Smoothening the Sliding Surface of Overhead Rigid Conductor Lines to Reduce Contact Loss

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A rigid conductor line is more reliable than a catenary wire because it is less likely to break as a result of abrasion. However, little elasticity is exhibited between a overhead rigid conductor line and pantographs, meaning that even a slight unevenness in the line can result in contact loss. Any arcing that accompanies the contact loss may result in undulating wear on the sliding surfaces. The undulating wear will further increase contact loss, leading to even more wear in contact wires and pantograph sliders. This phenomenon requires corrective action.

Unevenness exhibiting a variety of wavelengths may be found along the sliding surface of a contact wire under a rigid mount. One such unevenness is that seen between the long ear bolts used to attach the contact wire to the rigid mount. Another significant unevenness is seen at 200mm wavelengths when perpendicularly wound contact wire is used; this unevenness is presumably caused by the stretching machine when the contact wire was installed. On the other hand, when a sideways wound contact wire is installed, little unevenness at 200mm wavelengths is seen. Figure 1 indicates spectrum densities at the sliding surfaces of uneven contact lines attached to a rigid mounting soon after installation.

In many cases, the configuration of pantographs sliding under conductor lines where undulating wear occurs is like that shown in Figure 2: the distance between pantograph heads is 250mm, the distance between slider centers is 60mm, and a solid lubricant has been inserted between the sliders. With such a configuration, the solid lubricant has a tendency to ride up on uneven sections of the conductor line sliding surface, subjecting all four sliders to contact loss. The resulting arcing tends to cause part of the contact line to melt, and to cause wearing in the slider coming immediately after. This phenomenon will be repeated time after time, and the extent of the damage will depend on such factors as speed. The result will be undulating wear in wavelengths of 60mm, the same length as the distance between slider centers. To reduce contact loss arcing, the solid lubricant was removed from one of the pantograph heads. This did indeed control undulating wear in a catenary wire, but generally had little effect in the case of overhead rigid conductor lines.

Contact loss arcing exhibited on overhead rigid conductor lines can, however, be reduced by smoothening out the unevenness where undulating wear has occurred in the sliding surface. We therefore developed a grinding device (see Figure 3) that grinds the sliding surface to make it smooth. The device applies a grindstone at a fixed pressure to the sliding surface while grinding, and is equipped with a mechanism that tilts to adjust to flexures in the rigid conductor line. The device runs at a speed of about 4 km/h, continually grinding the sliding surface of the contact wire.

Figures 4 and 5 show the results of grinding the overhead rigid conductor line of a regularly operated railway line. The waveforms depicted in Figure 5 were observed on uneven sliding surfaces before smoothening, and on a regular basis during a period of 24 months after smoothening. Before smoothening, undulating wear occurred at wavelengths of approximately 60mm, but the grinding device smoothed out the sliding surface and, as Figure 5 shows, the undulating wear did not reoccur over time afterward.

Figure 6 shows the result of contact loss observations using a contact loss arcing detection method for the section that had been ground smooth. It was confirmed that, after smoothening, contact loss arcing was reduced. Using the device to smoothen out unevenness immediately after installation of contact wires can be even more effective in reducing contact loss on overhead rigid conductor lines.

(a) Before smoothening (b) Immediately after smoothening

Fig. 4 Sliding surface before and after smoothening

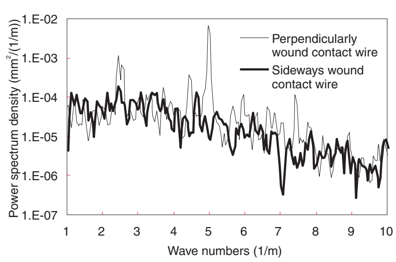


Fig. 1 Results of unevenness on the sliding surface of a overhead rigid conductor line

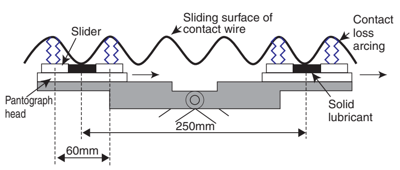
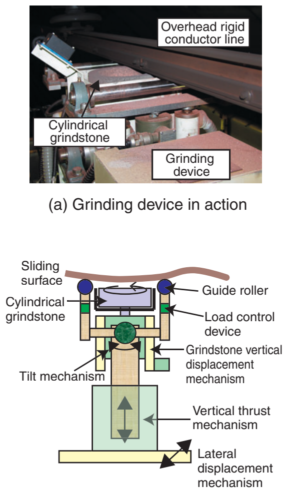


Fig. 2 Pantograph head configuration and contact loss arcing



(a) Grinding device in action

(b) Main mechanisms

Fig. 3 Salient features of grinding device

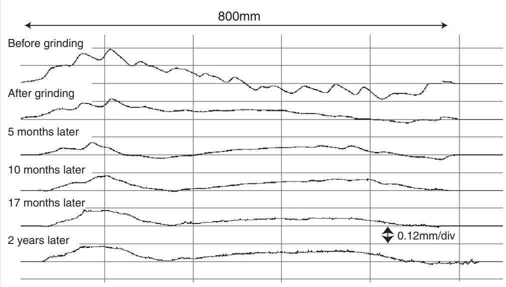


Fig. 5 Observed results of grinding of the sliding surface of an uneven overhead rigid conductor line

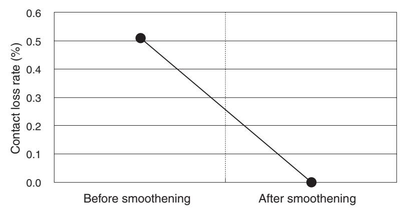


Fig. 6 Contact loss rate on a overhead rigid conductor line, before and after smoothening