OCS Inspection System for Newly-Installed Contact Wires

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Abstract

It is well known that if stable contact is not maintained between the pantograph and overhead contact wire due to variation in the condition of installation of contact wires for a high-speed railway like Shinkansen, it will adversely affect the current collection performance and accelerate the wear of the contact wire. As such, it is preferable to minimize variation in the installation of contact wire as much as possible. To show an acceptable design allowance range, an erection standard is stipulated.

We recently developed the Overhead Catenary System (OCS) inspection system for newly-installed contact wires and it is used to accurately measure the height and stagger of newly installed contact wire. At the same time, it detects the hanger position. According to the measured data, it is possible to confirm if newly installed contact wire is conforming to the relevant installation standard.

1 Preface

Hokuriku Shinkansen, between Nagano Station and Kanazawa Station, was inaugurated on March 14, 2015. The heavy compound catenary system is adopted as the contact wire system. Shinkansen collects current from the contact wire while the train travels at 260km/h. For a high-speed railway like Shinkansen, the condition of current collection is greatly influenced by variation of installation of the contact wire. Conformity to the relevant contact wire installation standard for Shinkansen is therefore required.

This paper introduces the newly developed Overhead Catenary System (OCS) inspection system intended to check a newly installed contact wire in order to assess whether or not the newly installed contact wire meets the requirements of the relevant installation standard.

2 Features of the OCS Inspection System

This system has been developed exclusively for the measurement of conditions of newly installed overhead contact wires. The inspection system is loaded on a dedicated maintenance vehicle for inspection in order to measure height, stagger, and gradient of the contact wire. A laser range scanner is used for measurements and a filtering treatment system is adopted to realize a high measuring accuracy (within ±3mm). In order to accurately calculate a measured position, pull-off arms and hanger positions are detected during measurements.

3 System Configuration

Fig. 1 shows the system configuration. Since the system has to be installed in the dedicated maintenance vehicle for inspection each time measurements are scheduled, the overall system configuration was designed to be simple and compact. The system consists roughly of two parts: a rooftop system and an interior system. The setting rack for the rooftop system is made of light-weighed aluminum frames.

3.1 Rooftop System

The rooftop system shown in Fig. 2 is set on the installation frame attached to the dedicated maintenance vehicle for inspection. Key system units and the features of each unit are outlined below.

(1) Laser range scanner

The laser range scanner is located in the center of the installation frame. It performs the sensing task on the contact wire in the direction of railway sleepers/ties and measures the height and stagger.

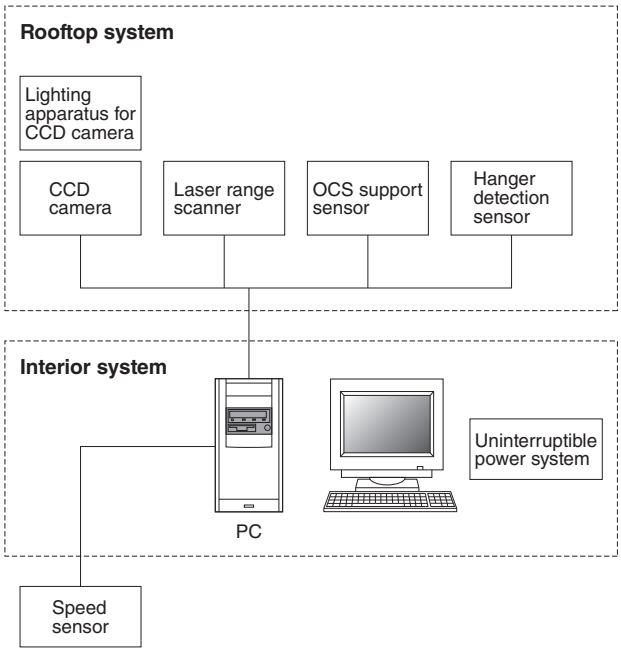

Fig. 1 System Configuration

This system comes in a simple and compact configuration. It is composed of a rooftop system and an interior system.

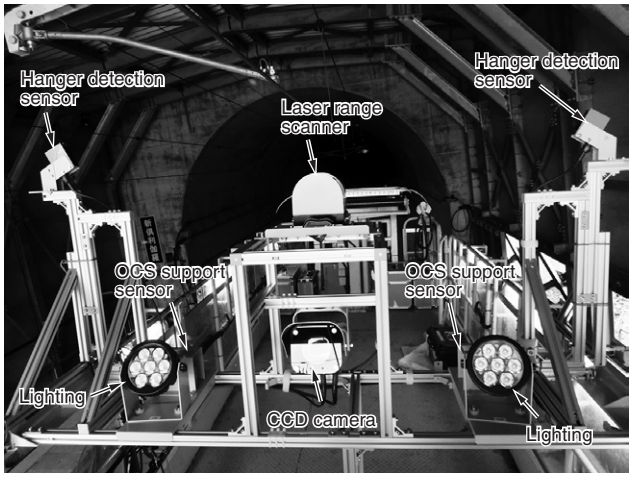

Fig. 2 Rooftop System

This system is installed on the installation frame attached to the dedicated maintenance vehicle. During measurement, it measures height and stagger of the contact wire, detects the OCS supports and hangers, and captures images of the contact wire and OCS supports.

(2) OCS support sensors

These sensors are mounted on the right and left sides of the installation frame. Each sensor vertically scans the upper area upwards and detects the positions of passing cantilever tubes and pull-off arms.

(3) Hanger sensors

These sensors are mounted on the right and left sides of the installation frame. Each sensor scans the central area diagonally upwards and detects the positions of hangers.

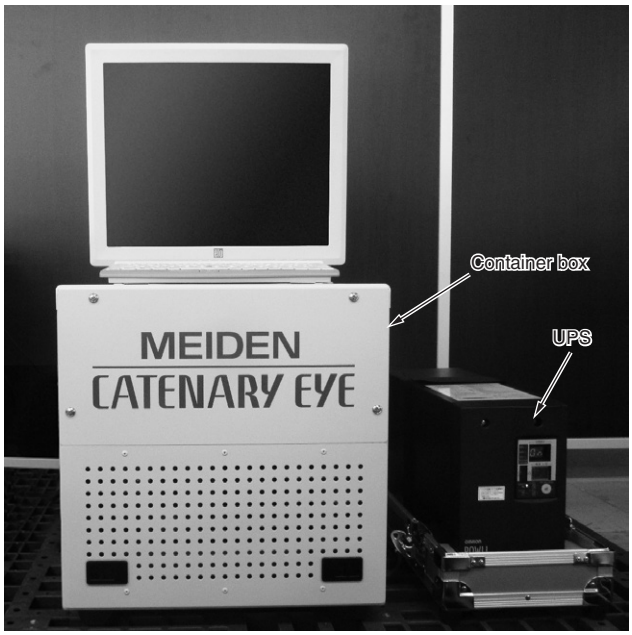

Fig. 3 Interior System

The interior system is installed within the dedicated maintenance vehicle. During inspection, data are collected from the rooftop system, and data analysis is carried out after taking measurements.

(4) CCD camera

The CCD camera is located in the center of the installation frame. It is used to capture images of the contact wire and OCS supports.

(5) Lighting

The lighting system is located on the right and left sides of the installation frame. It is used to illuminate the imaging site for the CCD camera.

3.2 Interior System

Fig. 3 shows the interior system to be installed inside the dedicated maintenance vehicle for inspection. A PC is accommodated in a container box so that various data together with the running speed can be picked up from the rooftop system during measurement. Various data are collected by time, serially, and saved in the built-in hard disk. After measurement, accumulated data are analyzed and the analytical result is used to produce tabular reports and chart reports based on the running distance that is calculated from the running speed. These tabular reports and chart reports are displayed on the screen.

4 Specifications for Measurements

Table 1 shows specifications for measurements conducted by the OCS Inspection System.

Table 1 Specifications for Measurements

In order to examine conformity of the contact wire installation standard, this system assures high accuracy inspection and detection of OCS supports and hanger positions.

Inspection item	Applicable sensor	Output	Accuracy under Static measurement
Contact wire height	Laser range scanner	Contact wire height (mm) No. of channels: 2	Within ±3mm @4800～5200mm
Contact wire stagger	Laser range scanner	Contact wire stagger (mm) No. of channels: 2	Within ±3mm @±250mm
Contact wire gradient	Laser range scanner	Contact wire gradient between poles (‰)	
Location data	Speed sensor	Vehicle location, running speed	
	OCS support sensor	Locations of steady arms and pull-off arms	
	Hanger detection sensor	Hanger position	
Contact wire monitor	CCD camera	Dynamic images of contact wire and OCS supports	30Hz

Note: During inspection, the running speed shall be 10km/h at the maximum.

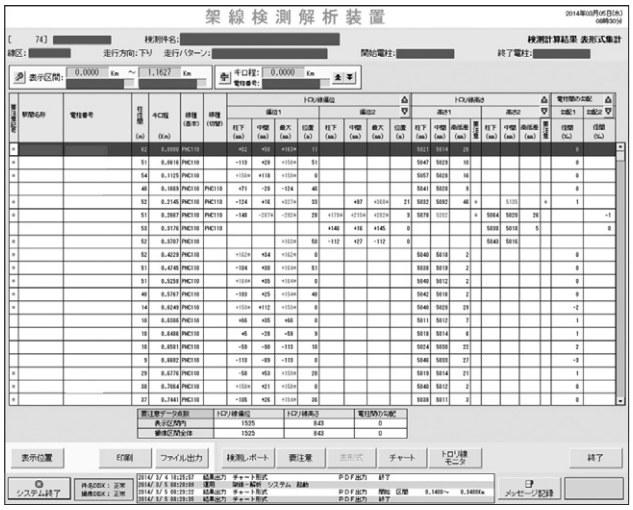

Fig. 4 Measurement Result Display Screen in Tabular Report Mode

Data of height, stagger, and gradient are gathered for each span and the measurement result is displayed in tabular report mode.

5 Measurement Result Display

The analytical data obtained from the interior system are displayed in the form of tabular reports or chart reports. Fig. 4 shows a measurement result display screen in tabular report mode and Fig. 5 shows a measurement result display screen in chart report mode. Fig. 6 shows a video screen of a contact wire photographed with a CCD camera during measurement. These screens are interlinked with each other. It is therefore possible to jump from a location specified on the chart report to a tabular report of the span where the said location is involved. It is also possible to jump to the monitor image of the contact wire in the said location.

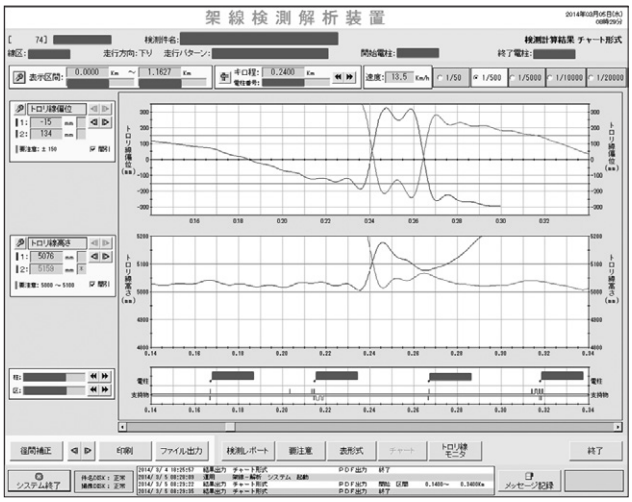

Fig. 5 Measurement Result Display Screen in Chart Report Mode

Based on the running distance, the result of height and stagger measurement is displayed in the form of waveforms.

Fig. 6 Contact Wire Monitor Screen

Video images of the contact wire taken during inspection together with measured height and stagger are displayed.

6 Postscript

The OCS inspection system for Shinkansen introduced in this paper was delivered to the Railway Technical Research Institute. The system performed the measurements in part of a section of Hokuriku Shinkansen that was then still under construction.

The result of measurements indicates that even a feeble wire sag caused between hangers was captured. This fact suggests that the OCS system demonstrates a high level of measuring accuracy. It is expected that this system will be useful in examining the conditions of newly installed contact wires through efficient measurements.

Lastly, we would like to express our gratitude to all individuals who offered their suggestions and cooperation during the development of this system.