Have a Safe Trip

On Japan's Shinkansen high-speed railway, punctuality and safety are never in doubt.

TAKASHI SASAKI

SINCE the Tokaido Shinkansen began operating between Tokyo and Osaka in 1964, the Shinkansen has become indispensable as a means of transportation in Japan. Today, its lines extend from the northernmost main island of Hokkaido to Kagoshima Prefecture at the southern end of Kyushu, with a total length of around 3,300 kilometers.

The Shinkansen bullet train is distinguished primarily by its ultra-high speed, which reaches up to 320 kilometers per hour, and its outstanding safety and accurate operation. One of the technologies that support its safety is the Automatic Train Control system (ATC), which has been in place in every section since the opening of the Tokaido Shinkansen.

"Unlike traditional railways, the Shinkansen runs at a super-high speed, which makes it impossible to visually check the wayside signal from the driver's seat. That's why ATC was introduced," says Yoshiyuki Onda of the Railway Operations Headquarters at East Japan Railway Company (JR East). "For example, when the inter-vehicle distance from the front train becomes shorter, the machine automatically performs the actual operations instead of the driver, such as slowing down and bringing the train to a stop, while also displaying the signals on the monitor at the driver's seat."

The cockpit of the E5 series bullet train
Courtesy of JR East

ATC's basic system, in which the vehicle detects the signal current flowing through the rail to control the traveling speed, has remained unchanged from its launch to the present date. However, its performance has made dramatic progress over the course of fifty years. The biggest evolution was the introduction of digital DS-ATC in 2002.

With conventional ATC, wayside equipment transmitted a signal of the allowed speed to the Shinkansen at certain sections as the train traveled. As a result, while a Shinkansen train was slowing down, it applied incremental, strong brakes in each section, making the ride uncomfortable.

"With DS-ATC, on the other hand, the on-board equipment autonomously calculates and controls the optimum speed of the train based on stopping point information transmitted from wayside devices. For speed calculation, it also takes account of the difference in the brake performance of each train, the curves and gradients of the railway tracks, and other information, so it applies appropriate braking to achieve smooth deceleration," says Onda. "As a result, the time loss due to deceleration and stopping has been reduced, and the ride has been made far more comfortable."

Introduced by JR East in 1995, the Shinkansen integrated system called COSMOS (COmputed Safety Maintenance and Operation systems of Shinkansen) is another indispensable element for the operation of the Shinkansen, along with ATC. The most important feature of COSMOS is that it allows the seven subsystems that are crucial for Shinkansen operations,

The E5 series bullet train has a top running speed of 320km/h.
Courtesy of JR East

namely transport planning, operation control, maintenance work management, electric power control, centralized monitoring, rolling stock management and yard management, to work in cooperation with each other and function as one single network.

"In the old system of the former Japanese National Railways, which was the predecessor of the JR Group, the fields such as operation control, maintenance, and vehicles were managed as separate systems. Under COSMOS, we manage them all in an integrated manner," Onda says. "For example, the maintenance of railroad tracks and the inspection of vehicles for the Shinkansen are performed at a much stricter level than those for conventional railways. With COSMOS, this information is fully linked to the operation control system. As a result, the first train cannot depart until the required maintenance and inspection work are completed."

In addition, COSMOS carries out appropriate operation management according to disasters and weather changes by amassing the full extent of information on a real-time basis, mainly from rain gauges, anemometers, and rail thermometers installed at stations and along railroad tracks, as well as seismometers installed at substations. Moreover, this information is shared via the network with not only the central office of the Shinkansen but also stations, vehicle bases, and many other places, enabling a prompt response when an emergency occurs.

In fact, when the Great East Japan Earthquake struck in 2011, causing unprecedented severe damage, the Tohoku Shinkansen, which operates in the affected area, had twenty-seven trains in operation, all of which stopped safely, with no one injured. According to the 2015 statistics, the average delay time of the Shinkansen (one train) running in JR East's jurisdiction was only 30 seconds.

"COSMOS is a custom-made operation management system built for the Shinkansen," says Onda. "We would like to further improve the technologies to achieve the even safer and more accurate operation of the Shinkansen."