



# Railway Accidents and Kavach System

**For Prelims:** [Rashtriya Rail Sanraksha Kosh \(RRSK\)](#), [KAVACH](#), [Committees](#)

**For Mains:** Railway Safety: Challenges, Measures Taken and Way Forward

[Source: IE](#)

## Why in News?

Recently, the collision at Rangapani involving the **Kanchenjunga Express** highlights the necessity for **enhanced safety measures**.

- Despite safety advancements, Indian Railways has experienced **fluctuating collision rates**, recording six incidents in 2022-23 and four in 2023-24, highlighting the ongoing need to prevent such incidents.

## What are the Reasons behind Railway Accidents?

- **Derailments:** Many train disasters in India are **caused by derailments**, with a government safety report from 2020 finding they were responsible for **70% of train crashes** in the country.
  - A 2022 [Comptroller and Auditor General](#) report noted that 7 in 10 railway accidents between 2018 to 2021 came due to derailments.
- **Human Errors:** The railway staff, who are responsible for operating, maintaining, and managing the trains and tracks, are **prone to human errors** due to **fatigue, negligence**, corruption, or disregard for safety rules and procedures.
- **Signalling Failures:** The signalling system, which controls the movement and direction of trains on the tracks, can fail due to **technical glitches, power outages**, or human errors.
- **Unmanned level crossings (UMLCs):** UMLCs are crossings where railway tracks intersect without barriers or signals, all unmanned ones on broad gauge routes have been removed, yet accidents still pose risks at [manned level crossings \(MLCs\)](#).
- **Infrastructure Defects:** The railway infrastructure, which includes tracks, bridges, overhead wires, and rolling stock, is **often defective** due to poor maintenance, ageing, vandalism, sabotage, or natural disasters.
  - Many routes are **operating at over 100% capacity**, which increases the risk of accidents due to congestion and overloading.
- **Safety and Information Flow Challenge:** Since the inception of railways in India, periodic field inspections by authorities at various levels have been crucial for ensuring compliance with established procedures and standards.
  - This **"top-down" approach** inherently places the responsibility of detecting deviations on higher authorities, creating a **"cops and robbers"** dynamic where **higher authorities view frontline staff with suspicion**, and the latter adopts a **"catch me if you can" attitude**.
    - This scenario **encourages superficial compliance** and conceals underlying issues, undermining transparency and frankness.

- Such dynamics can be counterproductive, especially in railway safety matters, where many accidents result from a series of 'near miss' situations, unsafe practices, or deviations from the norm over time.

## What Steps have been taken by Railways to Reduce Accidents?

- **Sufficient Funding:** Creation of special funds known as [Rashtriya Rail Sanraksha Kosh \(RRSK\)](#) and the [Rail Safety Fund](#) but also through capital grants it is permitted to utilise towards these essential requirements.
  - **Rashtriya Rail Sanraksha Kosh (RRSK)** is a **safety fund for critical assets** established in 2017-18 with a corpus of Rs 1 lakh crore over five years for critical safety-related works such as track renewals, signalling projects, bridge rehabilitation, etc.
  - An unprecedented allocation for **capex of over Rs 2.5 lakh crore** was made during 2023-24 and again for 2024-25.
- **Expansion of Railway Network:** While the rail network is being extended to cover the farthest parts of the country, **capacity augmentation** of the congested routes is also being undertaken.
  - The **National Rail Plan 2030** aims to identify [new dedicated freight](#) and high-speed rail corridors and increase the average speed of trains.
- **LHB Design Coaches:** Lighter and safer coaches for Mail/Express trains. These coaches are **based on German technology** and have better anti-climbing features, fire retardant materials, higher speed potential and longer service life than conventional ICF design coaches.
- **Modern Track Structure:** Stronger and more durable tracks and bridges. This includes using a **Prestressed Concrete Sleeper (PSC)**, higher Ultimate Tensile Strength (UTS) rails, fan-shaped layout turnout on PSC sleepers, Steel Channel Sleepers on girder bridges, etc.
- **Technological Upgradation:** Improved design and features of coaches and wagons. This includes **introducing Modified Centre Buffer Couplers**, Bogie Mounted Air Brake System (BMBS), improved suspension design and provision of Automatic fire & smoke detection system in coaches.
  - It also includes installing [KAVACH](#)- an indigenously developed Automatic Train Protection (ATP).
  - Indian Railways have installed **Block Proving Axle Counter (BPAC)** for better Railway traffic control. BPAC is a **train detection system** installed on trains, which **automatically detects** the crossing of a train between two points on the track.
    - It doesn't permit two trains to be within the same block section at the same time, which ensures the safety of trains.

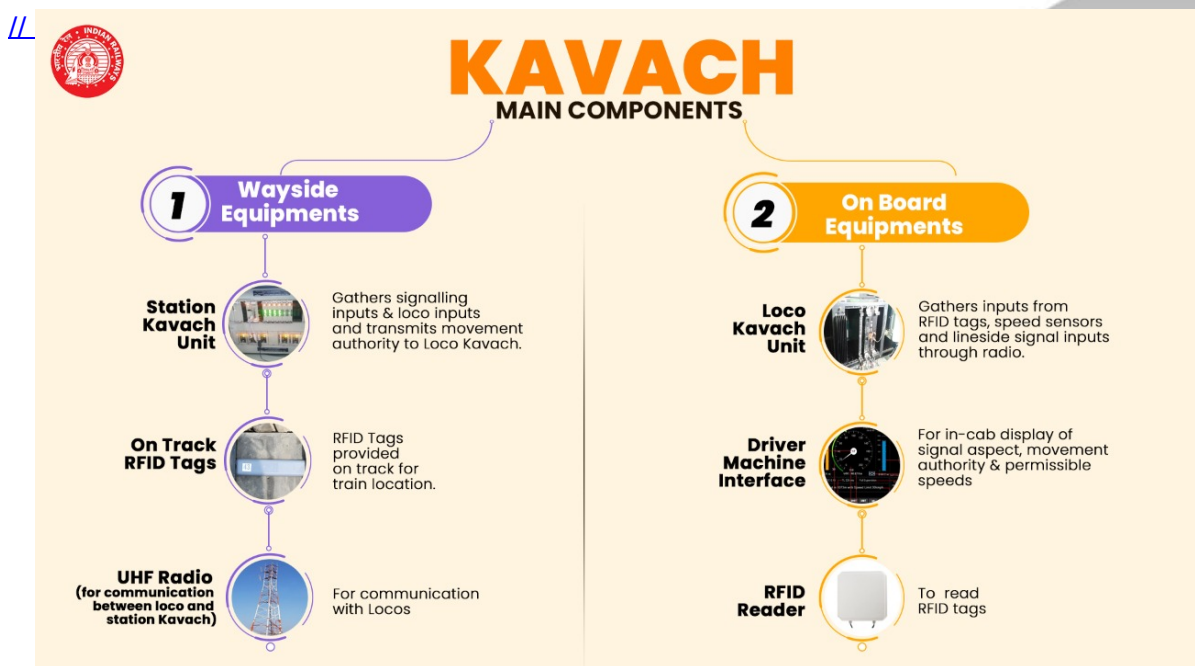
## Electronic Interlocking (EI)

- It employs **computer-based systems** and electronic equipment to control signals, points, and level-crossing gates.
- Unlike conventional relay interlocking systems, EI utilises software and electronic components to manage the interlocking logic.
- EI ensures the **synchronisation of all elements** to facilitate uninterrupted train movement.
- As of 2022, 2,888 stations in India were equipped with an electronic interlocking system comprising 45.5% of the Indian Railways network.

## What is the Kavach System?

- **About:**
  - [Kavach](#) launched in 2020, is a **cab signaling train control system** with **anti-collision features** developed by the [Research Design and Standards Organisation \(RDSO\)](#) in association with three Indian vendors.
  - It has been adopted as **National Automatic Train Protection (ATP) System**.
  - It adheres to **Safety Integrity Level-4 (SIL-4) standards** and acts as a vigilant watchdog over the existing signaling system, alerting the loco pilot when approaching a 'red signal' and applying automatic brakes if necessary to prevent overshooting the signal.

- Safety Integrity Level is a measure used in functional safety standards to quantify the level of risk reduction provided by a safety function. SILs are defined in range from SIL 1 (lowest level of safety integrity) to SIL 4 (highest level of safety integrity).
  - The system also **relays SoS messages** during emergency situations.
  - It features **centralised live monitoring** of train movements through the Network Monitor System.
- **Components of Kavach:**
- **The Kavach system's deployment involves three critical components:**
    - Firstly, [Radio Frequency Identification \(RFID\)](#) technology is integrated into the tracks. RFID uses electromagnetic fields to automatically identify and read information from a wireless device from a distance, without requiring physical contact or a line of sight
    - Secondly, the driver's cabin (locomotive) is equipped with **RFID readers**, a computer, and brake interface equipment
    - Finally, **radio infrastructure**, including towers and modems, is installed at railway stations.



- **Status of Kavach:**
- Kavach aims to secure India's extensive railway network of over 68,000 km, but **only 1,500 km are currently equipped** with the system since its initial rollout.
    - It costs ₹50 lakh per km for trackside installation and ₹70 lakh per train.
  - It aims to **cover 6,000 km by 2025**, including key routes like **Delhi-Mumbai and Delhi-Howrah**.
    - While current capacity is 1,500 km annually, it's expected to reach 5,000 km by 2026.
  - Upgrades are planned to make the system [4G/5G](#) compatible.
  - Installation is ongoing, with components like optical fiber cables, towers, and station equipment being deployed.

## Committees Recommendations

- [Kakodkar Committee \(2012\):](#)
  - Adopting **advanced technologies** for track maintenance and inspection
  - Improving **human resource** development and management
- [Bibek Debroy Committee \(2014\):](#)
  - Separating the **railway budget** from the general budget

- Outsourcing **non-core activities**
- Creating a **Railway Infrastructure Authority of India**
- [Vinod Rai Committee \(2015\)](#):
  - Establishing an independent Railway Safety Authority with statutory
  - Setting up a **Railway Accident Investigation Board** to conduct independent and impartial inquiries.
  - Creating a **separate Railway Infrastructure Company** to own and maintain railway assets.

## What Steps are Needed to Enhance Safety in India?

- **Creating Statutory Railway Safety Authority:** Set up a railway safety authority as a statutory body with **powers to frame safety standards**, conduct safety audits and inspections, enforce accountability and penalties for lapses, and investigate accidents.
- **Confidential Incident Reporting and Analysis System (CIRAS):** Given the rapid advances in communications and information technology, it is crucial to **introduce a confidential reporting system** like CIRAS in the UK for Indian Railways, focusing on **correction over punishment** and fostering a **culture of shared safety** commitment from management.
- **Enhance Coordination and Communication:** Improve the communication and coordination **among the railway board, zonal railways**, divisions, production units, research organisations, etc., which are involved in railway operations.
- **Invest More in Safety-Related Works:** Allocate more funds **for track renewal, bridge** repair, signalling upgrade, coach refurbishment, etc.
- **Train Employees to Minimize Human Errors:** Provide **regular and comprehensive training** to the railway staff on the latest technologies, equipment, systems, safety rules and procedures.
- **Improve Infrastructure:** Indian railway tracks **need regular checks**, especially because they expand in summer and contract in winter due to temperature changes, requiring **structural and geometrical evaluations** every **three months**.
- **Adopt advanced technologies:** Install [anti-collision devices \(ACDs\)](#) such as Kavach/ Train Collision Avoidance System (TCAS), Train Protection Warning System (TPWS), Automatic Train Control (ATC), etc.
  - The railways are in the process of installing these technologies on some sections of tracks, but they **need to be expanded** to cover the entire network.
  - Emulate **successful Automatic Train Protection Systems** from other regions, like **Mumbai's suburban system**.
- **Introduce Performance-Linked Incentives:** Reward the railway staff based on their **performance and compliance** with the safety rules and procedures.
- **Ensure accountability:** The government must consider presenting an **annual performance report** of the Railways in the Parliament, similar to the Finance Ministry's Economic Survey before the General Budget, **focusing on internal audit** of performance.
- **Indian Railways Management Service (IRMS):** Evaluate the IRMS scheme's impact on loyalty, ownership, and safety, and consider revising and implementing it to enhance specialization and commitment to safety.
- **Learning From Best Global Practices:**
  - Despite recent accidents, Indian railways **maintain a strong safety record** compared to international standards. In 2022, IR recorded 0.03 significant accidents per million train km, **significantly lower than** the 0.39 per million train km average **across 35 countries**.
  - **United Kingdom:** The UK has **one of the lowest rates of train accidents** in Europe.
    - The **Train Protection and Warning System (TPWS)**, **automatically stops trains** that pass signals at danger or exceed speed limits.
    - The European Train Control System (ETCS), provides continuous **communication** between trains and signalling centres.
  - **Japan:** Japan's high-speed Shinkansen trains, operating at up to 320 km/h, have maintained a **perfect safety record** since 1964 due to advanced safety measures like the **Automatic Train Control (ATC) system, Comprehensive Automatic Train Inspection System (CATIS)**, and Earthquake Early Warning System (EWS).



**Drishti Mains Question:**

Q. Discuss the major challenges faced by Indian Railways in preventing train collisions. What measures can be implemented to enhance safety and reduce the risk of such incidents?

**UPSC Civil Services Examination, Previous Year Question (PYQ)**

**Prelims:**

**Q. Consider the following communication technologies: (2022)**

1. Closed-circuit Television
2. Radio Frequency Identification
3. Wireless Local Area Network

**Which of the above are considered Short-Range devices/technologies?**

- (a) 1 and 2 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

**Ans: (d)**

**Mains:**

**Q.** The setting up of a Rail Tariff Authority to regulate fares will subject the cash strapped Indian Railways to demand subsidy for obligation to operate non-profitable routes and services. Taking into account the experience in the power sector, discuss if the proposed reform is expected to benefit the consumers, the Indian Railways or the private container operators. **(2014)**