Simple Catenary Equipment Offering High Speed Operation and Maintainability

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On the Shinkansen lines of this country, heavy-compound catenary equipment is used for those routes with a large volume of traffic, while simple catenary equipment is used for routes with lower transport capacity such as the new Shinkansen lines. While simple catenary equipment using a copper-steel (CS) contact wire has been traditionally put into service on the new Shinkansen lines, precipitation-hardened copper (PHC) alloy has recently been adopted more frequently because of the characteristics of this material. PHC is a copper alloy based oxygen free copper, containing tiny amounts of chromium, zirconium, and silicone, which has excellent durability against wear and recyclability.

A trial calculation shows that the CO_2 discharge of the PHC contact wire during the life-cycle decreases by 10 % as compared with that of the CS contact wire. Accordingly, this paper first briefly describes an overview of the PHC simple catenary equipment, and then reports on the wear rate of the contact wire exhibited during a period of four years in operational service and its current collection characteristics measured by a Shinkansen high-speed test train.

Figure 1 shows the structure of the PHC simple catenary equipment. This type of equipment comprises a contact wire having a cross section of 110 mm^2 stretched by a force of 19.6 kN and a stranded messenger wire of hard drawn copper with a cross section of 150 mm^2, also tensioned by a force of 19.6 kN. The standard specified hanger interval is 5 m.

Figure 2 shows the development of the wear process of the contact wire at a location where the PHC simple catenary equipment was actually used in service for four years. Furthermore, for comparison, the development of the wear process at a location where CS simple catenary equipment was constructed at the same location is also plotted in Fig. 2. Figure 2 shows that the wear rate of the PHC wire is 0.054 mm^2 per ten-thousand pantographs which is 70 % of that exhibited by the CS wire.

Finally, the result of high-speed running tests on a section of PHC simple catenary equipment is reported. The test comprises a Shinkansen high-speed test train with one pantograph running at a maximum speed of about 340 km/h. The test result shows that the maximum uplift of the contact wire is about 45 mm, which is below 100 mm, a standard value for high-speed running on a section of catenary equipment. Meanwhile, the maximum strain of the contact wire is 710×10^{-6}, which is also below the value allowed for the PHC contact wire, and thus running at a speed over 300 km/h is considered to be practicable enough.

Figure 3 then shows a graph depicting the values of the contact loss ratio of the test vehicle running through the PHC simple catenary equipment. This test gives the contact loss ratio as below 1 %, consequently showing sufficient current collection performance.

As stated above, the PHC simple catenary equipment provides a smaller environmental load during the life-cycle than the CS simple equipment, proving sufficient current collection capability even at a velocity exceeding 300 km/h. This PHC equipment was employed on the Tohoku Shinkansen (between Hachinohe and Shin-aomori) and on the Kyushu Shinkansen (between Hakata and Shin-yatsushiro).

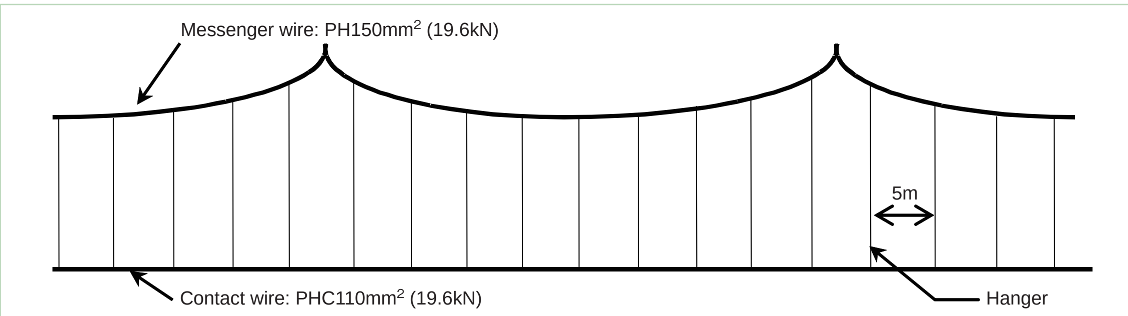

Fig. 1 Structure of PHC simple catenary equipment

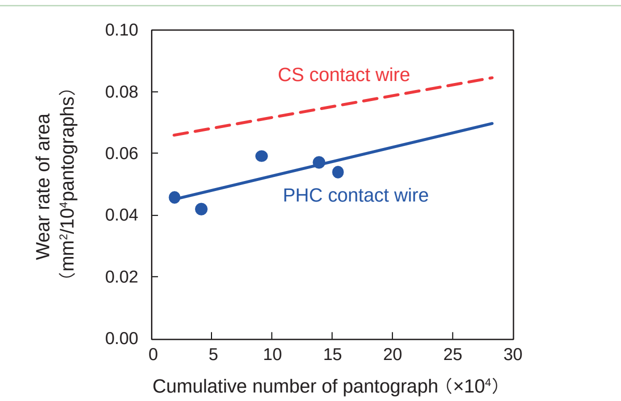

Fig. 2 Wear process of PHC contact wire

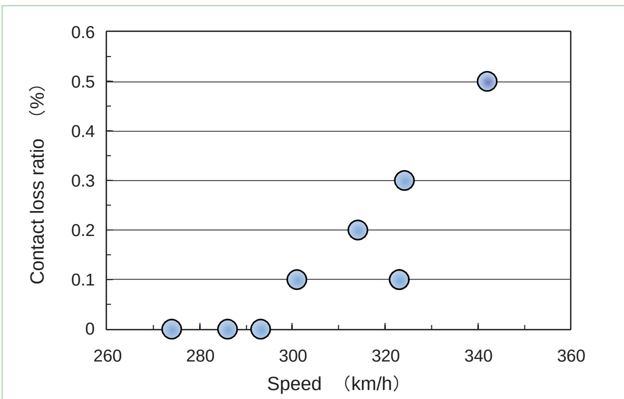

Fig. 3 Contact loss ratio during high-speed running tests