Overhead Catenary System (OCS) Inspection System, CATENARY EYE, Delivered to Karetapi Tanah Melayu Berhad (KTMB), Malaysia

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Abstract

We delivered six units of Overhead Catenary System (OCS) inspection system called "CATENARY EYE", for Keretapi Tanah Melayu Berhad (KTMB) or Malayan Railways Limited. A batch delivery of multiple CATENARY EYE units was a first for the company.

KTMB requested a variety of measurement items, not limited to wiring conditions of contact wires and their wear plus various kinds of monitoring but also items relating to tracks. Among these, there were many items of our first production.

When items for measurement increase, the quantity of needed equipment increases accordingly. Practically, however, the installation space in a railway car was extremely limited for the OCS inspection system and all equipment had to be strictly contained in the loading gauge requirement of the car. We solved these issues, and CATENARY EYE was successfully installed on the maintenance car and handed over to KTMB.

1 Preface

Karetapi Tanah Melayu Berhad (KTMB) or Malayan Railways Limited has two railway lines, the East Coast Line (not yet electrified) and the West Coast Line. The West Coast Line runs from the southern border of Singapore to the northern border of Thailand. The distance of this railway line is approximately 750 km and there are four maintenance offices for this line. Each maintenance office conducts the maintenance work for its designated train section.

We delivered six units of the Overhead Catenary System (OCS) inspection system called "CATENARY EYE" for the West Coast Line. These Catenary Eye units are permanently installed on six newly constructed maintenance cars. One or two maintenance cars are assigned per maintenance office to maintain the West Coast Line. This paper introduces the features of the supplied CATENARY EYE.

2 Loading Car

The car where CATENARY EYE is loaded is a diesel type maintenance car newly designed and produced by HOKURIKU HEAVY INDUSTRIES LTD. Fig. 1 shows equipment-loaded car. In addition to CATENARY EYE, this car is fully equipped with a pantograph for inspection and facilities needed to maintain contact wires. All such equipment must be accommodated within the loading gauge requirement.

Fig. 1 Equipment-Loaded Car

CATENARY EYE (interior equipment) is installed on the cabin front side.

The maintenance car needs to be designed to meet these mounting requirements and to enable the overhead contact wire maintenance work. From the stage of designing the car, both companies shared related information and frequently reviewed it so that CATENARY EYE could be installed in the limited space of the car rooftop and interior.

3 Measuring Items

Table 1 shows the measuring items. In addition to the measurement of the conditions of the contact wire setup and state of wear, monitoring of pantograph conditions and track along the line is also carried out. In addition, items relating to the railway track are examined. Some of these measuring items are a first for us. Contents of these items are introduced below.

3.1 Measurement of Pantograph Contact Force

We applied the non-contact pantograph contact force measurement by a camera vision system for Taiwan High Speed Rail (THSR) for high-speed railway pantographs. This was the world's first practical application. There is, however, a great difference in specifications and structures between pantographs for high-speed railways and those for conventional railway lines. As a result, the newly developed method cannot be applied immediately. The commercial cars used in KTMB is equipped with the pantograph compliant IEC62486 A2.1, and the pantograph for measurement mounted on the maintenance cars must also be compliant with the same standard.

Based on the techniques to measure contact force of pantographs for high-speed railways, we developed the method of contact force measurement conforming to this standard. By measurement and verification of the contact force, it becomes possible to define the locations where mechanical contact loss occurs, and conditions of contact wires can be evaluated.

Table 1 Measuring Items

In addition to the inspection of the contact wire setup conditions and measurement of wear amounts, there are also new items relating to monitoring and track facts.

Measuring items	New items
Contact wire height	
Contact wire stagger	
Contact wire wear	
Contact wire gradient	
Separation of crossover wire	
Pantograph contact force	○
Contact loss	○
Pantograph monitoring	
Track monitoring	
Track offset	○
Rail cant	○
Wear forecast	○

3.2 Measurement of Contact Loss

Since pantographs for inspection to be loaded on the diesel engine driven (hydraulic transmissions type) maintenance car are non-current collective, it is incapable of finding contact loss by detecting arcs. For this reason, we newly adopted a function to detect where the contact force becomes below zero so that such a place can be regarded as the location of the occurring current loss.

3.3 Measurement of Track Offset

This is a function for use of a sensor to measure the pole distance from rails in the transversal direction. This function is intended to confirm whether there is any displacement between the center of contact wire stagger and that of track due to track maintenance. If any displacement occurs, an error can arise in the contact wire stagger. In addition, such an error can lead to an accident that a contact wire can be dislocated from the pantograph. For this cause of a contact wire stagger error, this function is considered to lead to a solution.

3.4 Measurement of Rail Cant

Based on video images from track monitoring of the front of the car, the rails are detected and their curvature is measured. Judging from the rail curvature, car velocity, and gauge width, the rail cant is calculated. This function is required when it is necessary to avoid such an operation that an actual rail cant is wrongly used as a result of rail maintenance, or when a needed rail cant must be determined along with an improvement of the commercial car velocity.

3.5 Wear Forecast

To raise the accuracy of a forecast of contact wire wear, wear assumed to result from a measurement error is excluded by statistical treatment based on the result of the latest and past accumulated

Fig. 2 **Roof-Top Equipment**

This equipment consists of cameras, lightings, and sensors.

Fig. 3 **Car Interior Equipment**

This equipment collects data from the roof-top equipment and saves the data in a set of external disks.

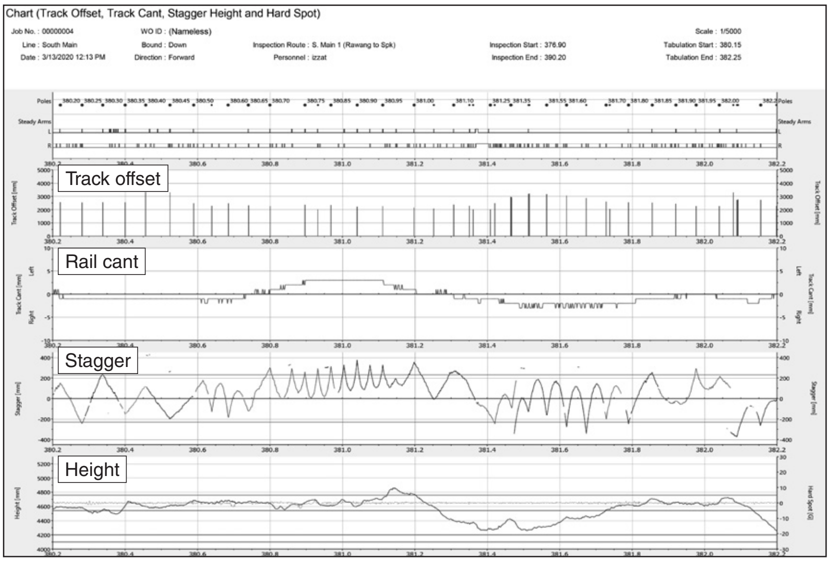

Fig. 4 **Chart Style of Report 1**

The result of measurement of the track offset, rail cant, stagger, and height is shown. Since this result has been obtained from measurement at a curving section, an output of the rail cant is included.

wear measurements. Using the normally measured wear values only, simulation is carried out to forecast the future transition of wear in the contact wire. The date of the contact wire replacement is predicted for each tension at a high accuracy so that jobs for a replacement plan can be favorably supported.

4 Equipment Configuration

In addition to the roof-top and internal equipment installed on the car, CATENARY EYE is composed of ground equipment that is installed in the office room of the maintenance base. The roof-top equipment is mainly composed of cameras, lighting, and sensors. During inspection, car interior equipment collects various data from the roof-top equipment and the gathered data are saved in a set of external storage devices. After the completion of inspection, the set of external storage devices is connected to the ground equipment for analysis. The result of the measurement is then outputted. Fig. 2 shows the roof-top equipment and Fig. 3 shows the car interior equipment.

5 Result of Measurement

Fig. 4 and Fig. 5 show a chart style of reports

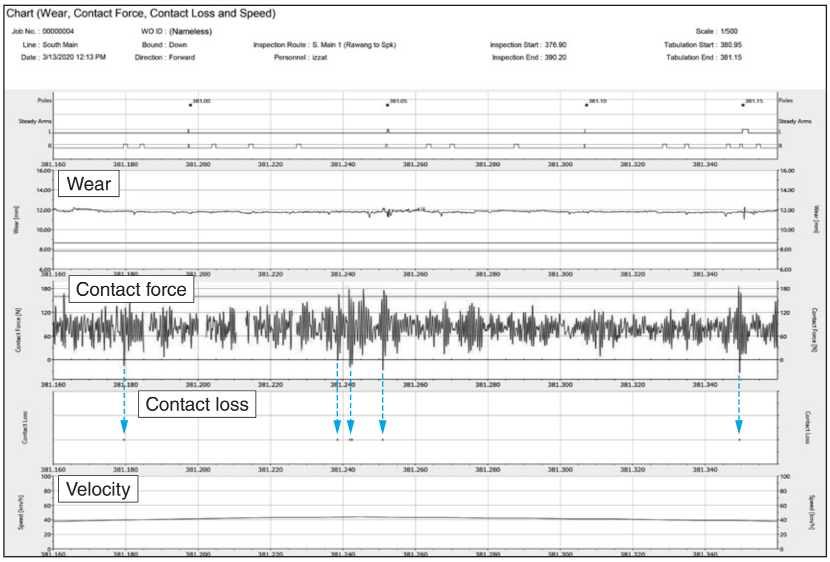

Fig. 5 **Chart Style of Report 2**

The result of measurement of wear, contact force, and contact loss is shown. An output of contact loss is generated when the contact force is zero.

Table 2 **Wear Forecast (Sample)**

The date of trolley replacement is predicted based on each tension.

Drum No.	Starting Chainage (km)	Ending Chainage (km)	Result of analysis				Final date of replacement
			Average (mm)	Minimum (mm)	Wear rate (mm/y)	Date of replacement	
10000	0	0.2999	12.09410419	11.80710162	0.094195795	2036/8/31	2012/4/1
10001	0.241	0.5499	11.09846154	5.58300256	1.083039719	2014/5/16	2012/4/1
10002	0.55	1.2499	11.93487068	11.55519506	0.134217052	2029/5/21	2012/4/1
10003	1.1471	2.8499	11.97877152	11.32306497	0.171096354	2025/9/9	2012/4/1
10004	2.7252	4.4999	12.16075808	11.15269895	0.198162988	2023/11/9	2012/4/1

that provide the result of the measurement acquired when test running was carried out along the KTMB line. All the measuring items show good inspection results.

Regarding wear forecast, there is no accumulation of past inspection data because this system was used soon after the new introduction. For this reason, the wear forecast (sample) is shown in **Table 2** to show what it may look like by using reference values.

6 Postscript

There were many requests from KTMB about a variety of measuring items. To cope with these measuring items that are a first for the company, we promoted development to realize the related technologies. As a result, we were successful in the supply of CATENARY EYE that meets KTMB's requirements. We will continue to cooperate with KTMB's overhead wire inspection work and continue to contribute to the maintenance of overhead wire facilities in Malaysia.

Lastly, we would like to thank HOKURIKU HEAVY INDUSTRIES LTD., who designed the equipment to be mounted on the vehicle, TOYO DENKI SEIZO K.K., who produced the IEC standard-compliant pantograph, and Yashima & Co., Ltd., who coordinated the whole process. We would like to express our special appreciation to them.