DI04006071: Railway, Harbour & Tunnel Engineering

Lecture 3.17: Types of Point or Switches, High-speed S&C

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Civil Engineering

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Introduction to Points and Switches I

Points (or switches) are critical components of a turnout assembly that allow trains to be diverted from one track to another. They consist of movable rails known as tongue rails that guide the wheels toward the diverging or straight route.

Key Points

- A switch assembly primarily includes stock rails and tongue rails.
- Tongue rails are machined to a fine point at the toe to fit snugly against the stock rail.
- The operation of switches determines the route of the train safely.

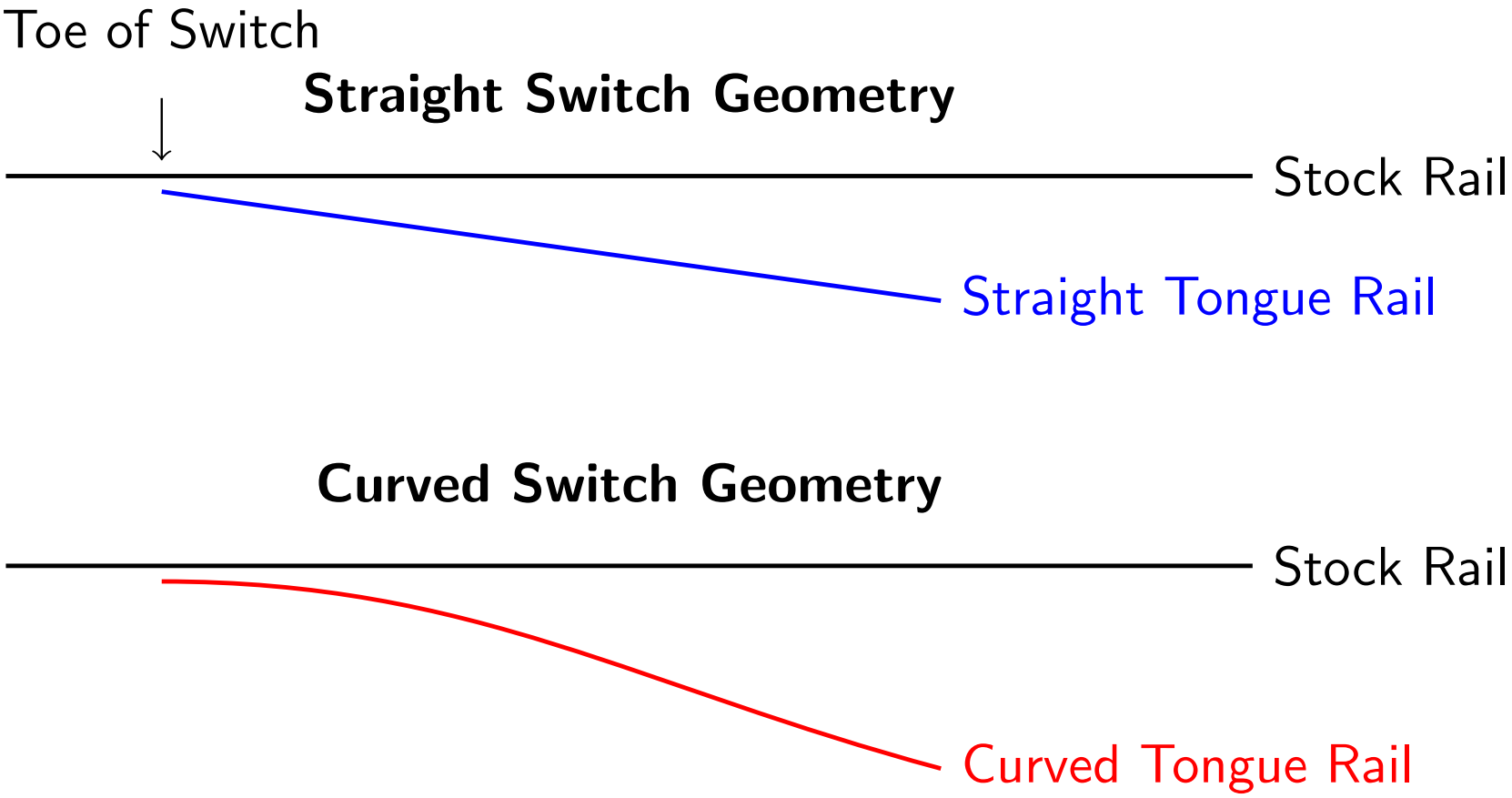
Types of Switches: Based on Shape I

Switches are broadly classified into two categories based on the geometric shape of the tongue rails: straight switches and curved switches. The choice depends on speed requirements and space constraints.

Key Points

- Straight Switches: The tongue rail is straight from toe to heel. Typically used for low-speed turnouts due to an abrupt change in alignment.
- Curved Switches: The tongue rail is curved to match the radius of the diverging track, providing a smoother transition for higher speeds.
- Curved switches reduce the entry angle and subsequent lateral forces on the wheels.

Geometric Layout: Straight vs. Curved Switches I



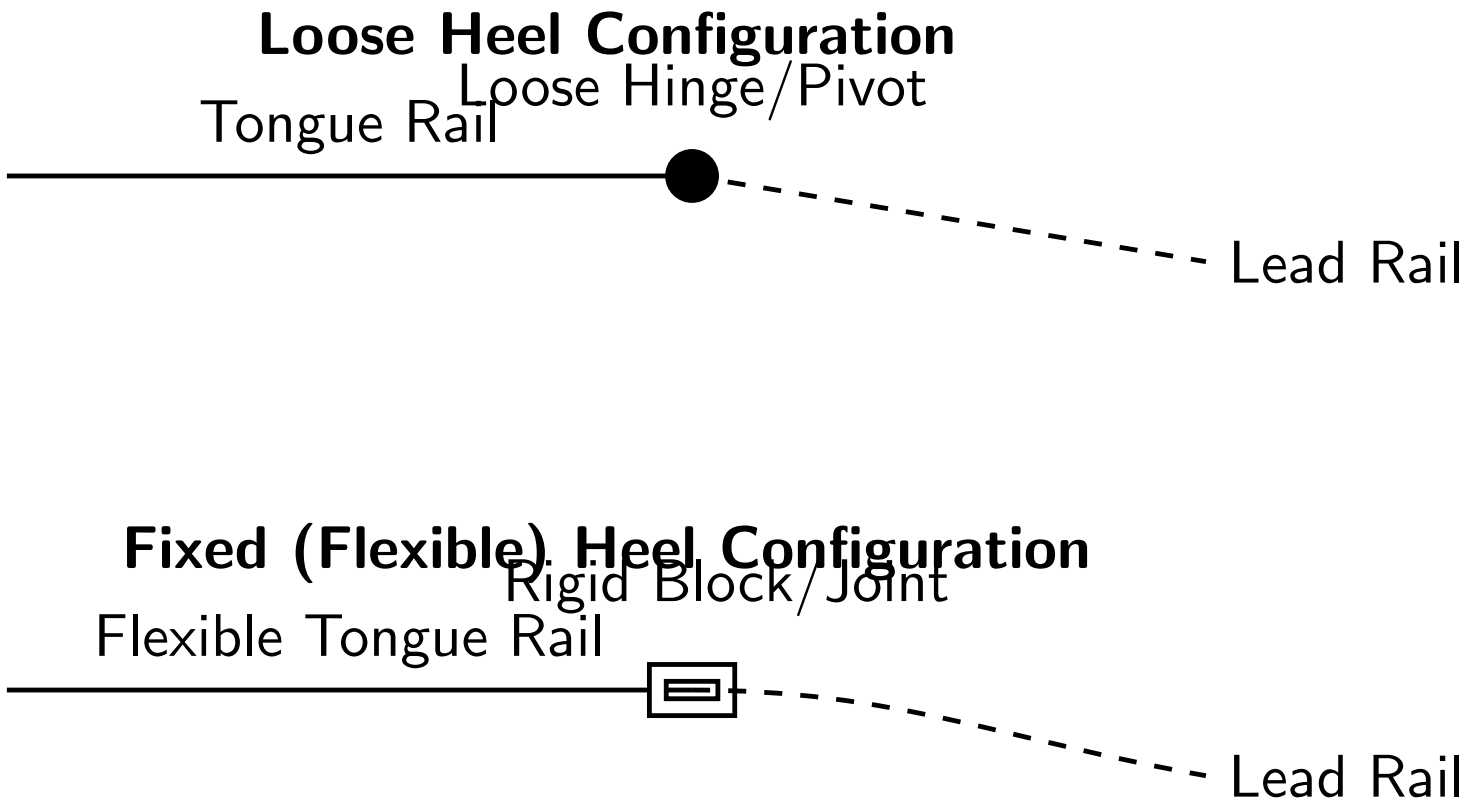
Types of Switches: Based on Heel Connection I

The heel is the fixed end of the tongue rail. Switches are classified by how the tongue rail is attached at the heel to the lead rail.

Key Points

- Loose Heel Switch: The tongue rail is attached via a fishplate joint that acts as a hinge. It allows easy movement but causes maintenance issues and track weakness.
- Fixed Heel Switch: The tongue rail is rigidly connected at the heel. The movement at the toe is accommodated by the inherent flexibility of the rail steel.
- Fixed heel switches are preferred for modern, heavier, and faster traffic due to better alignment stability.

Heel Configurations Diagram I



Introduction to High-Speed S&C I

As train speeds increase, standard switches and crossings pose significant risks due to dynamic impact loads, gaps in the track, and abrupt geometric variations. High-speed S&C (Switches and Crossings) are engineered to mitigate these issues.

Key Points

- Requires flatter turnout angles (e.g., 1 in 20, 1 in 40) for larger radii.
- Must provide continuous rail support to prevent wheel drop.
- Demands high precision in locking and detection to prevent derailment.
- Uses specialized components like Thick Web Switches and Moveable Nose Crossings.

Standard vs. High-Speed Switches I

A comparison showing the shift in design parameters necessary to accommodate high-speed rail operations.

Key Points

- | Feature | Standard Switch | High-Speed Switch |
- |———|———————|———————–|
- | Tongue Rail Section | Standard rail, machined | Thick Web Switch (TWS) |
- | Heel Joint | Loose or Fixed | Always Fixed (Flexible) |
- | Crossing Type | Fixed V-crossing with gap | Moveable/Swing Nose Crossing |
- | Locking Mechanism | Single point lock | Multiple clamp point locks |
- | Permissible Diverging Speed | Usually < 50 km/h | Can exceed 100-200 km/h |

Thick Web Switches (TWS) I

Thick Web Switches are specially rolled steel sections used for high-speed turnouts. Unlike standard machined rails, TWS provide higher structural integrity at the switch toe.

Key Points

- The web of the tongue rail is exceptionally thick, resisting lateral bending forces.
- Accommodates shallow entry angles for high speeds.
- Eliminates the structural weakness found in heavily machined standard tongue rails.
- Requires powerful switch machines due to the stiffness of the rail section.

Moveable Nose Crossings (Swing Nose) I

In a standard crossing, there is an inherent gap where the wheel flange passes, causing an impact load. A Moveable Nose Crossing (MNC) physically closes this gap.

Key Points

- The V-shaped nose is flexible and moves to physically abut the wing rail.
- Provides a continuous running surface for the wheel tread.
- Eliminates impact loads, extending the lifespan of the crossing and improving passenger comfort.
- Requires its own point machine synchronized with the main switch.

Actuation and Safety Locking I

Due to the extreme lengths and stiffness of high-speed switches (such as TWS), standard single-point actuation is insufficient. Advanced actuation is required.

Key Points

- Multiple Point Machines: Placed along the length of the switch to ensure it closes completely.
- Clamp Point Locks: Directly lock the tongue rail to the stock rail, independently verifying closure.
- Micro-processor based condition monitoring continuously checks for proper alignment and lock before clearing signals.

Summary I

Switches and crossings form the fundamental routing mechanism in railway engineering. The progression from standard to high-speed S&C represents a significant technological leap focused on safety and ride quality.

Key Points

- Switches can be straight or curved; fixed or loose heel, depending on the speed criteria.
- High-speed rail requires Thick Web Switches (TWS) for lateral rigidity.
- Moveable Nose Crossings are essential for continuous wheel support at high speeds.
- Robust, multi-point locking systems guarantee safety in high-speed turnout operations.