Friction Moderating System To Reduce Wheel/rail Interface Problems at Sharp Curves

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When negotiating sharp curves, railway vehicles must generally cope with major lateral forces while depending on the steering performance of bogies . Those lateral forces are a major factor causing problems at the wheel/rail interface. Problems include: wheel flange climb derailment at low speeds; high rail gauge face wear; thin flange wear; low rail corrugations; and squealing. Japanese railway operators are currently working on resolving these problems, in order to decrease maintenance costs and alleviate environmental issues such as squeals, other rolling noise, and ground vibrations, all of which are closely related to low rail corrugations. A friction modifier was developed for delivery between wheels and rails, and examined to determine how it can be used effectively. For its part, the Railway Technical Research Institute (RTRI) has been developing another lubrication system, the Friction Moderating System (FRIMOS) for Wheel/rail Interface, to reduce lateral forces that cause squealing at sharp curves. The purpose of FRIMOS is the same as that of other friction modifiers[1].

We first examined the effect that lubrication at sharp curves, and lubrication on the top of low rails and at the high rail gauge face, would have on lateral forces. These experiments were carried out on a test track and a commercially operated line. Results indicated that lubrication on the top of low rails offers far better performance than the more common lubrication on high rail gauge faces[2]. However, top-of-rail lubrication for low rails entails some risk of wheel slide, since it reduces the coefficient of friction between the wheel tread and the rail top. We therefore adopted a solid lubricant, in the expectation that its traction coefficient would permit the avoidance of wheel slide as much as possible.

RTRI developed a carbon-based solid lubricant after taking into account the requirements of a system for delivering the lubricant onto the wheel/rail interface. The size of the carbon grains was made appropriate for the device used to deliver the lubricant (similar to a Cerajet system[3]). The main component parts of the device are a nozzle, solenoid valve and jet control system. Fig. 1 shows the schematic structure of FRIMOS. The traction characteristics of the carbon-based lubricant, which is called a friction moderator, has less of a positive slope than a friction modifier. Fig. 2 shows the appearance of the friction moderator. Fig. 3 is a photo of FRIMOS installed on the test vehicle.

To ensure proper functioning of the track circuit, the friction moderator must not impede wheel-to-rail shunting, but at the same time it must not reduce insulation performance at the insulation rail joints, even when the moderator is applied at amounts a little greater than usual. These opposing electrical-related functions of the friction moderator were examined on an actual track, and acceptable results were obtained.

In addition, one of the main requirements of the friction moderator, to have little impact on vehicle braking performance, was verified through laboratory simulations using a test stand, and through running tests using a test vehicle with FRIMOS installed. Acceptable braking distance test results were obtained.

The effect of the friction moderator in reducing squealing from the wheel tread/top-of-low-rail interface was verified through track site measurements during running tests, using a vehicle with FRIMOS installed. Fig. 4 shows the results of A-weighted sound pressure level measurements obtained at a location 2.1 meters from track gauge center. In the figure, the A-weighted sound pressure level reduction obtained from the friction moderator is readily apparent. The ability of the friction moderator to reduce lateral forces was also verified by track site measurements[4].

The FRIMOS system has been installed by a railway operator, in order to conduct further studies on the capability of the friction moderator to prevent low rail corrugations. Because the test results indicate a reduction in lateral forces, it is expected that the friction moderator will prove to be effective.

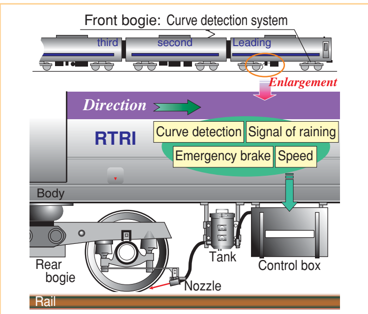

Fig. 1 Schematic structure of the Friction Moderating System (FRIMOS) for wheel/rail interface

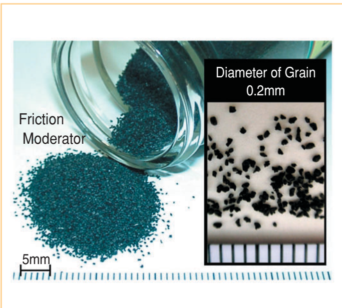

Fig. 2 Grain diameter

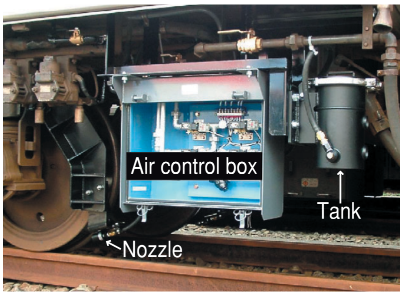

Fig. 3 FRIMOS installed

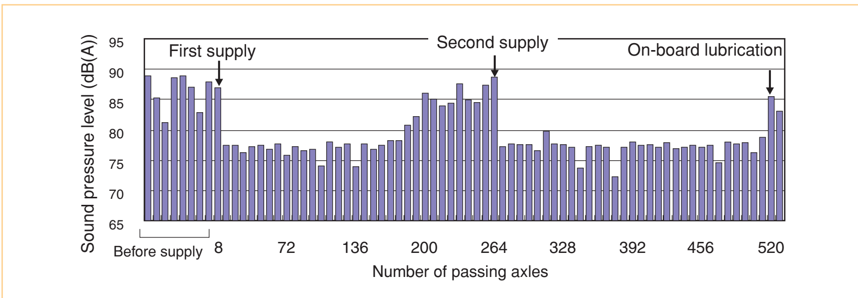

Fig. 4 Effect of the friction moderator in reducing rolling noise, measured at 2.1 m from center of track gauge

References

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