Railway Trucks for Continuous Measurement of Derailment Coefficient and Observation Systems Using Such Trucks on In-serve Trains


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1. Overview

Derailment coefficient Q/P, which is the ratio of the lateral contact force Q to the vertical contact force P (Fig.1), is one of the most important safety measures in railway operation. If it is retained under the safety limit, which is calculated by geometric relation and friction condition between wheel and rail, the running safety of train is ensured.

In the past, derailment coefficients used to be measured in the limited occasions, such as trial runs of new type vehicles or new line opening, and the time variation of them have not been observed yet.

But according to recent researches, derailment coefficient changes minute by minute, so it becomes important to develop a new measurement system that can observe the change of wheel/rail interface condition at every time.

2. Technical Features

Measurement System

In conventional measurement methods, specially equipped wheelsets, so-called PQ-wheelsets, have been used for the measurement of derailment coefficient. These wheelsets cloud not be used on in-service vehicles, because they have many strain gauges attached on them, through-holes for signal cables, and slip rings or telemeters for data transmission. Moreover braking is inhabited for heat damage protection. So continuous monitoring is impossible.

Newly developed system has no sensors on rotating parts, such as wheelsets. Vertical force P is measured by the deflection of primary suspension, which is verified good linearity by bogie rolling stand tests.

Lateral force Q is measured directly by lateral distortion of wheel, using non-contact gap sensors attached on bearing box (Fig.3). The distortion is small, so the following measures are taken for increase of measurement accuracy.

a) Reduction of lateral movement and inclination of wheel axle by using roller bearings and bearing box keys
b) Compensation of them by two additional gap sensors
c) High flatness of wheel web by machining

Agreement of the results between new method and conventional method was verified by stand tests and train running tests. A practical truck, which has brake discs, was designed (Fig.4) and attached on a commercial vehicle. Using this truck, the measurement of derailment coefficient on in-service train was realized, and measured data have been gathered every day. This system can also observe the friction coefficient of wheel/rail interface on sharp curve from Q/P value of inside rail, which is nearly equal to Coulomb friction coefficient.

Sample of Measured Data

Fig.5 shows measured Q/P data through a 160m-radius curve from start to end, including the transient curve sections. Each line shows each train pass with what it looks like a similar shape, but the level changes according to each pass. These facts show that the derailment coefficient depends upon the position on the whole curve, but its level seems to change depending on the time. A lubricator is set at the entrance of the curve, so lubricating timing is one of the causes of such variation.

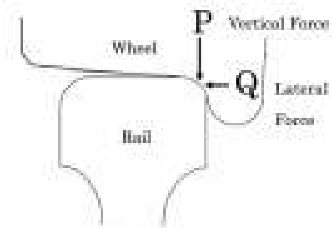

Fig.1 Contact of wheel and rail

Fig.2 Sensor for P measurement

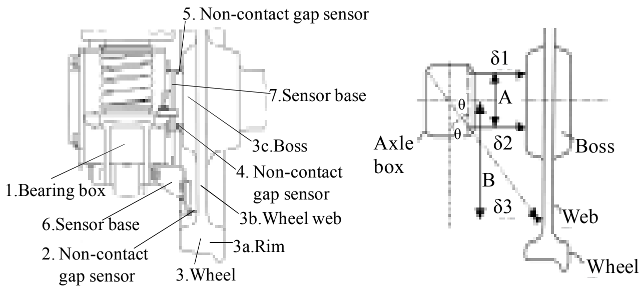

Fig.3 Measurement mechanism for Q

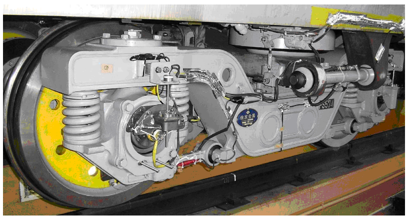

Fig.4 Feature of continuous Q/P measuring truck

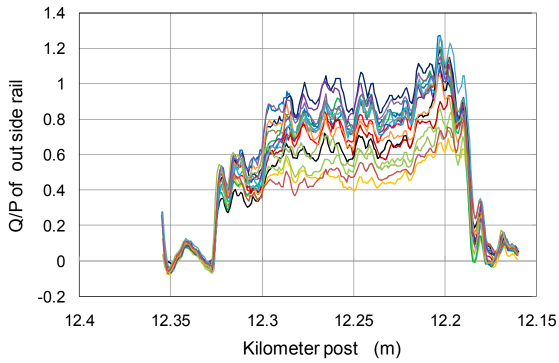

Fig.5 Measured data of Q/P with repeating runs through a curve

Another finding is the fact that derailment coefficients are different among curves of same specification. So we will analyze the factors caused high value, and carry out appropriate track management in order to reduce it and increase the safety of train running.

3. Conclusion

Continuous monitoring of derailment coefficient by in-service trains makes possible to grasp the change of track condition on whole commercial line. We believe this system is useful for the advance of the safety and reliability of railway transportation, and hope to apply more railway systems.

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