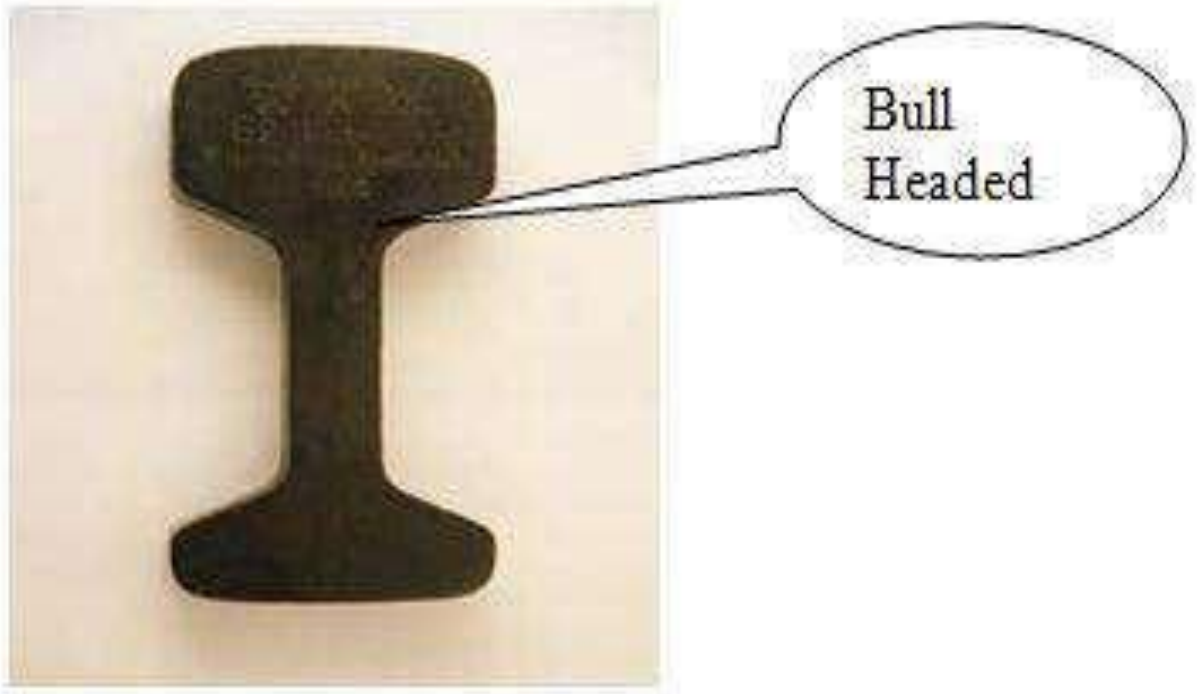


Double headed rails

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

Bull headed rails

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

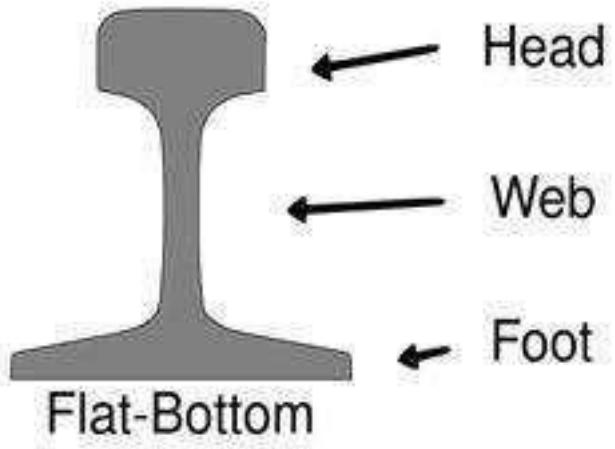


Flat footed rails

a. These rails are also called as vignole's rails.

b. Initially the flat footed rails were fixed to the sleepers directly and no chairs and keys were required.

c. Later on due to heavy train loads problems arise which lead to steel bearing plates between the sleeper and the rail. at rail joints and other important places these are the rails which are most commonly used in India.



Creep of Rails

Creep is defined as the longitudinal movement of the rail with respect to the sleepers.

Theories of creep

1. Wave action or wave theory:

Wave motion is set up by moving loads of wheels.

The vertical reverse curve ABC is formed in the rail ahead of wheels, resulting from the rail deflection under the load.

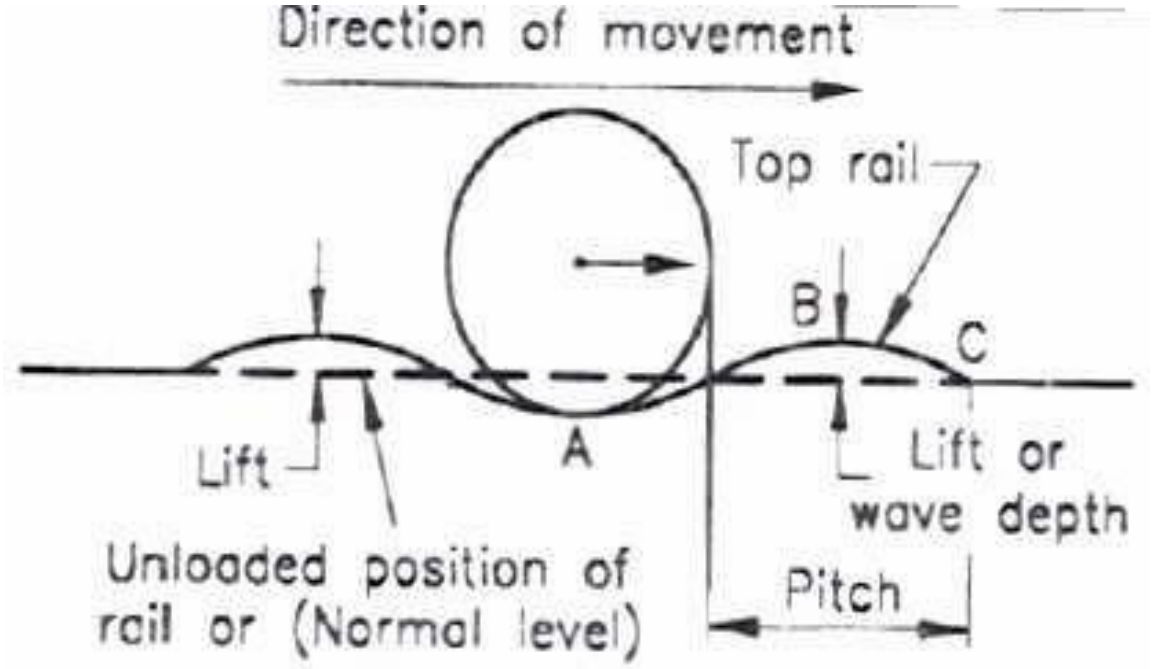


Fig. 8.2. Wave Theory of Creep (Formation of Wave)

Drag (or) Dragging theory

- ✓ Backward thrust on driving wheels of locomotive of train push the rail off track backward.
- ✓ Mean while other wheel of locomotive and vehicles push the rail in the direction of travel.
- ✓ Since drag effect is more as explained in Wave Action Theory resultant creep of rails in forward direction.

Percussion Theory

This theory states that the creep is due to impact of wheels at the rail end ahead at joints. Hence as and when wheel leave the trailing rail and strike the facing rail end at each joint it pushes the rail in forward direction resulting in creep

Factors effecting the magnitude & direction of creep.

- Alignment of track: Creep is more on curves than on tangent tracks.
- Grade of track: More in case of steep curves, particularly while train moving downward with heavy loads.
- Type of rails: older rail have more tendency than new one.
- Direction of heaviest traffic: In heavier load moving direction occurs more creep.

Effects of creep

- Most serious effect of creep is being buckling of track.
- Sleepers move out of square and out of position, affects the gauge and alignment of track. As sleepers move surface is disturbed results uncomfortable riding.
- When joints are opened out beyond the permissible stress in bolts and fish plates tendency to occurrence of failure in them.
- Its difficult to fix the removed rail at proper position during repair works since the time gap becomes too short or too long due to creep.
- Smashing of fish plates, bolts, bending of bars, kinks at joints of rails and forging of ballast ahead, common effects of creep.

Contd..

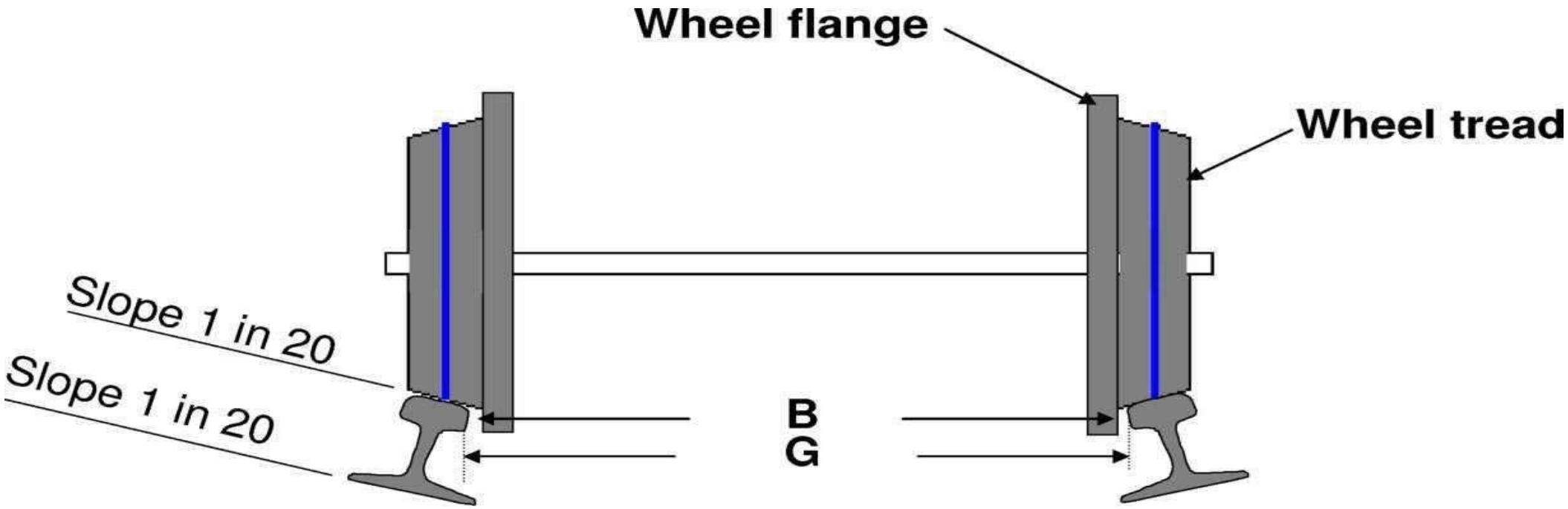
- Points and crossings get distorted, its too difficult to set them to correct gauge and alignment. Movement of switches is made difficult and interlocking is thrown out of gear.

Remedies of creep

1. Pulling back the rails
   - ✓ pull back the rail to its original position. By means of crow bars and hooks provided through the fish bolts wholes of rails
   - ✓ By considering the position of joints relative to sleepers and both rails should be in respective position.
2. Provision of anchors :
   - ✓ By use of anchors and sufficient crib ballast.
   - ✓ For creep 7.5 cm-15 cm 4 anchors per rail
   - ✓ For creep 22.5 to 25 cm 6 anchors.
3. Use of steel sleepers:
   - ✓ Sleepers should be made up of good material with proper fitting. Sleepers should provide good grip with ballast to resist the movement of sleepers. Increase in no. of sleepers.

CONING OF WHEELS

Coning of Wheels



1. The flanges of wheel is never made flat, but they are in the shape of cone with a slope of 1 in 20. (Sloping of the wheel from the vertical axis)
2. The coning of wheels is mainly done to maintain the vehicle in the central position with respect to the track.
3. It is done to maintain the vehicle in the central position with respect to the track.

Advantages of coning

a. Reduce the wear and tear of wheel flanges and rails.
b. To provide possibility of lateral movement of the axle with its wheels.
c. To prevent the slipping of wheels.

FASTENING OF SLEEPERS

Sleepers are transverse members of the track placed below the rails to support and fix them in position.

FUNCTIONS OF SLEEPERS

Sleepers serve the following functions:

(i) To hold the rails to proper gauge.

(ii) To transfer the loads from rails to the ballast.

(iii) To support and fix the rails in proper position.

(iv) To keep the rails at a proper level in straight tracks and at proper super elevation on curves.

(v) To provide elastic medium between the rails and the ballast.

(vi) To provide stability to the permanent way on the whole.

REQUIREMENTS OF GOOD SLEEPERS

The following are the requirements of good sleepers:

(i) The sleepers should be sufficiently strong to act as a beam under loads.

(ii) The sleepers should be economical.

(iii) They should maintain correct gauge.

(iv) They should provide sufficient bearing area for the rail.

(v) The sleepers should have sufficient weight for stability.

(vi) Sleepers should facilitate easy fixing and taking out of rails without disturbing them.

(vii) They should facilitate easy removal and replacement of ballast.

(viii) They should not be pushed out easily of their position in any direction under maximum forces of the moving trains.

(ix) They should be able to resist impact and vibrations of moving trains.

(x) They should be suitable to each type of ballast.

(xi) If track-circuiting is done, it should be possible to insulate them from the rails.

TYPES OF SLEEPERS

Sleepers are of the following types:

1. Wooden sleepers.
2. Steel sleepers.
3. Cast iron sleepers.
4. R.C.C. sleepers.

1. Wooden Sleepers: These sleepers are regarded to be the best as they satisfy all the requirements of good sleepers and are the only sleeper suitable for track circuiting. The life of wooden sleepers depends upon their ability to resist wear, attack by white ants and quality of timber used. Timbers commonly used in India for sleepers are sal, Teak, Deodar and chair wood.

The standard sizes of wooden sleepers for different gauges are as follows:
For B.G. – 2740 mm X 250 mm X 130 mm
For M; .G. – 1830 mm X 203 mm X 114 mm
For N.G. – 1520 mm X 150 mm X 100 mm

ADVANTAGES

(i) Timber is easily available in all parts of India.
(ii) Wooden sleepers are suitable for all types of ballast.
(iii) Wooden sleepers require less fastening and simple in design.
(iv) These sleepers give less noisy track.
(v) These sleepers absorb shocks and vibrations more than any other sleepers.
(vi) These sleepers are best suited for track circuiting.

DISADVANTAGES

(i) The life of wooden sleeper is less as compared to other types of sleepers.
(ii) It is difficult to maintain guage of the track in case of wooden sleepers.
(iii) These sleepers are subjected to wear, decay, and attack by white ants etc.
(iv) Track laid over wooden sleepers is easily disturbed.
(v) Maintenance cost is more as compared to other sleepers.

2. Steel Sleepers: These sleepers consist of steel through made of 6 mm thick sheets, with its both ends bend down to check the running out of ballast. At the time of pressing of sleepers, an inward slope of 1 in 20 on either side is provided to achieve required tilt of rails. The standard length of these is 2680 mm

Steel sleepers are of two types:

(a Key type steel sleepers
(b) Clip and bolt type steel sleepers

ADVANTAGES

(i) Steel sleepers are light in weight and can be handled easily.
(ii) These require less fastenings.
(iii) He life of steel sleepers is more than the wooden sleepers.
(iv) The gauge can be easily maintained and adjusted.
(v) The scrap value is more than the wooden sleepers.
(vi) The track laid on steel sleepers has good lateral and longitudinal rigidity.
(vii) Creep of rails can be checked by using steel sleepers.

DISADVANTAGES

(i) Initial cost of these sleepers is more than wooden sleepers.
(ii) Cracks are developed at rail seat of these sleepers.
(iii) Steel sleepers are not suitable for track circuiting.
(iv) These are not suitable for all types of ballast.
(v) These are liable to corrosion.

3. Caste Iron Sleepers:

The sleepers made of cast iron, known as cast iron sleepers, have been extensively used in India as compared to other countries in the world. Cast iron sleepers are of the following types:

(i) Pot or bowl sleeper
(ii) Plate sleeper
(iii) Box sleeper
(iv) CST-9 sleeper
(v) Duplex sleeper

Advantages of C.I sleepers are more.

(i) The life of C.I sleepers is more.
(ii) The maintenance cost of these sleepers is low.
(iii) Gauge can be easily maintained and adjusted with these sleepers.
(iv) These sleepers are more durable.
(v) Creep rails can be checked by using these sleepers.

Disadvantages

(i) More ballast is required than any other type of sleepers.
(ii) The number of fittings required is more.
(iii) These sleepers are liable to break.
(iv) C.I. Sleepers are liable to break.
(v) These are not suitable for all types of ballast.

4. R.C.C. Sleepers:

Reinforced cement concrete sleepers are of two types:

(i) Through type

(ii) Block and tie type

Advantages of R.C.C. Sleepers

(i) Concrete sleepers have long life, generally 40to 60 years.

(ii) These are free from natural decay and attack by insects etc.

(iv) These sleepers require less fittings.

(v) Track circuiting is possible in these sleepers.

(vi) These sleepers provide more lateral and longitudinal rigidity as compared to other sleepers.

(vii) The maintenance cost is low.

(viii) Due to higher elastic modulus, these can withstand the stresses due to fast moving trains.

Disadvantages

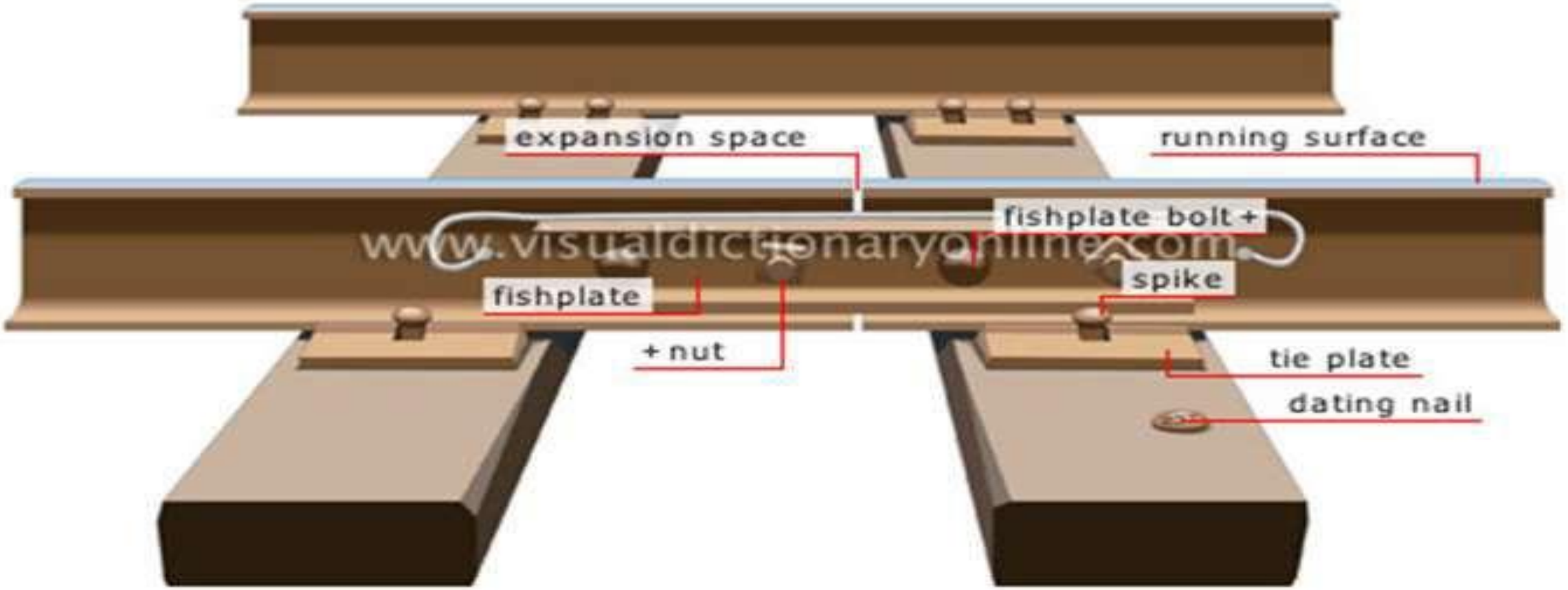
(i) Due to heavy weight, handling and transportation of these sleepers are
Difficult.

(ii) If not handled properly, the chance of breaking is more.

(iii) The renewal of track laid with these sleepers is difficult.

(iv) The scrap value is nil.

TRACK FITTINGS: FIXTURES AND FASTENINGS



TRACK FITTINGS FIXTURES AND FASTENINGS

- The Purpose of providing track fitting and fastenings in railway tracks is to hold the rails their proper position in order to ensure the smooth running of trains.
- These fittings and fastenings are used for joining rails together as well as fixing them to the sleepers.

FUNCTIONS OF FIXTURES AND FASTENINGS

Rail fixtures and fastenings have the following functions:

(i) To join the rails end to end to form full length of track.

(ii) To fix the rails to sleepers.

(iii) To maintain the correct alignment of the track.

(iv) To provide proper expansion gap between rails.

(v) To maintain the required tilt of rails.

(vi) To set the points and crossings in proper position.

TYPES OF TRACK FITTINGS

1. Fish plates
2. Spikes
3. Bolts
4. Chairs
5. Plates
6. Blocks
7. Keys

Fishplate

- In rail terminology, a fishplate, splice bar or joint bar is a metal bar that is bolted to the ends of two rails to join them together in a track.
- The top and bottom edges are tapered inwards so the device wedges itself between the top and bottom of the rail when it is bolted into place.

- In rail transport modeling, a fishplate is often a small copper or nickel silver plate that slips onto both rails to provide the functions of maintaining alignment.

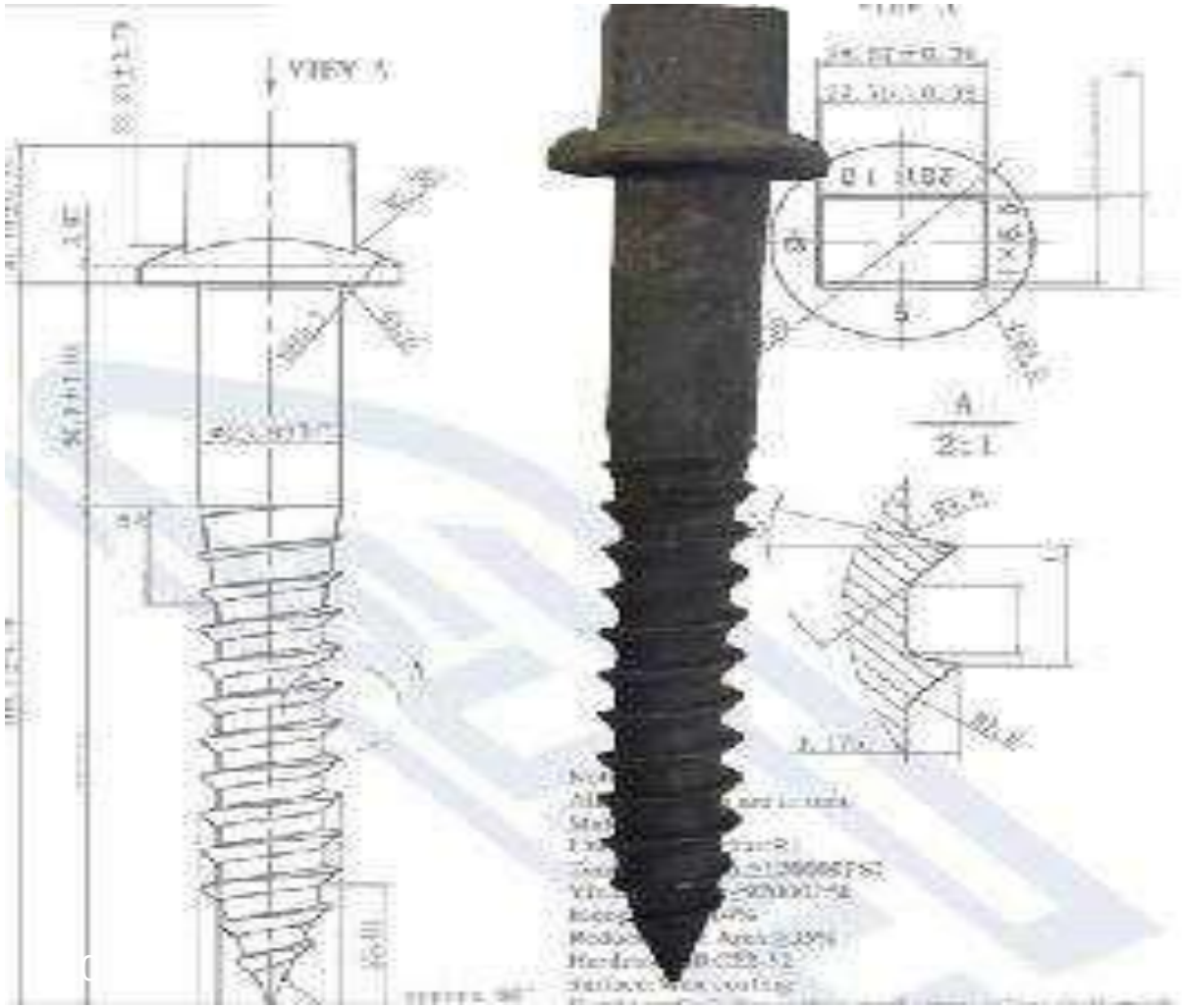
2.Spikes

Dog spikes

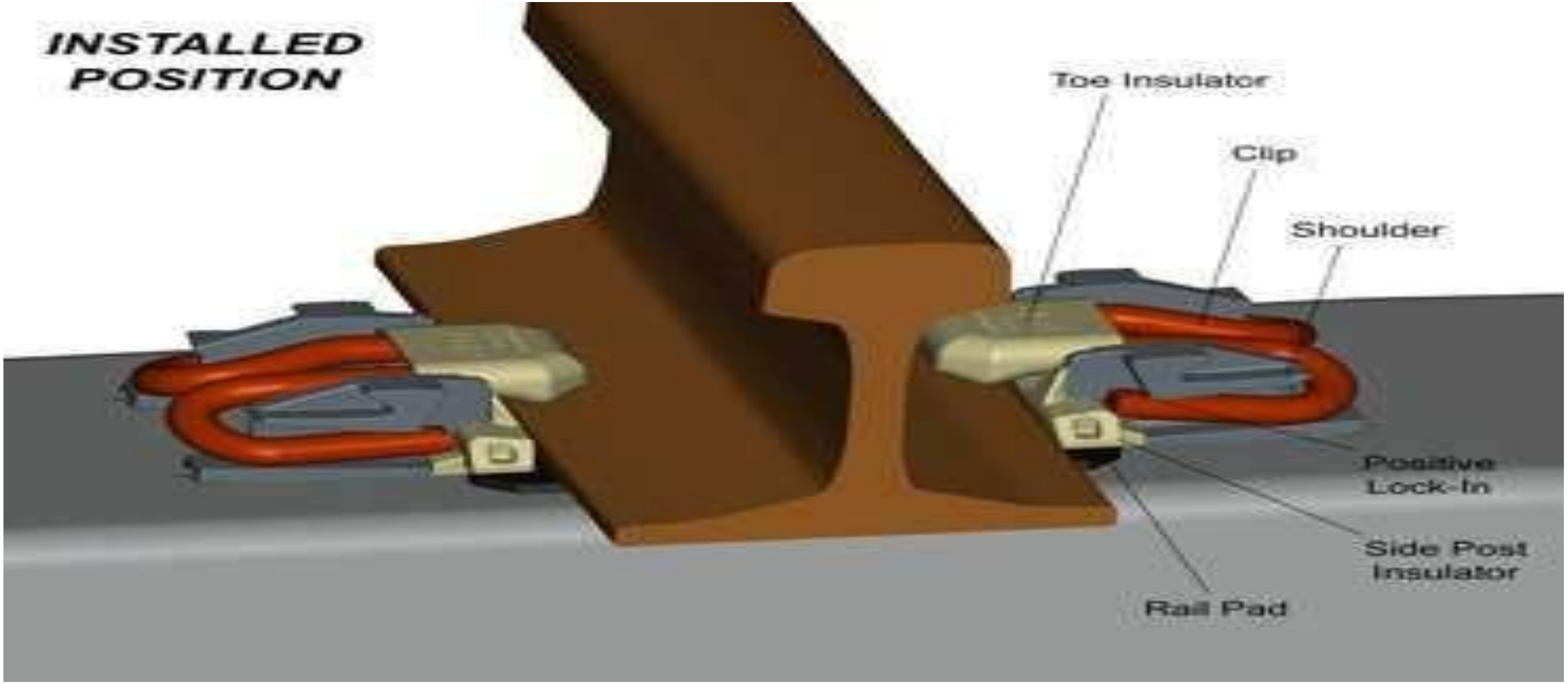

Tensile Strength:≥420Mpa
Yield Point:≥320Mpa


Import-Export
imexbb.com

Screw spike

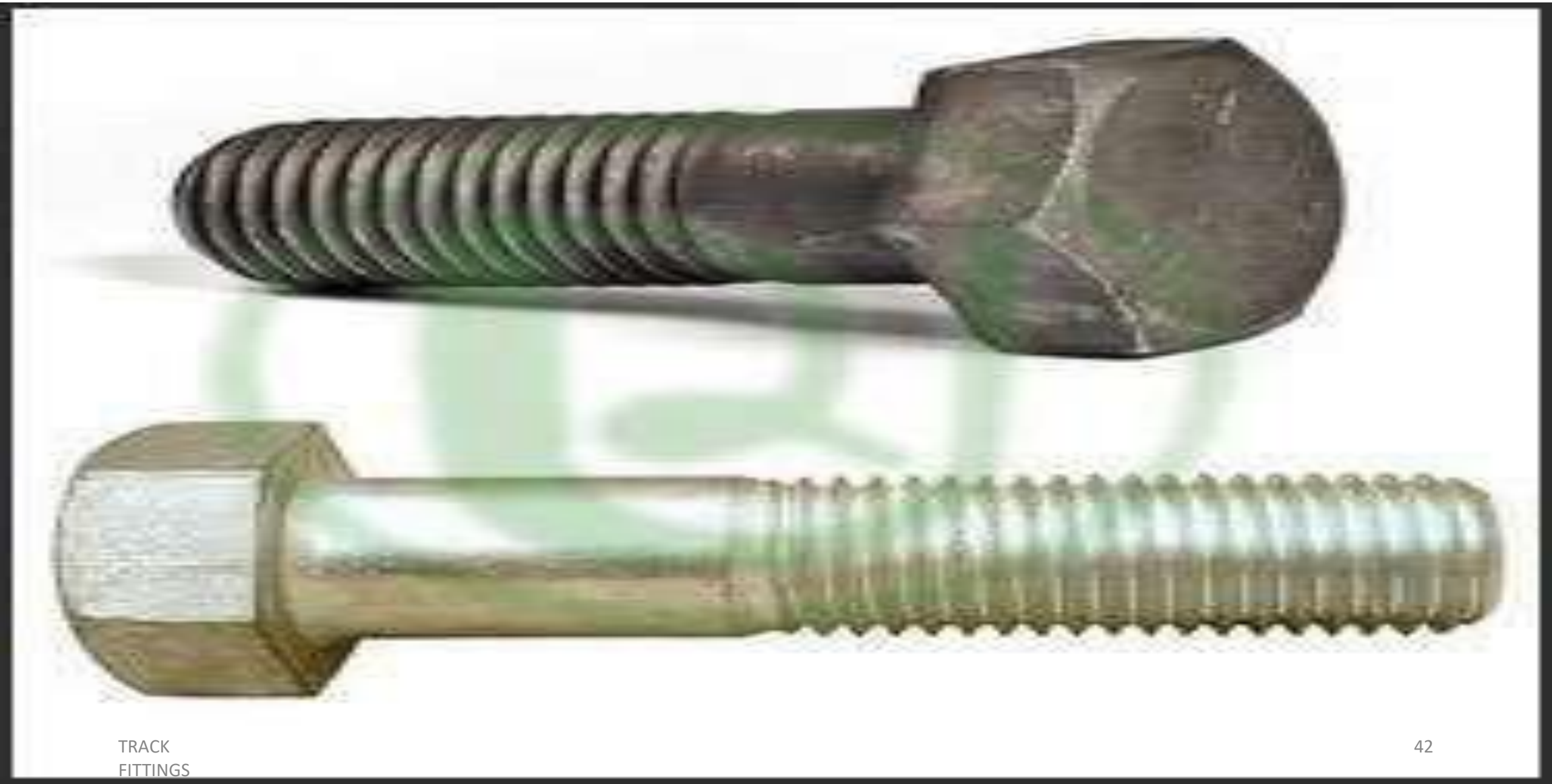


Standard spikes



Elastic spikes

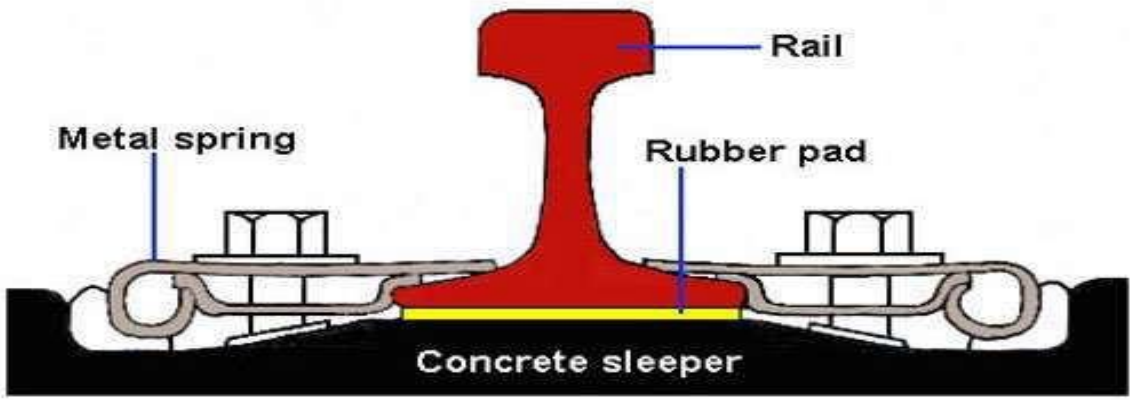
3.Bolts



Hook bolt

Fish bolt

Anyang Lida Railway Equipments Co.,LTD



Email : business@railwayfasteners.cn

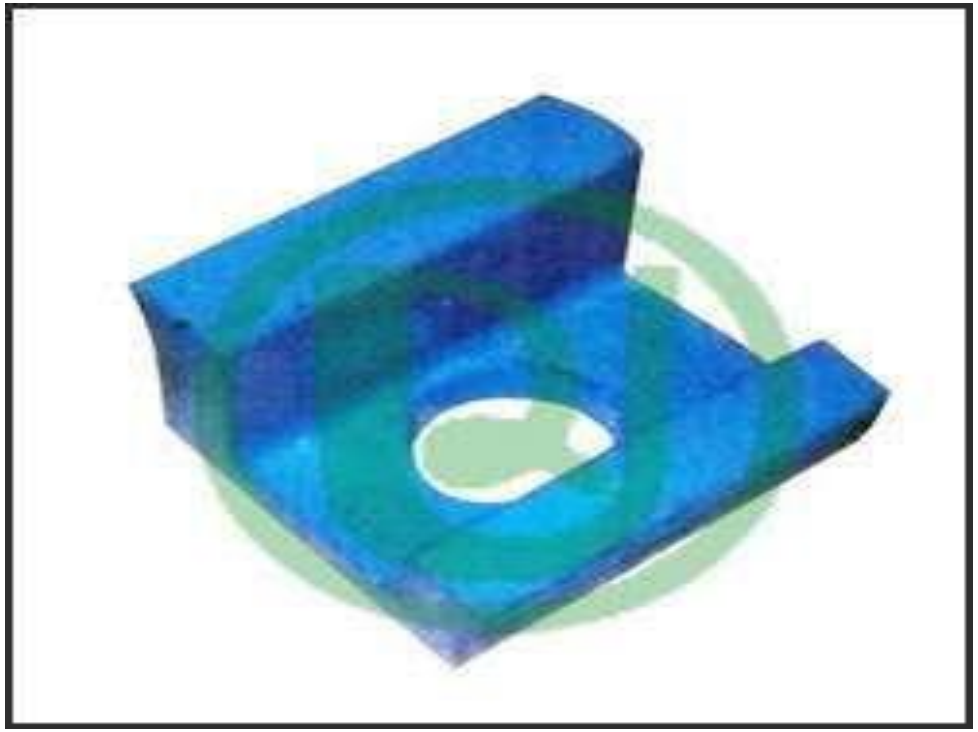
Rag bolt

Fang nut and bolt

4.Chairs

Chairs

MILD STEEL AND CAST IRON CHAIRS



5.Plates

Plates

Tie plate

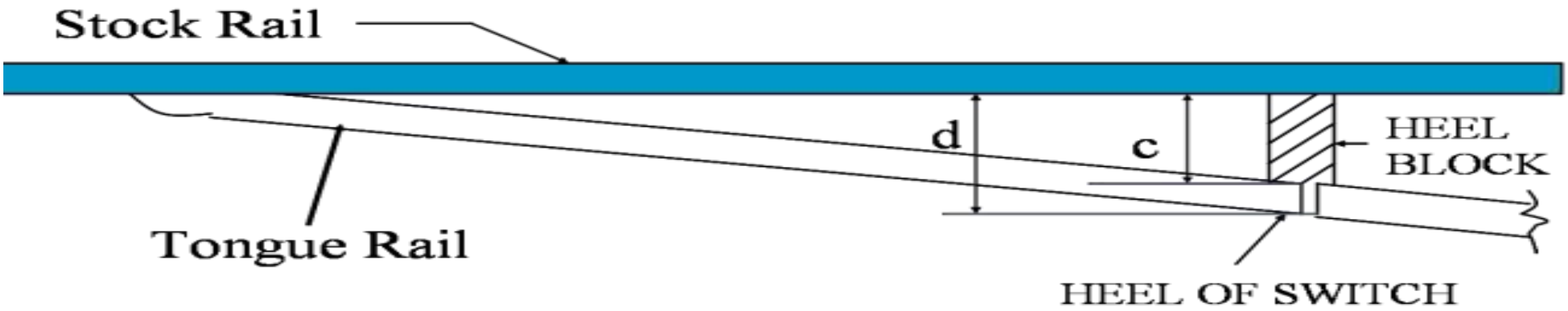
Elastic ribbed plate

6.Blocks

1. Heel blocks
2. Distance blo
3. Check block
4. Crossing blo

cks ck

Heel blocks



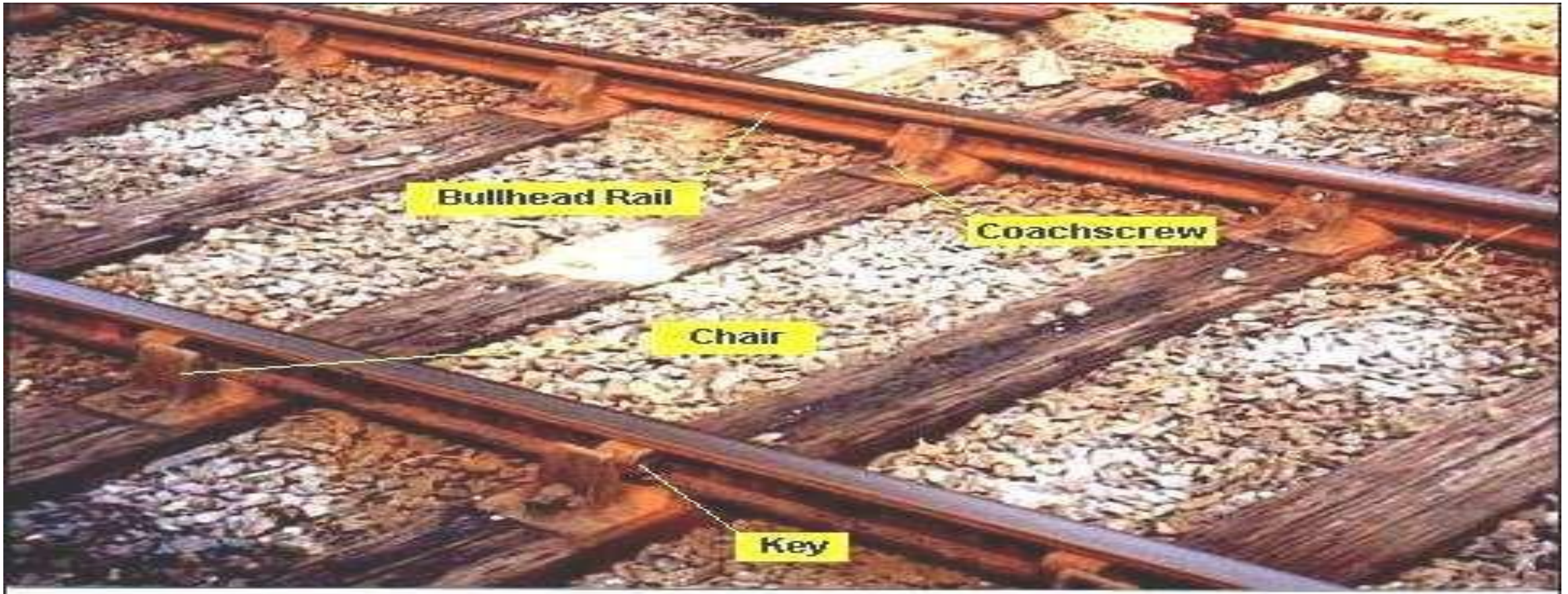
c= heel clearence

d= heel divergence

7. Keys

1. Wooden key for C.I. chair
2. M.S. key for steel through sleepers
3. Stuart’s key
4. Morgan key
5. Cotter and tie bars

Spring steel clip(key)



Track using the UK bullhead rail profile. The rail is supported in a cast iron chair and secured with a spring steel clip called a key. Sometimes these are wooden.

Thank You