Prediction of Contact Wire Wear on High-speed Railways

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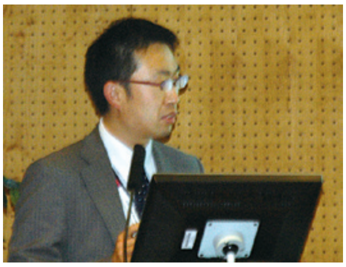

Although wear of contact wire is one of the most important problems in maintaining the catenary system, there are many unsolved questions. This is due to the mechanism of the wear progress of contact wire being very complicated. So far, various studies in this field have been carried out using a test bench. However, there has been no study to develop a prediction model of contact wire wear, because of the difficulty of using test equipment to simulate wear phenomena in the field, which includes the effect of oxidation of the contact wire surface, etc.

The authors have started to research the quantitative effects on contact wire wear caused by the contact force of the pantograph and arcing due to contact loss in order to clarify the mechanism, by which contact wire wear progresses. For this purpose, the contact force of pantographs, the arc due to contact loss and the collected current of all the trains, which pass through two measurement sections on a commercial Shinkansen line, must be measured, because several types of pantographs are involved, and trains run at different speeds. The authors have developed a contact force measurement method by equipping a catenary with sensors as well as arc measurement equipment which detects the UV ray emitted from an arc at the wayside. The contact force of pantographs, the arc due to contact loss and the collected current of all the trains which pass through the two measurement sections of the commercial Shinkansen line have been measured regularly. The wear of contact wire on these sections has also been measured regularly. We have compared this data in order to build a wear prediction model for the contact wire.

In the measurement section where high current is drawn, the progression of wear of the contact wire is greatly affected by the arcing, which has a high probability of occurring. On the other hand, in the measurement section where low current is drawn, the progression of wear of the contact wire is greatly affected by the high contact force. One set of results is shown in Fig. 1.

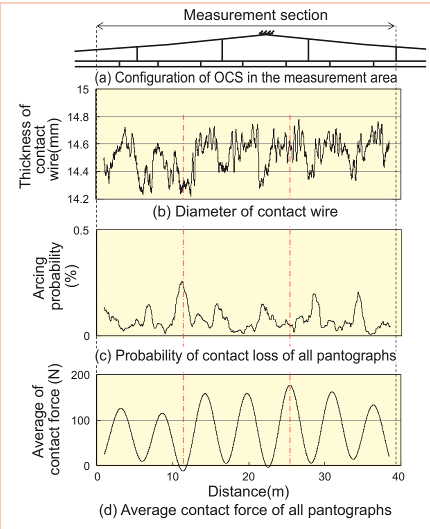

Fig. 1 Measurement results

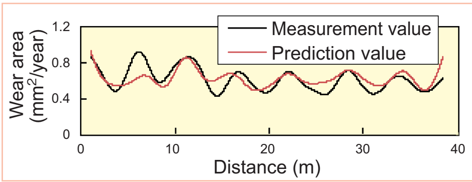

Fig. 2 Prediction results of the area of contact wire wear

From these measurement results, we have developed a prediction model for contact wire wear. An example of the wear prediction result is shown in Fig. 2. Finally, we have reported the results of the case study on evaluation indexes of current collection performance.

Influential Factors on Adhesion between Wheel and Rail under Wet Conditions

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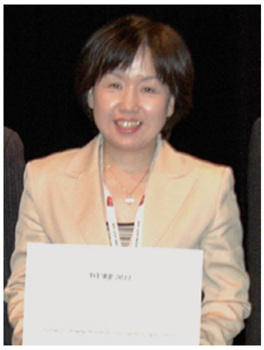

It is empirically common knowledge that the adhesion coefficient between wheel and rail is low under wet conditions due to rain or snow-fall, compared with the dry conditions experienced during sunny weather. With a low adhesion coefficient, it is not only hard to achieve a desired higher running speed, but also to minimize the distance for bringing a train to a halt. Moreover, some damage on the top surface of rails and on wheel treads is likely to occur due to wheels slipping during acceleration and/or sliding during deceleration. This damage will cause noise and vibration of the vehicle and hence a deterioration in ride quality.

This paper describes a study of the adhesion coefficient between wheel and rail under wet conditions using both theoretical and experimental approaches. The purpose of the study was to achieve a good understanding of the mechanism of a low adhesion coefficient when a film of water exists on the rail surface. Theoretical analysis was based on a numerical model (Fig. 1) applying a Mixed Lubrication theory. A laboratory experiment was conducted with a twin-disc rolling contact machine and a water spray system (Fig. 2). In order to clarify how the adhesion coefficient was affected by the contact parameter, the author focused on several factors such as running speed, slip ratio, axle load, water temperature and the surface roughness of wheel and rail, as they play important roles in the lubrication behaviour of the water film. The analysis results and the experimental results indicated approximately the same tendencies showing that, among the factors mentioned above, rolling speed, water temperature and surface roughness have significant effects on the adhesion coefficient. Therefore, the author presented a proposal to improve the adhesion coefficient between wheel and rail under wet conditions by raising the water temperature or by increasing the surface roughness.

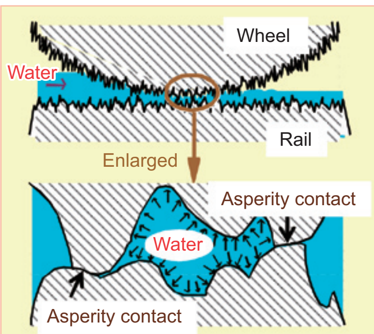

Fig. 1 Numerical model of wheel/rail contact under wet condition

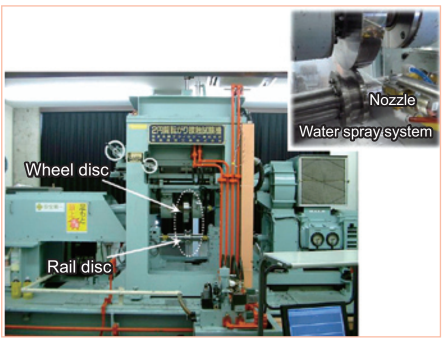

Fig. 2 Twin-disc rolling contact machine with a water spray system