Wear Tester for Current Collecting Materials for High Speed Railway

Shunichi KUBO
Senior Researcher, Laboratory Head, Frictional Materials, Materials Technology Division

This tester consists of a revolving disk to which a ring made of copper plates (simulated contact wire) is fitted. With a pantograph contact strip pressed against the simulated contact wire, an electrical current is passed to them to turn the simulated contact wire, in order to measure the coefficient of friction, the rate of contact loss, wear of the contact strip and simulated contact wire, and the sliding surface conditions (Fig. 1 and Fig. 2). This tester has made it possible to grasp the tribological characteristics of various current collecting materials under various sliding conditions. The tester was completed in December 2003, replacing to the former wear tester introduced in the 1970s.

A pantograph contact strip slides on the contact wire at the train's running speed. A current as large as about 100 to 1,000 A passes to it. The contact strip must have enough strength as an important vehicle component, high electric conductivity as an electrical material, and high lubricating ability and wear resistance as a frictional material. The frequency of contact strip replacement depends on its wear resistance, and the contact wire life is significantly influenced by the contact strip's lubricating ability. Therefore, from the standpoint of railway management as well, improving the performance of the contact strip material is an important issue. On the other hand, with the increase in train speed and the decrease in the number of pantographs per train in recent years, the conditions under which the contact strip is used have become increasingly severe. This tester is used to develop high performance contact strip materials which can be reliably used even under the rigorous conditions of recent years.

As a tester for current collecting materials, the apparatus boasts the highest performance in Japan, allowing for a maximum sliding speed of 500 km/h, hence can easily respond to future increases in train speeds. Fig. 3 shows the wear characteristics of various contact strip materials measured at sliding speeds of up to about 300 km/h. In the future, the apparatus will permit the wear characteristics of various contact strip materials at higher speeds to be grasped.

The maximum current that the tester can pass to each contact strip is 500 A (DC/AC). The tester accepts not only actual contact strips but also small test pieces. This permits testing even of contact strip materials which are still in the prototype stage. Plates of pure copper are used for the simulated contact wire. However, a material other than pure copper can be substituted as long as it is in the form of a plate. The sliding conditions are either constant speed, constant current, or programmed conditions in which the speed and current are varied according to the actual train running conditions.

The greatest factor causing contact strip wear is arc discharge, which occurs when the pantograph loses contact. It has been known that the rate of contact strip wear increases nearly in proportion to the rate of occurrence of arc discharge due to contact loss. The contact strip holder of the tester is provided with an vibrator, which is capable of forcing a contact loss to occur, making it possible to check the wear characteristics of a contact strip under conditions close to the actual pantograph conditions.

The specifications of the tester are as follows.

(1) Simulated contact wire: Pure copper ring (2 m in diameter, 5 mm in width).
(2) Contact strip test piece: Full-scale contact strip (270 mm in length, 40 mm in width, 30 mm in thickness); smaller test piece (90 mm in length, 50 mm in width, 30 mm in thickness).
(3) Maximum sliding speed: 500 km/h.
(4) Maximum current: 500 A (100 V DC/AC; polarity reversing possible with DC).
(5) Applied force: 9.8 to 196 N (1 to 20 kgf).
(6) Items that can be measured simultaneously during tester operation: friction coefficient (frictional force/applied force); current passed; contact loss rate (voltage drop and occurrence of arc between contact strip and simulated contact wire); contact strip temperature.
(7) Items that can be measured with tester out of operation: shape of wear and surface condition of simulated contact wire; amount of wear of contact strip material.

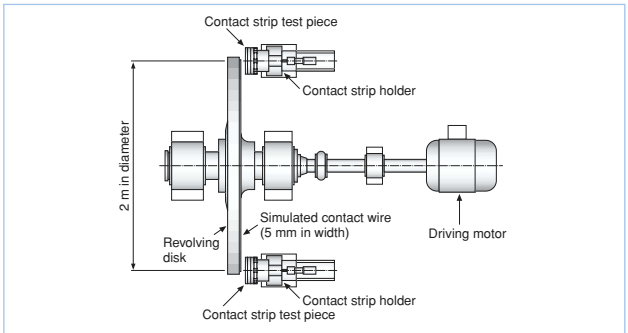

Figure 1. Scheme of wear tester for current collecting material for high speed railway.

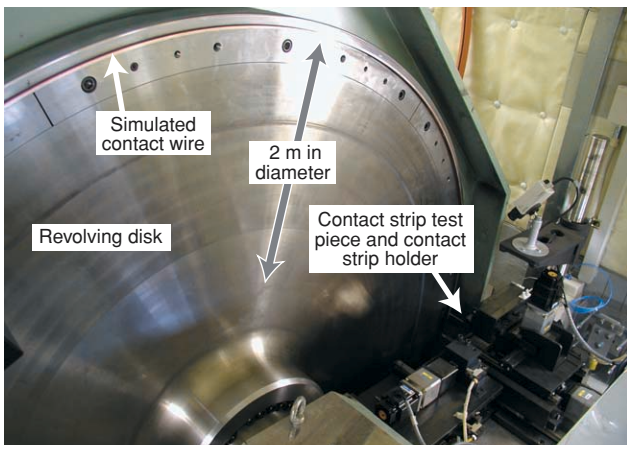

Figure 2. Appearance of wear tester.

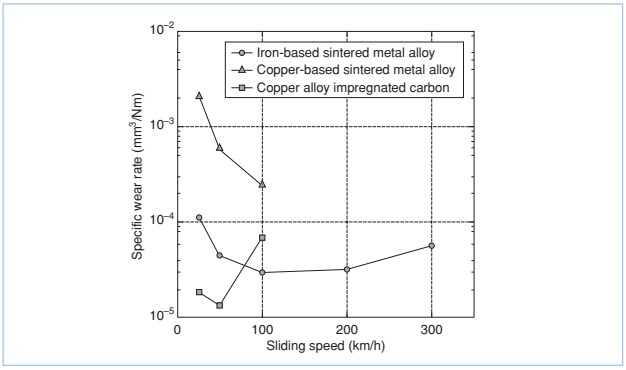

Figure 3. Examples of measured wear characteristics of various contact strip materials.