DI04006071: Railway, Harbour & Tunnel Engineering

Lecture 2.13: Maintenance of surface levels of track, Alignment, Drainage, track materials

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Civil Engineering

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Importance of Track Maintenance I

Railway tracks are subjected to heavy dynamic loads from rolling stock. Regular maintenance is essential to ensure passenger comfort, safety, and to prolong the lifespan of track components. It involves preserving the geometric parameters like gauge, alignment, and level, alongside ensuring robust drainage and material integrity.

Key Points

- Prevents derailments and ensures safe train operations.
- Maintains passenger ride comfort by minimizing vibrations.
- Extends the service life of rails, sleepers, and ballast.
- Reduces long-term operational and renewal costs.

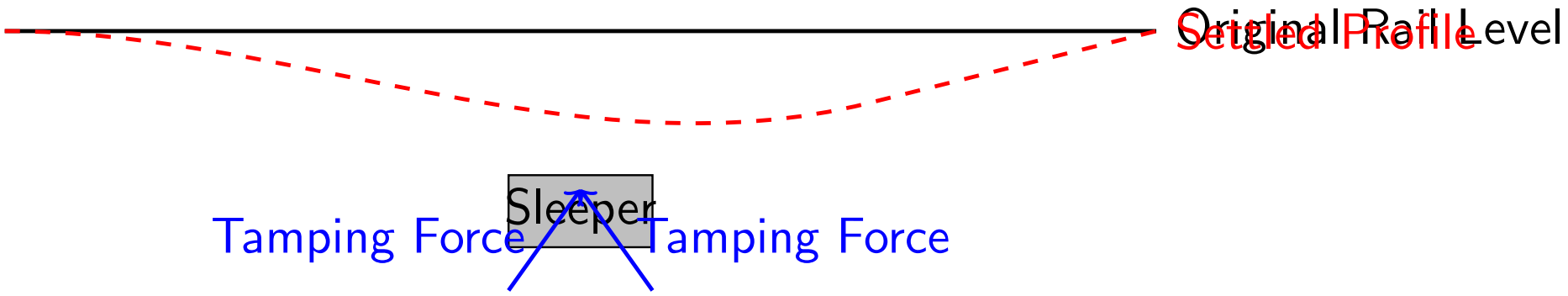
Maintenance of Surface Levels (Packing & Tamping) I

Maintaining the surface level involves ensuring both rails are at the correct relative heights, especially on straight tracks and curves. Uneven surface levels lead to rough riding and increased wear. This is corrected primarily through packing or tamping the ballast under the sleepers to restore the track's vertical profile.

Key Points

- Beater packing: Traditional manual method using beaters.
- Measured Shovel Packing (MSP): More accurate manual method for flat-bottom sleepers.
- Mechanized Tamping: Uses heavy machines to lift, align, and tamp ballast simultaneously.
- Cross-levels must be meticulously checked using a spirit level and gauge.

Track Settlement and Tamping Operation I



Ballast consolidation restores level

Key Points

- Diagram illustrates localized track settlement due to traffic loads.
- Tamping tines apply lateral and vertical forces to consolidate ballast.
- Restores the original rail level and ensures uniform load distribution.

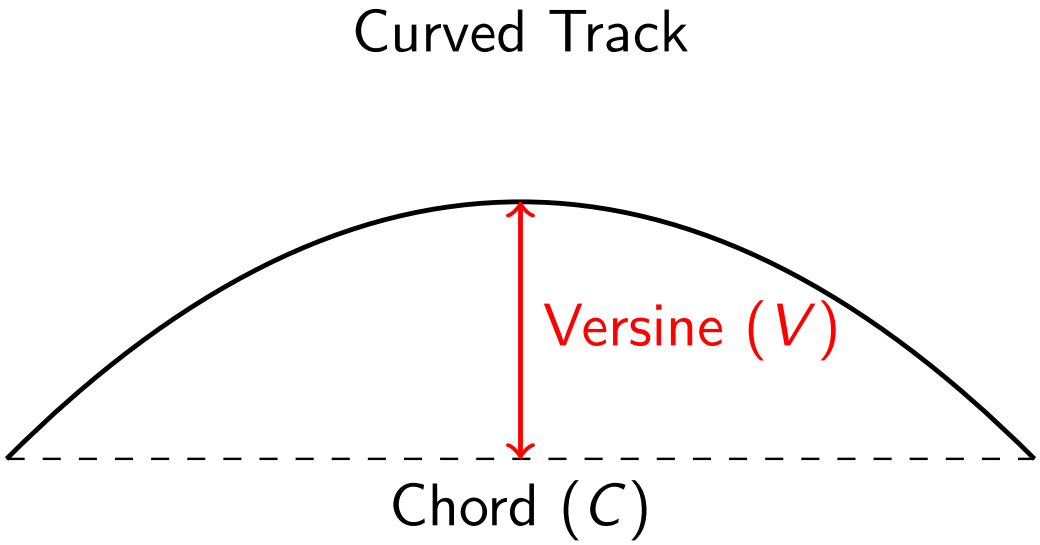
Alignment Maintenance I

Alignment refers to the correct positioning of the track in the horizontal plane. Poor alignment causes lateral oscillations, increasing flange wear and the risk of derailment. Maintaining alignment requires checking the versines on curves and correcting any deviations by slewing the track.

Key Points

- Straight tracks: Checked visually and using string lines.
- Curved tracks: Checked by measuring versines using a 20m overlapping chord.
- Slewing: The process of shifting the track laterally to its correct alignment.
- Often performed concurrently with lifting and tamping operations.

Versine Measurement on Curves I



Formula: $V = \frac{C^2}{8R}$

Versine Measurement on Curves II

Key Points

- Versine is the perpendicular distance from the chord to the arc.
- Used to determine the exact degree of curvature and local irregularities.
- Correct alignment ensures smooth transitions and safe curving speeds.

Track Drainage Systems I

Effective drainage is critical for track stability. Excess water in the track structure reduces the bearing capacity of the soil, causes ballast to become clogged (pumping sleepers), and accelerates the degradation of track materials. A comprehensive drainage system manages both surface and sub-surface water.

Key Points

- Surface Drainage: Catches and diverts rainwater using side drains and catch-water drains.
- Sub-surface Drainage: Lowers the water table using perforated pipes and French drains.
- Formation Slope: The subgrade is typically sloped (1 in 30 to 1 in 40) to shed water.
- Ballast section must be kept clean to ensure rapid percolation of water.

Drainage Requirements by Soil Type I

| Soil Type | Permeability | Drainage System Requirement | Vulnerability to Water | | :— | :— | :— | :— | | Gravel / Sand | High | Minimal (Standard side drains) | Low (Good natural drainage) | | Silt | Medium | French drains, deeper side ditches | Medium (Prone to frost heave) | | Clay | Low | Extensive sub-surface drains, blanket layer | High (Loss of shear strength, swelling) | | Peat / Organic | Very Low | Specialized stabilization, deep trenching | Very High (Extreme settlement) |

Key Points

- Clayey soils require a sub-ballast or blanket layer to prevent mud pumping.
- High permeability soils naturally facilitate the rapid removal of rainwater.
- Proper geotechnical assessment is required before designing the drainage network.

Maintenance of Track Materials: Rails I

Rails undergo intense wear and tear, including head wear, side wear on curves, and fatigue defects like squats or corrugations. Maintenance involves regular inspection, lubrication, and timely replacement or reprofiling to prevent rail fractures.

Key Points

- Ultrasonic Flaw Detection (USFD) used to identify internal micro-cracks.
- Rail grinding is performed to remove corrugations and restore the rail profile.
- Gauge face lubrication reduces side wear on curves.
- Defective rails must be classified (OBS, IMR) and replaced within stipulated timeframes.

Maintenance of Sleepers and Fastenings I

Sleepers hold the rails to the correct gauge and transfer loads to the ballast. Over time, wooden sleepers decay, concrete sleepers may crack, and steel sleepers can corrode. Fastenings (like ERC clips and rubber pads) lose their elasticity and clamping force, necessitating regular renewal.

Key Points

- Concrete sleepers inspected for hair-line cracks and crushing at rail seats.
- Elastic Rail Clips (ERC) require periodic greasing to prevent corrosion.
- Grooved Rubber Sole Pads (GRSP) are replaced when they lose their resilience.
- Anti-sabotage checks ensure fastenings are not missing or tampered with.

Maintenance of Ballast I

Ballast provides resilience, drainage, and lateral stability. Over time, it gets pulverized and mixed with dirt, losing its interlocking and draining properties. Maintenance involves cleaning the ballast and replenishing it to maintain the required cushion profile.

Key Points

- Deep Screening: The entire ballast section is cleaned using mechanized cleaners.
- Shallow Screening: Only the crib and shoulder ballast are cleaned manually.
- Ballast replenishment compensates for the loss due to pulverization and settlement.
- Clean ballast prevents the formation of 'pumping joints' and 'mud holes'.

Summary I

The comprehensive maintenance of surface levels, alignment, drainage, and track materials is vital for the safe and efficient operation of a railway network. Proper integration of manual and mechanized techniques ensures the track geometry remains within tolerances while maximizing the lifespan of the assets.

Key Points

- Surface levels and alignment are maintained via systematic tamping and slewing operations.
- Effective surface and sub-surface drainage preserves the formation's bearing capacity.
- Regular inspection and renewal of rails, sleepers, and ballast prevent catastrophic failures.
- Modern track maintenance relies heavily on mechanized tools and ultrasonic inspections.