Transportation Engineering II: Highway Design & Railways

Lecture 6

SLEEPERS (TIES)

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Sleepers

- Functions
  - Holding rails in correct gauge and alignment
  - Providing a firm and even support for rails
  - Transferring load from rails to wider areas of ballast
  - Absorb impact and vibration
  - Providing lateral and longitudinal stability to the permanent way
- Design of sleepers
  - Choose material
  - Determine spacing

Desirable Properties of Sleeper

- Should be capable to withstand vertical load, impact and vibrations
  - Higher for high speed rails
- Minimum lifecycle cost
  - Production, laying, maintenance, scrap/resale value
- Easy to handle
  - Moderate weight
  - Not easily susceptible to damage
- Gauge adjustment is possible
- Should have anti-sabotage and anti-theft features
- Should have track circuiting (electric insulation) quality

Track Circuiting

- Circuit used to detect presence of trains as part of automated/semi-automated signaling
  - Electric circuit formed along each rail and connected to the signal and cabin
  - The circuits are isolated/ electrically insulated by sleepers
  - When track is occupied, the two rails are short-circuited because of the wheels and axle of the train and breaks the circuit connected to the signals indicating danger

Track Circuiting

Shape of Sleepers

- Reason:
  - Tilting of rail
  - Drainage

Shape of Sleepers

Adzing of Wooden Sleepers

- Cutting of wooden sleepers in 1:20 slope
- High precision required

Types of Sleepers

- Wooden
- Cast Iron (obsolete now)
- Steel
- Concrete

Wooden Sleeper

Wooden Sleepers

- Advantages
  - Good dampening property: absorbs vibrations
  - Low manufacturing cost
  - Easy to handle
    - Moderate weight
    - Not easily susceptible to damage
  - Gauge adjustment is easier
  - Good track circuiting (electric insulation) quality

Wooden Sleepers

- Disadvantages
  - Short life (12-15yrs)
  - Difficult to maintain gauge (hole widening problem)
  - High maintenance cost
    - Fire hazard
    - Pest attack
  - Higher probability of theft due to high opportunity cost
  - Negligible scrap value
  - Light weight makes it unsuitable for fast track

Steel Sleepers

- **Advantages**
  - Longer life (30 - 40 yrs)
  - Ensure smoother track
  - Easy to maintain gauge
  - Lesser damage during handling and transport
  - Not susceptible to
    - Fire hazards
    - Vermin attack
  - Have good scrap value

- **Disadvantages**
  - Corrosion prone
  - Unsuitable for track circuiting areas
  - Develops cracks at rail seats
  - Gauge change is not possible
  - Light weight (80kg) and not suitable for fast track

Concrete Sleeper

- **Advantages**
  - Offer higher longitudinal and transverse stability
  - Easy to maintain gauge, cross level and alignment
  - Suitable for modern methods of track maintenance
  - Can be used in track circuited areas
  - Longer life (40-50yrs) allows renewal of both rail & sleeper together
  - Suitable for mass production with locally available materials
  - Not susceptible to
    - Corrosion
    - Fire hazards
    - Pest attack
- **Disadvantages**
  - Heavy to handle
  - Track laying need mechanical method
  - Damage is heavy at the time of derailment
  - Have no scrap value

HW: Comparison of Sleeper Types

Property	Wood	Steel	Concrete
Ability to withstand vertical load, impact load and vibration	Excellent, specially for vibration	Good	Very good
Construction cost	…		
…			

Spacing of Sleeper

- Sleeper density= Number of sleepers per unit rail length (per unit track length for welded rail)
- Factors affecting spacing/density
  - Axle load and speed
  - Type and section of rails
  - Type and strength of sleepers
  - Type of ballast and ballast cushion
  - Nature of formation
- Tradeoff between stability and cost

Minimum Density

- MKS: Minimum sleeper density= M+7 (BG)
- FPS: Minimum sleeper density= N+3 (MG)
- Problem:
  - If length of rail is 15m and the track is broad gauge, what is the minimum sleepers density per rail? If the joint spacing is 0.15m, what is the minimum sleepers density per km?
- Spacing is not uniform
  - Closer near the joints
    - Joints are weak points
    - Impact of moving loads

Sleeper Spacing