Smart Safety Response Technology Centered on Railway Systems

Climate-Adaptive Traffic Safety Control Technology

2026. 05. 06.

NATIONAL INSTITUTE OF GREEN TECHNOLOGY

Contents

Climate-Adaptive Traffic Safety Control Technology

Chapter
1

Overview

The impact of climate change on railways

Temperature Impact (Heatwave)

Increased Risk of Rail Buckling

Snowfall Impact (Heavy Snowfall)

Track Switch Failure

Precipitation Impact (Torrential Rain)

Subgrade Subsidence, Flooding

Wind Impact (Strong Winds)

Risk of Vehicle Overturning

Existing Railway Safety Control Limits

01

Operation Restrictions Based on Fixed Thresholds

■ Concept

A method of restricting operation based on a predetermined threshold value

■ Examples

① Temperature 0℃ or higher
→ Slow speed

② Rainfall 0mm or higher
→ Operation restriction

③ Wind speed 0m/s or higher
→ Operation suspension

02

Insufficient Real-time Weather Reflection

■ **Concept**

A structure that fails to reflect weather data in real-time and locally

■ **Problems**

Climate risks are 'localized'Control is 'wide-area'

■ **Specific Limitations**

① Rail temperature
→ Rise only in certain sections

② Flooding
→ Occurs only in specific low-lying areas

③ Strong winds
→ Risk only in bridge sections

03

Reactive Operation

■ **Concept**

A method of responding after a problem occursReactive System

■ **Problems**

Level of 'accident avoidance' rather than prevention

■ **Types**

① Rail buckling
→ Operation suspended after discovery

② Flooding
→ Subsequent control

③ Switch failure
→ Action taken after breakdown

Implications

Existing railway safety control systems are unable to effectively respond to dynamic risks, such as climate change, due to static standards, non-real-time information, and a reactive response structure.

Definition of Climate-Adaptive Safety Control Technology

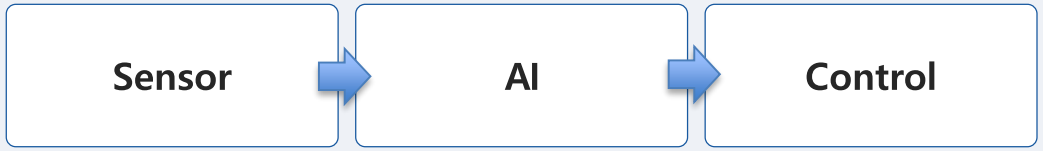
Definition

Basic Definition

Intelligent control technology that ensures safety by collecting and analyzing climate/environmental change data in real time and actively adjusting operating conditions of transportation systems.

Expanded Definition

A dynamic safety control system that integrates weather, environmental, facility, and operational data to predict risks in advance and automatically apply optimal control strategies.



Definition Key Components

Sensing	Temperature Rainfall wind speed snowfall	Rail temperature Track deformation Flooding status	Acquisition of higher-density real-time data than before
Analytics	Data fusion (weather+facility +operation)	Risk assessment	Prediction
Decision	Determination of speed limit requirements	Determination of operation suspension	Determination of maintenance necessity
Control	Automatic deceleration	Train spacing adjustment	Signal system interlocking

Key Definition

Climate-adaptive safety control technology is an ‘intelligent railway safety system’ that independently judges and responds to environmental changes.

Chapter
2

Key Technology Elements and Features

Key Technology Elements and Features

Hazardous Environment Detection Technology

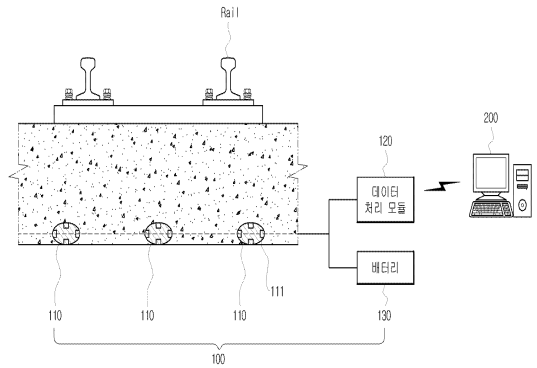
1.

Hazardous Situation Detection

Rainfall and flood detection

Rail Temperature Sensor

Anemometer / Track Deformation Monitor



Key Technology Elements and Features

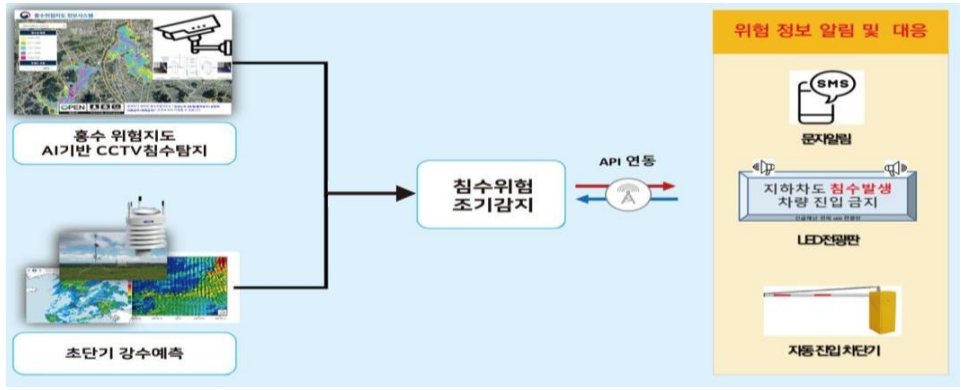
AI Predictive Control

2.

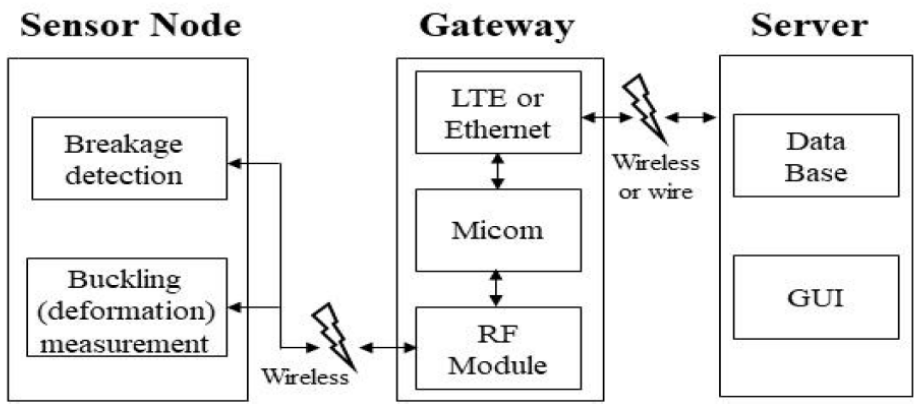
▶▶▶

Risk preparedness measures

Rainfall-based flood risk prediction



Rail Buckling Prediction Algorithm



Advance warning of branch failure

Key Technology Elements and Features

Automatic Driving control

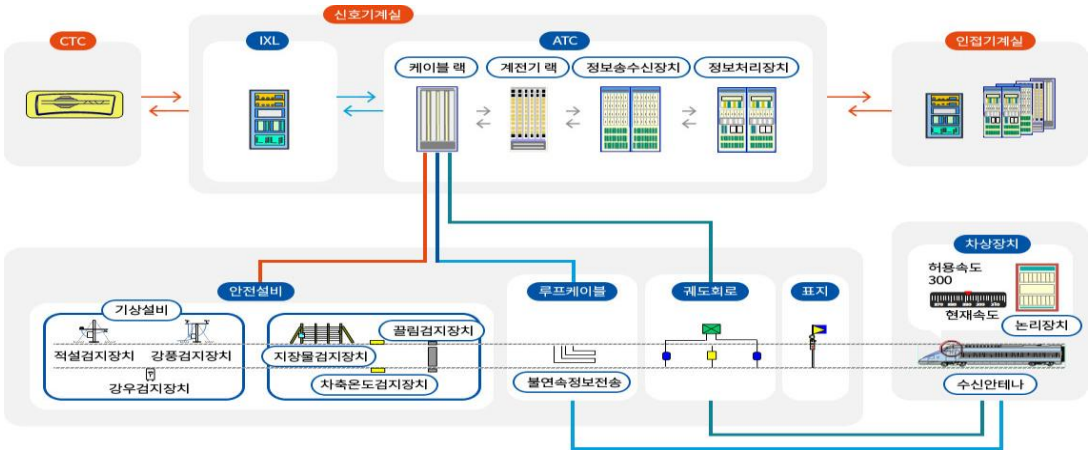
3.

►►►

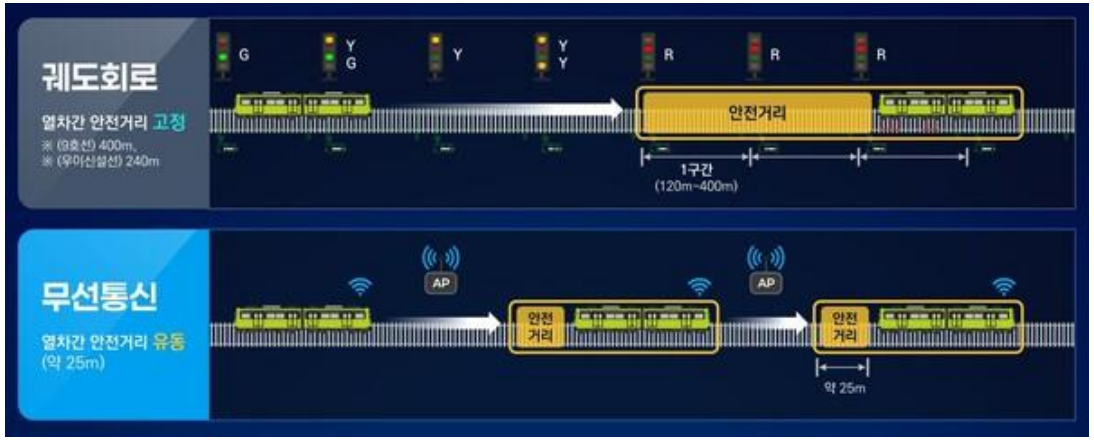
Elimination of risk factors

Decision to suspend operation

Automatic Deceleration Command



Signal Control Interlock / Train Interval Adjustment

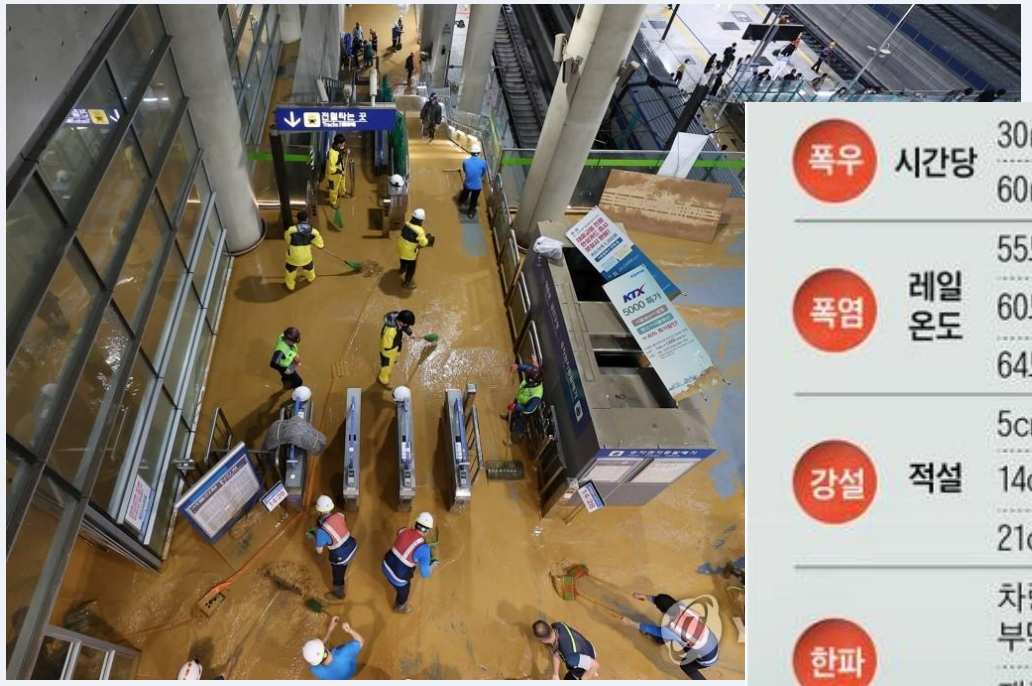


Chapter
3

Application Examples

Domestic Application Cases

Operation Restrictions on Flooded Sections



폭우	시간당	30mm 이상	170km/h 이하 서행
		60mm 이상	운행 중지
폭염	레일 온도	55도 이상	230km/h 이하 서행
		60도 이상	70km/h 이하 서행
		64도 이상	운행 중지
강설	적설	5cm 이상	230km/h 이하 서행
		14cm 이상	170km/h 이하 서행
		21cm 이상	130km/h 이하 서행
한파		차량에 얼음 튀어 부딪힐 경우	230km/h 이하 서행
		재차 부딪힐 경우	170km/h 이하 서행

자료=코레일

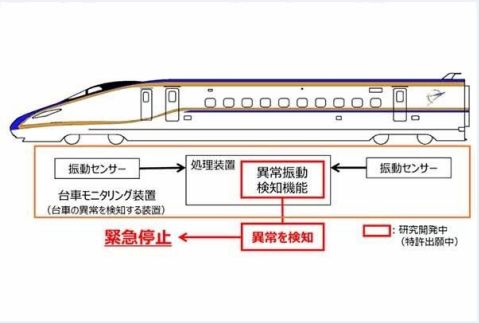
Slow Driving During Heatwaves

Key Point

Various technologies to adapt to climate are being developed and applied across various domestic railway sectors, including high-speed rail, conventional rail, and urban rail.

Overseas Application Cases

Climate Factors and Application Background



■ Background of Application

Frequent complex disasters such as typhoons, torrential rains, and earthquakes

Shinkansen Application Technology

■ Rainfall-Based Automatic Operation Control

① Real-time measurement of rainfall per track

② When thresholds are exceeded: Automatic deceleration and suspension of operation
Feature: Control by section rather than the entire route

■ Wind Speed-Based Operation Restrictions

① Wind speed sensors on bridges and elevated sections

② Control: Speed limiting and stopping based on wind speed levels

■ Earthquake Early Warning Interlock System
Detection of seismic waves (P-wave)
→ Automatic emergency stop

Key Point

This is a representative implementation of the Shinkansen's real-time detection function and automatic control, and various climate-responsive technologies are being developed in countries such as Germany, the UK, and the US.

Chapter
4

Conclusion

Conclusion

Summary

■ Accident Prevention (Reactive → Preactive)

① Current : Response after an accident occurs

② Improved : Preactive response based on risk prediction

○ Enables prevention of major accidents such as derailments, collisions, and flooding

■ Improved Operational Stability

① Optimal operation control tailored to weather conditions

② Minimization of unnecessary operational restrictions

○ Enhanced punctuality and service reliability

■ Streamlined Maintenance

① Condition-based maintenance

② AI-based optimization of inspection timing

○ Reduced unnecessary inspections and proactive prevention of breakdowns

Expected Effects

■ Accident Prevention

■ Improved Operational Stability

■ Streamlined Maintenance

■ Cost Reduction

■ Implementation of Smart Railways

“Railway safety that does not consider climate is no longer safe.”

Conclusion

Future railway safety is determined not by the ‘ability to adapt’ to the climate, but by the ‘ability to utilize the climate as a control variable.’

Thank You!