Restraint of the Scoring Phenomenon in Abrasive Blocks Using Control Techniques

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On Shinkansen trains, single-step braking is applied for deceleration from high-speed running to stop without releasing the brake. As a result, marked scoring is often observed on the surface of abrasive blocks installed in wheel tread cleaner and on tread brake shoes found on conventional trains. The development of this phenomenon causes wheels to wear in a concave shape, and wear fragments may also fall onto rails. Eventually, it causes unusual vibration and extraordinary noise. In this study, attempts were made to reproduce wear fragment using a dynamo brake test stand with a view to resolving these problems. A control technique to restrain wear fragments was consequently identified, and its effectiveness was confirmed in a running test. This paper introduces the results of the dynamo test and the running test.

Keywords: wheel tread cleaner, abrasive block, scoring, single-step brake

1. Introduction

Wheel tread cleaner is installed on high-speed vehicles to press adhesion-intensifying abrasive blocks onto the wheel tread for the purpose of improving adhesion. Such blocks play a variety of roles, including cleaning wheel treads to prevent wheel slip and skid, improving sensitivity for operating track circuits and reducing running noise. Recently, however, unusual vibration and extraordinary noise generated by scoring fragments adhering to abrasive blocks or by concave wear resulting from scoring on the wheel tread have become problematic. In this study, such problems were observed on vehicles of a certain type running on lines where single-step brakes are applied. A vehicle running test was conducted using a control technique developed in the course of tests for reproducing scoring fragments. The next part of this description introduces the results of comparison between the control technique developed and the present control technique with respect to the scoring phenomenon restraint effect, which reduces the formation of scoring fragments.

2. Scoring Fragments under Present Circumstances

Figure 1 shows an abrasive block of an actual vehicle and some scoring fragments. The fragments for the portion corresponding to the rolling width of the wheel tread are those shown in Fig. 1 (a). From this figure, the formation of scoring fragments is assumed to be related to a certain substance intervening between the wheel and the rail in different rolling conditions. Wedge-like cut metal pieces are visible on the surface, with melting marks or high-temperature oxidation visible on the reverse surface (Fig. 1 (b)). The scoring fragments are assumed to have been formed after the surface layer of the wheel tread started to peel under high-temperature conditions. Such fragments are found with conventional vehicles using snow-proof brakes in winter, and this phenomenon has been studied previously [1].

Fig. 1 Abrasive block and scoring fragments of a vehicle

3. Reproduction Test on a Dynamo Test Stand

Figure 2 shows a dynamo test stand. Dry and wet conditions were combined with the presence/absence of

Fig. 2 Dynamo test stand in the laboratory

Table 1 Dynamo test specifications

Brake initial velocity	260 km/h
Release velocity of abrasive block	70 km/h
Brake patterns	Single-step braking (normal brake 6 notches) Multi-step braking (normal brake 7 notches)
Brake distances	6,900 m (single-step braking) 7,800 m (multi-step braking)
Powdered materials	Cement, rail rust, vehicle sludge, alumina, quartz sand, white sand
Environment conditions	Dry, wet, powdered material
Quantity of sprinkling	130 ml/min
Quantity of powdering	100 g/min

Fig. 3 Brake patterns

sample sprinkling to simulate the conditions of actual vehicle running environments. Powdered materials such as cement, rail rust, vehicle sludge, alumina, quartz sand and white sand were used as samples to be sprinkled onto the wheel tread to provide the same conditions as those in tunnels, on open sections and on new lines, and an adhesion-intensifying injection device was operated on certain sections, as shown in Table 1. Both single-step and conventional multi-step brakes were used to generate different braking patterns as shown in Fig. 3.

In the single-step braking test to reproduce actual vehicle conditions, scoring fragments were observed both under only wet conditions and under wet conditions when samples of powdered material were sprinkled onto the wheel. In particular, when quartz sand was sprinkled onto the wheel surface in wet condition, scoring fragments similar to those observed with an actual vehicle were formed (Fig. 4 (a)). In the multi-step braking test conducted under the same conditions, scoring fragments smaller than those observed in the previous condition were formed (Fig. 4 (b)). Intermittent operation of the abrasive block, which occurs when multi-step braking is used, is assumed to provide a restraint effect. The single-step brakes were then subjected to both continuous control (as presently used) and intermittent control with a combination of 20 seconds operation and 10 seconds release, which closely corresponds to the movement of multi-step brakes. The two types of control were compared with respect to the wheel tread roughness contributing to the adhesion coefficient [2]. It was found that the same wheel tread roughness (dry: R_a 0.5 μm ; wet: R_a 0.2 μm) arises from intermittent control and from continuous control.

(a) Single-step brakes

(b) Multi-step brakes

Fig. 4 Scoring fragments formed in laboratory tests

4. Running Test

Comparison was made of the continuous control and intermittent control applied to the leading vehicle (Car No. 1) on each train set, which is likely to generate more scoring fragments. These train sets had been subjected to running tests using single-step brakes in winter or during the season when scoring fragments are most of-

(a) Present control

(b) Developed control

Fig. 5 Scoring fragments formed in a running test

ten observed (Fig. 5). Under the intermittent control conducted in the test, both the operation period and the release period were corrected to 17 seconds in consideration of the operational characteristics of the abrasive block used on the actual vehicle. The test results show that intermittent control effectively suppresses the formation of scoring fragments while maintaining an equivalent adhesion-intensifying effect (Fig. 5 (b)), since there are no records of influences such as wheel slip or skid in the ATC charts. Furthermore, the wear depth of the abrasive block and wheel tread was reduced from 25% to 50%.

5. Conclusions

Based on the results of the running test, intermittent control is considered as one of the optimum techniques to suppress the scoring phenomenon while maintaining the adhesion-intensifying effect. Application of this control method to other vehicle types will be further examined by evaluating adhesion and the restraint ef-

fect throughout the year.

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References

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