Transportation Engineering II: Highway Design & Railways

Lecture 4
SURVEYS, RAILS

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Surveys

- Traffic Survey
- Reconnaissance Survey
- Preliminary Survey
- Final Location Survey

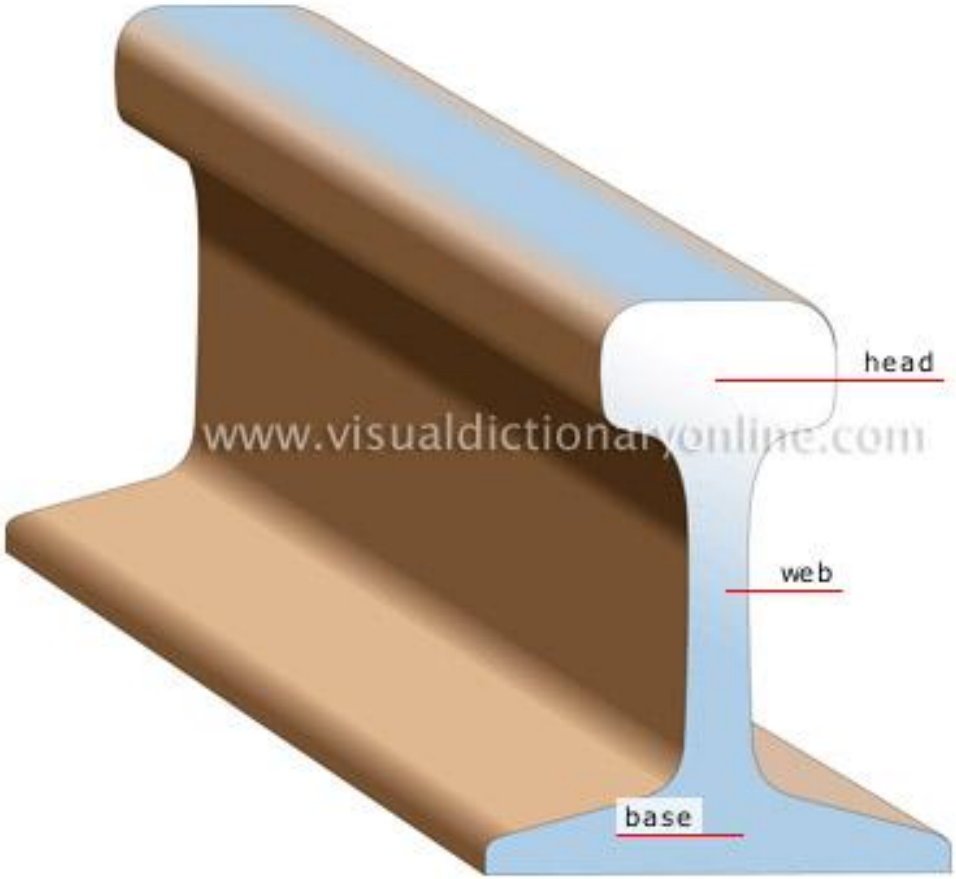
Traffic Survey

- Why?
- How?
  - Visit all trade centers
  - Consult local bodies, state governments, important organizations
    - Info collected: human resources, agricultural and mineral resources, patterns of trade and commerce, industries located, prospective tourist traffic, existing transport facilities, important government and private offices

Rails

- Similar to steel girders
- Functions
  - Provide a smooth surface for movement of train
  - Provides lateral guidance to wheels
  - Bear stresses developed due to
    - Vertical load
    - Acceleration and deceleration actions
    - Braking and thermal forces
  - Transmit wheel loads to wider area of sleeper

Parts of Rail

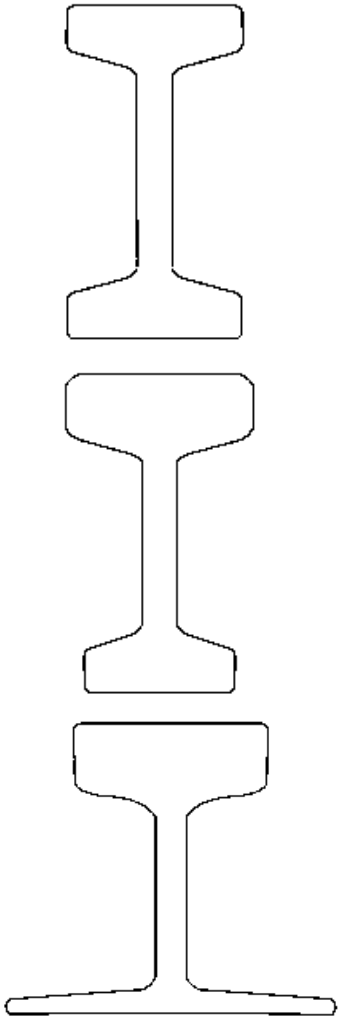


Requirements of an Ideal Rail

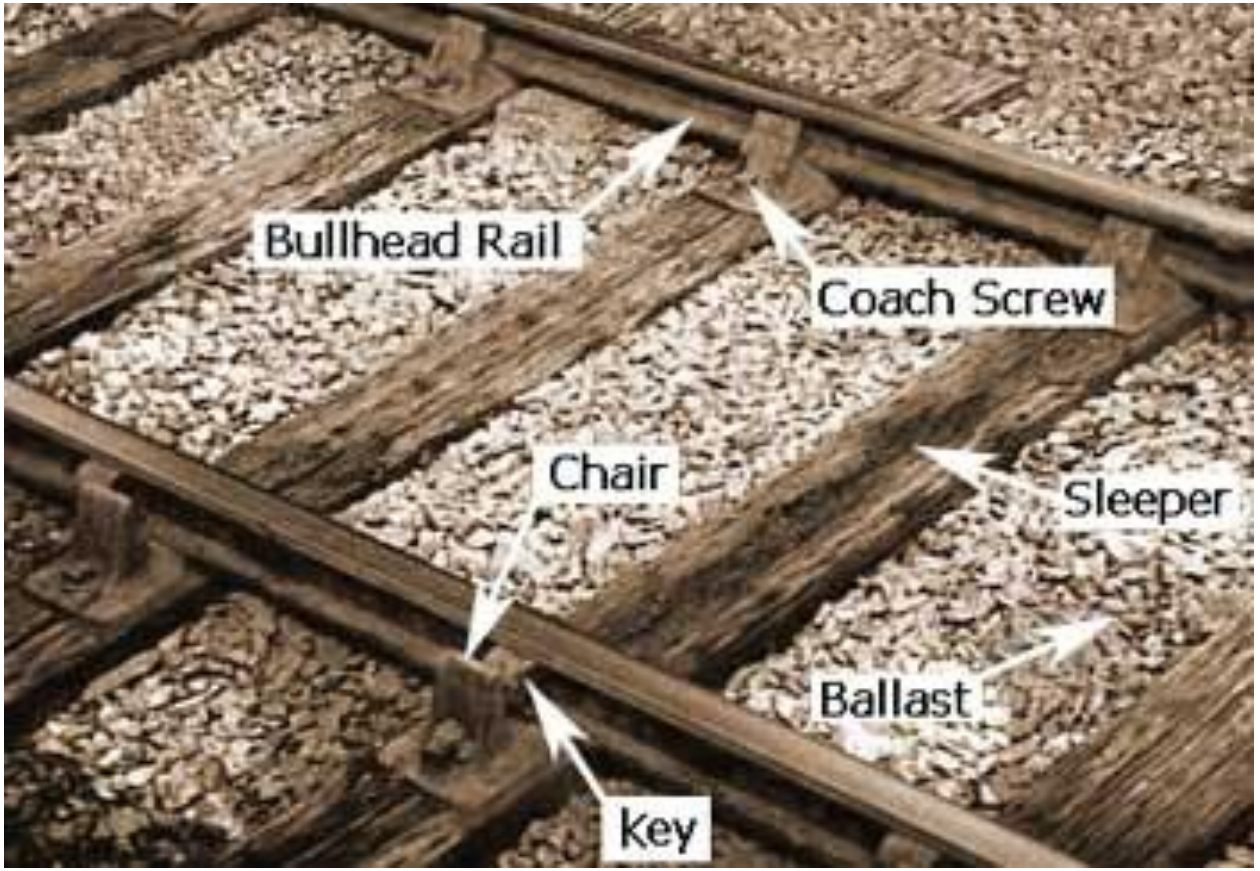
- Most economic section consistent with strength, stiffness and durability
  - Balanced distribution of materials
- Center of gravity should be close to mid-height
  - Maximum tensile and compressive stresses are equal

Types of Rail

- Double headed (DH)
  - Symmetric
    - Equal thickness of web and base
    - Reversible
- Bull headed (BH)
  - Thicker head
    - Better withstand the higher wear and tear at top
    - Sits on “chairs”
- Flat footed/ Vignole rail
  - Wider base
    - Increases lateral stability and spreads load to wider area of sleeper
    - Connected with “spikes”



BH Rail



BH Rail

- Disadvantages
  - Because of chairs, requires more maintenance and inspection than flat-footed
    - BH rail is held in chairs by a wedge/key. The wedge is hammered into position so that any movement of the rail will force the wedge in tighter. The chair is bolted to the sleeper.

FF Rail

FF Rail

- Advantages
  - No chairs required and connected to sleepers directly with spikes. Requires less maintenance and inspection than BH
  - Higher lateral and vertical stiffness
    - Less liable to develop kinks
  - Distributes load to a wider area
    - Increased stability, longer life of rail and sleepers

Choice of Rail Section

- Designated by weight per unit length
  - FPS: lb/yard (e.g. 90 lb/yard)
  - MKS: kg/m (e.g. 52 kg/m)
- Factors affecting choice of rail section
  - Heaviest axle load
  - Maximum permissible speed
  - Depth of ballast cushion
  - Type and spacing of sleeper
- Rule of thumb: Max axle load =560 * sectional wt of rail lb/yard or kg/m
  - Max axle load for 52 kg/m rail= 560* 52 =29.12 t

Choice of Rail Length

- Advantages of long rails
  - Less joints and fittings
  - Less maintenance cost
  - Smooth and comfortable rides
- Limitations
  - Difficulties in manufacturing
  - Difficulties in transporting rails during construction
  - Heavy internal thermal stresses
  - Bigger expansion joints
- Bangladesh, India, Srilanka
  - BG 12.80m , MG 11.89m

Welded Rail

- Shorter rail sections welded together to get advantages of longer rail without the associated disadvantages
- Expansion gaps eliminated by ‘Elastic fasteners’ and ‘Heavy concrete sleepers’
- Longitudinal strain of rails restrained locally and cannot accumulate
- Commonly used in high speed tracks

Causes of Rail Failure

- Inherent defects
- Defects due to fault of rolling stock and abnormal traffic
- Excessive corrosion
- Badly maintained joints
- Defects in welded joints
- Improper maintenance
- Derailments

Rail Wear

- Reasons
  - Friction between rail and wheels of the rolling stock
  - Impact of moving load
  - Forces of acceleration, deceleration and braking
  - Abrasion due to rail-wheel interaction
  - Weather effects
- Effects
  - Causes loss of weight and reduces stress bearing capacity
  - Replaced after reaches permissible stress
- Locations
  - Vertical wear: On top of rail head
  - Lateral wear: On sides of the rail head
  - Battering of rail end: On end of rail

Common Locations of Wear

- On sharp curves
  - Due to centrifugal forces
- On steep gradients
  - Extra force applied by the engine
- On approaches to stations
  - Acceleration and deceleration
- Tunnels and coastal areas
  - Humidity and moisture

Methods to Reduce Wear

- Better maintenance of track
- Reduction of number of joints
- Use of heavier rails and special steel alloys
- Lubricating the gauge face of the outer rail in curves
- Providing check rails in sharp curves
- Interchanging inner and outer rails
- Coning of wheels and tilting of rails