Safety System for Track Maintenance Vehicle Operation of Shinkansen

Atsushi SASAKI
Safety Research Laboratory
Research and Development Center
East Japan Railway Company
JR East Shinkansen Network

Joetsu Shinkansen
303.6km

Akita Shinkansen
(127.3km)
(Mini Shinkansen)*

Akita

Yamagata Shinkansen
(148.6km)
(Mini Shinkansen)*

Yamagata

Shinjo

Morioka

Sendai

Shin-Aomori

To Shin-Hakodate

Shinjo

Extension to Shin-Aomori

Tohoku Shinkansen
(631.9km)

Nagano Shinkansen
(117.4km)

Nagano

Takasaki

Fukushima

Niigata

To Toyama

Extension to Toyama
(Hokuriku Shinkansen)

Now
Route length
1052.9km + 275.9km

Future
Route length
1194.4km + 275.9km

*Mini Shinkansen: Conventional lines converted for through Shinkansen service

Safety Research Laboratory
Railway track maintenance

Separation train operation and rail maintenance.

Reasons:
- Extensive maintenance equipment.

Trains run up to 275 km/h.

Goal:
- Total prevention of collisions.
Track Schedule

Train Operation Hours

6:00 - 12:00

Maintenance Service Hours

0:00 - 6:00

Transition

Inspection Vehicle Operation Hours

Safety Research Laboratory
Inspection Vehicle Functions

Inspection vehicles verify:

- the end of maintenance service hours, and

- whether any obstacles were left on train lines.
Conventional Inspection Vehicle
Reasons for improvement

(1) Fewer maintenance service hours.

(2) Fewer personnel willing to work at night.

(3) Rising costs.
New inspection car specifications

- Detection of obstacles on tracks
- Automated operation

Time frame:

1991 ~ 1995  Basic development
1995 ~ 1997  Rework for practical application
New inspection Vehicle
Key Technologies

- Obstacle detection by computer image processing

- Built-in automated control system
Obstacle Detection System

- Searchlight
- CCD camera
- Camera mount
- Rail tracking system

Track data

Obstacle detection system

Special Searchlight

Computer image processing for curved track

Example of obstacle detection
Architecture of On-Board System

- Searchlight
- Obstacle detection system
- Rail tracking unit
- Track data
- Speed data
- Camera mount
- Monitoring unit
- Automatic operation system
- Master controller
- Automatic
- Manual
- Brake control unit
- Drive unit
- Kilometer post reader
Additional features

Swivel-type control center

Remote Control

Emergency procedure panel
Wait to start “maintenance service hours”.

Start “maintenance service hours”.

Safety Research Laboratory
Collision of maintenance vehicle in Shinkansen

1. August 6, 1993: Tokaido Shinkansen in JR Tokai
   The operation of Shinkansen stopped at half a day.

2. September 3, 1998: Sanyo Shinkansen in JR West
   3 persons were injured
The Function of Safety System for Track Maintenance Vehicle

Collision prevention function

Position sensing → Data communication → Data calculation

Warning → Approaching without braking

Braking automatically
Position Detection System for Maintenance Vehicle

A track maintenance vehicle

GPS antenna

A track maintenance vehicle transceiver

Speed sensor
gear
torque converter

kilometer post

non-contact sensors

• It placed every 1 kilometer

• It corrects the position error every 1 kilometer
Operation Image (Route setting～Route restoring)

- Route setting
- Route restoring

Safety Research Laboratory
Station Layout (Route setting～Route restoring)

Safety Research Laboratory

Maintenance work management system
Example of Cab Monitor Display

- The yard track layout
- Lives position of track maintenance vehicle
- Setting route section (line) (approved moving area)
- Setting route section (index) or information massage
- Kilometer position of track maintenance vehicle
- Speed
- Organization information
- Limit object
- Remainder distance
New Type of Transceiver under development

East Japan Railway

Safety Research Laboratory
Thank you very much for kind attention.
Shinkansen safety

1. Automatic Train Control (ATC).
2. Elimination of level crossings.
3. Highly reliable equipment.
4. Optimal maintenance system.
Outline of Safety System for Track Maintenance Vehicle

- Portable Receiver
- Vehicle Transceiver
- Transceiver of Work Area

• Calculation distance + Correction of Ground coil = Position Detection
• Data communication by radio (speed, position and direction)

- In the Station
  - Collision avoidance
  - Positional correction
  - Trailing-point movement prevention

- Transceiver of Work Area

• Collision avoidance function
• Prevention function of going into Work Area
• Approach warning function for track engineer

- Displayed on the cab monitor (track layout, lives position, route information)  ➔ Improvement of man-machine interface

- Import routing information from Handy Terminal
- Database including turnout positions

• Recognition of lives position and setting route
• Automatically stop before a non-approved area

- Advancement prevention function outside approved area
• Trailing-point movement prevention function

Safety Research Laboratory
Detecting Obstacles 400 m ahead

Detection System for Obstacle on the Shinkansen track