Improvement of curving performance of railway vehicle by onboard friction control system

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1. Summary

Running performance of railway vehicle greatly depends on frictional characteristics between wheel and rail. High friction is necessary for acceleration and braking, otherwise at a sharp curve low friction can reduce lateral force, squeal noise and rail corrugation. These controversial problems conflict in railway system for long time. As some conventional countermeasures, sand blasting or grease lubrication has been applied to wheel and/or rail, but each application has a limitation that the application can only obtain high or low friction. Authors have tried to apply friction modifier that is designed to have suitable characteristics for wheel/rail lubrication and also have developed new friction control method to atomize friction modifier from onboard device equipped to running railway vehicle. After several evaluations by bench test, computer analysis and field running test, onboard friction control devices have been equipped to some commercial trains of Tokyo Metro, the largest subway company in Japan (Figure1). During a long- term application of onboard wheel/rail friction control, wheel spin or skid that is annoying railway operator has not happened.

2. Detail of techniques

For the onboard friction control system, friction modifier KELTRACK™ that can keep appropriate frictional condition between wheel/rail is used. For little slippage that is equivalent to curve passing, friction modifier can keep low coefficient of friction, otherwise according to an increase of slippage the friction modifier has a positive characteristic with increase of coefficient of friction as shown in Figure 2. These characteristics are very effective for application at railway that is necessary for reducing lateral force and squeal noise at curve section and also demands to keep traction for preventing wheel slipping or spin. Oil grease is already widely used in railway system, but its application is restricted only for no acceleration or braking sections because of low coefficient of friction.

As shown in Figure 3, authors have introduced new concept of onboard friction control system that can atomize the friction modifier to top of rail accurately. Friction modifier can be sprayed from nozzle equipped to wheel guard of bogie at an end of train set, and controller equipped under floor of vehicle can supply the friction modifier precisely to the nozzle. Atomized friction modifier can be sprayed as a small particle that enables to properly scatter friction modifier in the region of contact area between wheel/rail. In the contact patch of wheel/rail, contact region of steel/steel can also improve traction performance against wheel slipping or spin. Since atomized friction modifier is sprayed from the tail end of train, there is sufficient time to dry out friction modifier on top of the rail. The next train running through this curve section can get a benefit of friction control by passing over the sprayed rail. Figure4, figure 5 and figure 6 that show some results of field tests of sound level, rail acceleration and lateral force in average at curve section proves the effect of spraying friction modifier.

3. Conclusion

As a solution for curving negotiation problem of railway vehicle, authors have developed a new onboard device to spray friction modifier on top of the rail and that enables to control friction condition between wheel/rail at appropriate level. By applying onboard friction control to commercial railway vehicle, curving performance such as lateral force or squeal noise have greatly improved. As a next step, authors are trying to develop feed back friction control system by detecting coefficient of friction by sensors attached to bogie that will lead to improvement regarding efficiency and economical problem.

Fig.1

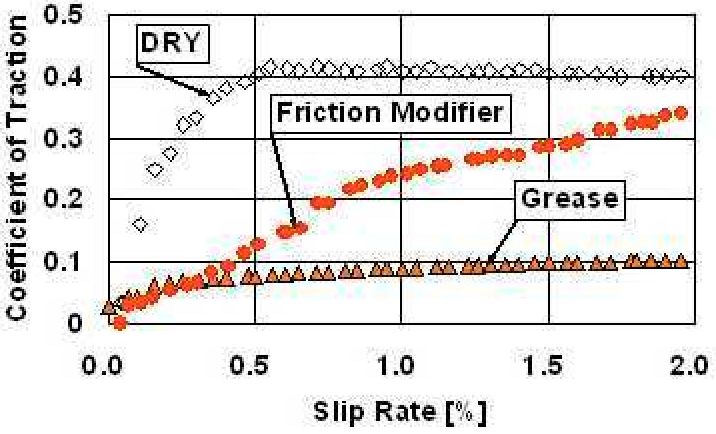

Fig.2

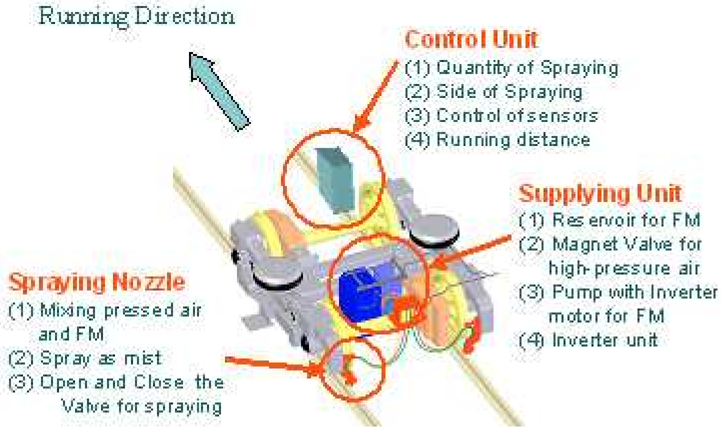

Fig.3

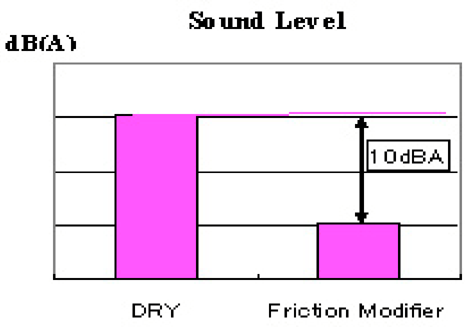

Fig.4

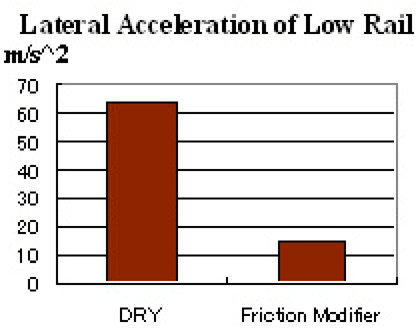

Fig.5

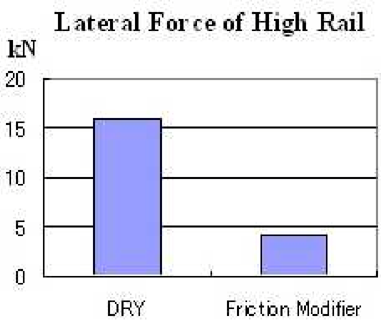

Fig.6