Detection of Pantograph Failures Using Sensors Fixed to the Catenary System

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A serious failure of a pantograph not only can damage contact wires at the point where the pantograph fails but can also inflict widespread damage on the catenary system network. Pantographs are subject to regular inspection at rolling stock depots, but there are some defects that are difficult to detect by the visual checks. In addition, the visual check at the depots cannot directly help to quickly detect pantograph failures in operation. For these reasons, development of a reasonable abnormality-detecting technique is needed in order to assess pantograph abnormalities in quantitative terms at high frequencies. Hence we developed a technique to monitor pantographs passing a particular section where sensors are fixed to the contact wire and their components, thereby detecting pantographs operating under abnormal conditions without delay. This particular study focused on monitoring two types of pantograph defects, i.e., (1) the uneven (step-shaped) wear of pantograph contact strips and (2) the abnormal aerodynamic upward force working on the pantograph.

(1) Detection of uneven wear on contact strips

To detect contact strips having uneven wear, vertical/lateral vibration sensors fixed on the contact wire are used to observe the abnormal vibration caused by the uneven wear. See Fig. 1 for a schematic drawing of the system used for this purpose. The schematic shows one potentiometer and five vertical /lateral accelerometers placed as shown. However, the type and the number of sensors depend on the train speed or the type of catenary system in the section where this system is installed.

(2) Detection of abnormal aerodynamic upward force

The system measures (1) the dropper tensile/compressive force in the vertical direction and (2) vertical gradient of the contact wire in the monitoring section. Then, it calculates the average contact force between contact wire and pantograph, which equals the sum of the static upward force and aerodynamic upward force. In case the resultant value exceeds the allowable limit, the system judges that the aerodynamic upward force is abnormal. See Fig. 2 (a) for the disposition of the sensors used in this study.

To verify the abnormal pantograph detecting technique introduced above, we implemented running tests in the premises of the Railway Technical Research Institute and confirmed the following:

(1) The pantograph wear detecting system is capable of detecting the uneven wear of pantograph contact strips with high precision in a speed range up to 120 km/h.

(2) The abnormal aerodynamic upward force detecting system can observe the average contact force at sufficiently high precision. See Fig. 2 (b).

It should be noted, however, that in this test to check the abnormal aerodynamic upward force detecting system, we changed the pantograph static upward force between +30 and -30 N, instead of changing the aerodynamic upward force itself.

This technique detects pantograph abnormalities and meets the purpose of this study, thereby providing an effective contribution to the prevention of contact line failures.

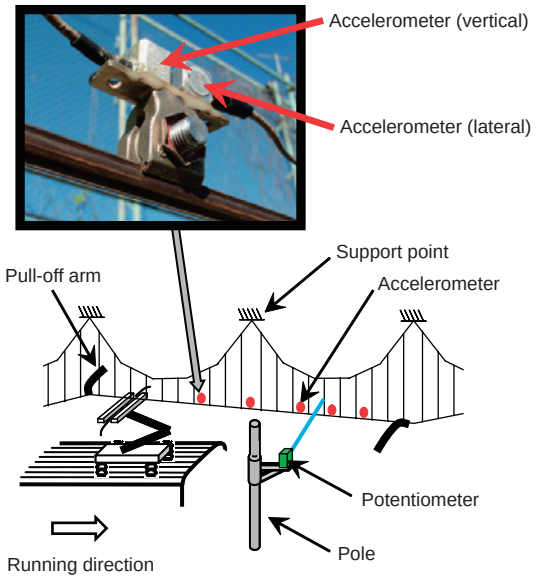

Fig. 1 Disposition of sensors to detect uneven wear on contact strips

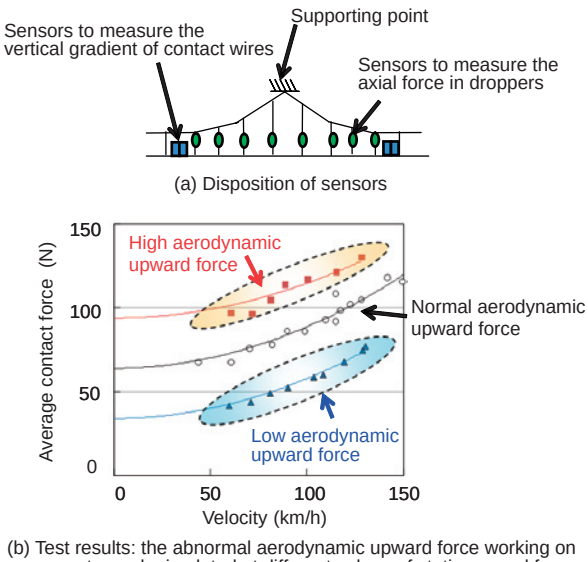

Fig. 2 Detection of abnormal aerodynamic upward force