DI04006071: Railway, Harbour & Tunnel Engineering

Lecture 1.3: Railway Track, Concept of Gauge, Advantages of Uniform Gauge and Loading Gauge

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Civil Engineering

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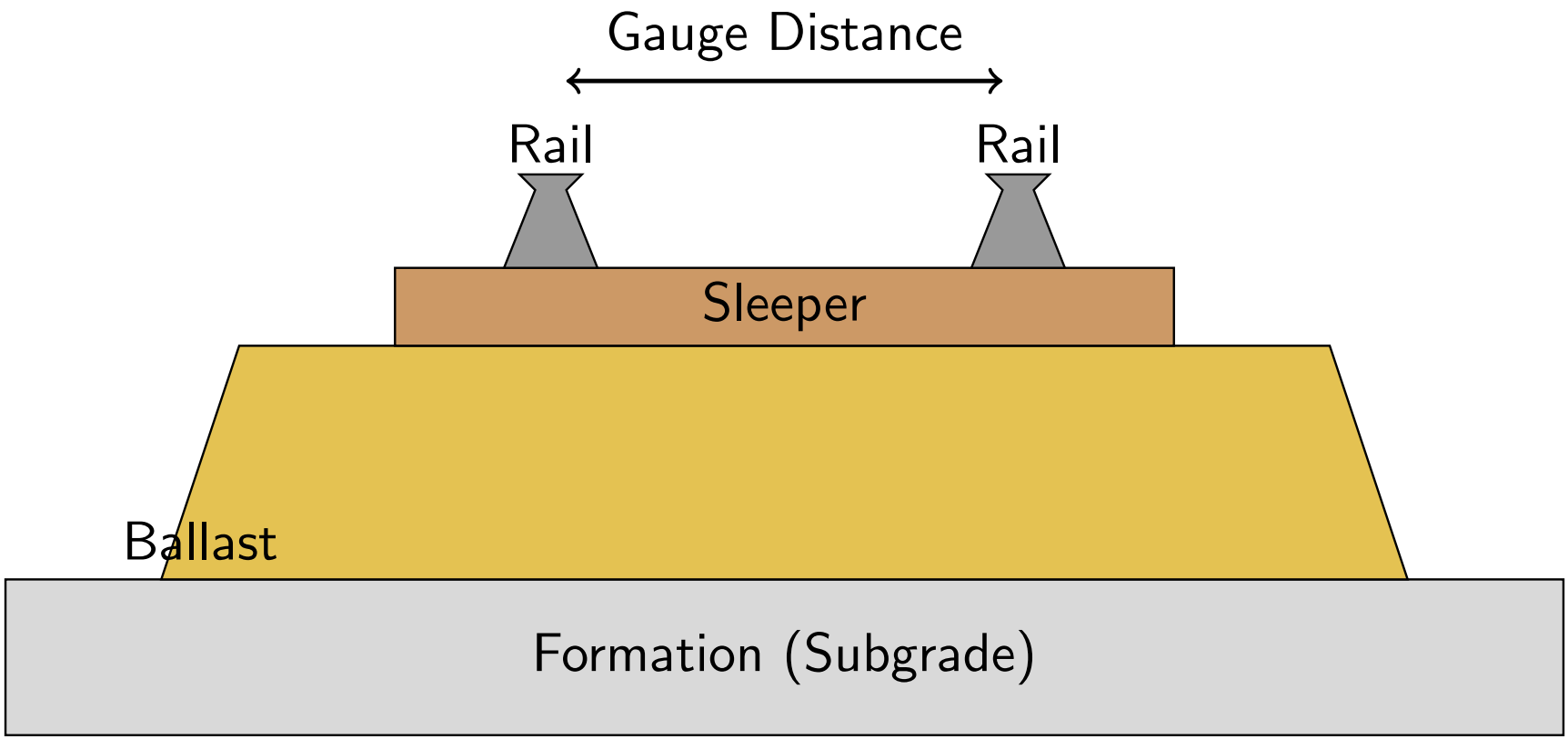
Introduction to Railway Track (Permanent Way) I

A railway track, also known as the permanent way, is the structure consisting of the rails, fasteners, railroad ties (sleepers), and ballast, plus the underlying subgrade. It provides a dependable surface for train wheels to roll upon. The basic requirement is to distribute the axle loads of the trains to the subgrade safely and efficiently.

Key Points

- Provides a continuous, level surface for train movement.
- Distributes train loads over a wider area of the subgrade.
- Maintains alignment and gradient for safe speeds.
- Reduces friction between steel wheels and steel rails.

Cross-Section of a Permanent Way I



Cross-Section of a Permanent Way II

Key Points

- Formation prepares the ground to take the load.
- Ballast transfers the load to the formation and provides drainage.
- Sleepers hold the rails at the correct gauge.
- Rails act as continuous girders supporting the wheels.

Functions of Track Components I

The permanent way acts as a composite structure where each component plays a vital role. The failure of any single component can compromise the safety and efficiency of the entire railway system. Rails withstand direct wear and tear, sleepers distribute point loads, and ballast absorbs vibrations.

Key Points

- Rails: Guide the wheels and transmit the load to sleepers.
- Sleepers (Ties): Hold the rails to the exact gauge and transfer load to ballast.
- Fastenings: Secure rails to sleepers and maintain alignment.
- Ballast: Holds sleepers in position, provides elasticity, and drains water.

Concept of Railway Gauge I

The gauge of a railway track is defined as the clear minimum perpendicular distance between the inner faces of the two rail heads. It is the most fundamental parameter of a railway network, dictating the design of the rolling stock, stability of trains, and permissible speeds.

Key Points

- Measured 14 mm below the top surface of the rail head.
- Dictates the maximum width and length of rolling stock.
- Influences the maximum safe speed and hauling capacity.
- Different countries and regions adopted various gauges historically.

Standard Railway Gauges I

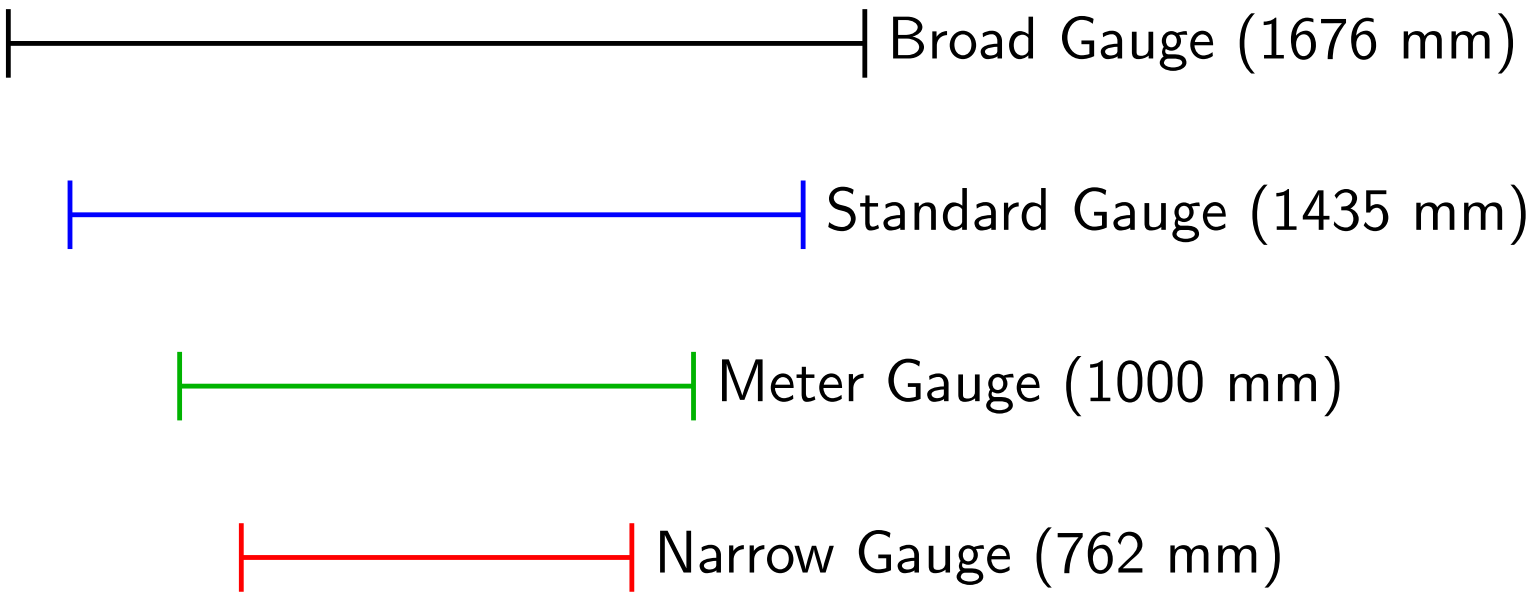
Globally, several gauges are in use. The following table summarizes the primary gauges used globally and in India:

Gauge Type	Name	Width (mm)	Typical Usage
Broad Gauge	BG	1676	India, Pakistan, Sri Lanka
Standard Gauge	SG	1435	Global standard (High-speed rail, Metro)
Meter Gauge	MG	1000	Heritage routes, some developing networks
Narrow Gauge	NG	762 / 610	Hilly terrain, industrial railways

Key Points

- Broad Gauge (BG) is used extensively in India, Pakistan, and Russia.
- Standard Gauge (SG) is the global norm for high-speed rail.
- Meter Gauge (MG) was widely used in India but is being converted.
- Narrow Gauge (NG) is used in hilly and difficult terrains.

Visualizing Different Gauges I



Key Points

- Broad Gauge offers higher stability and capacity.
- Standard Gauge facilitates international connectivity.
- Narrow Gauge has sharper curves and lower construction costs.
- Gauge uniformity is crucial for a seamless network.

Problems with Multi-Gauge Systems I

A network with multiple gauges creates bottlenecks at junctions where passengers and freight must be transferred from a train of one gauge to another. This process, known as transshipment, leads to significant operational inefficiencies.

Key Points

- Inconvenience to passengers requiring train changes.
- Delays in goods movement, causing economic losses.
- High cost of transshipment (labor, specialized equipment).
- Damage and pilferage of goods during transfer.
- Requirement of duplicate facilities at junction stations.

Advantages of a Uniform Gauge I

Adopting a single, uniform gauge across a railway network, such as India's 'Project Unigauge', eliminates transshipment bottlenecks, dramatically improving the efficiency, speed, and economics of railway transportation.

Key Points

- Uninterrupted travel for passengers and freight.
- Optimal utilization of rolling stock (wagons and locomotives).
- Reduction in overall transport time and operational costs.
- Enhanced strategic and military mobility during emergencies.
- Simplified maintenance and standardization of track components.

Concept of Loading Gauge I

A loading gauge defines the maximum height and width to which rolling stock (passenger coaches and freight wagons) can be safely built or loaded. It acts as an envelope that trains must fit within to ensure they do not collide with trackside structures.

Key Points

- Defines the external physical limits of trains.
- Ensures safe passage under bridges and through tunnels.
- Prevents collisions with platform canopies and signals.
- Varies depending on the track gauge and country standards.

Loading Gauge vs. Construction Gauge I

While the loading gauge dictates the maximum size of the train, the construction gauge (or structure gauge) defines the minimum clearance required for all permanent structures near the track. The difference between these two gauges provides the necessary safety margin.

Key Points

- Loading Gauge: Maximum profile of the train.
- Construction Gauge: Minimum profile of fixed structures.
- Clearance: The gap between the two gauges to account for train sway.
- Ensures kinematic envelope is safely accommodated.

Summary I

The permanent way is a complex structure designed to distribute train loads safely. The gauge is the fundamental dimension determining train size and capacity. A uniform gauge is essential for an efficient, uninterrupted railway network. The loading and construction gauges work together to ensure trains can operate safely without striking trackside structures.

Key Points

- Permanent way components: Rails, sleepers, ballast, subgrade.
- Gauge: Inner distance between rails (e.g., BG, SG, MG).
- Uniform gauge eliminates costly and slow transshipment.
- Loading gauge ensures trains fit within structural limits.