Management of Rail Top Irregularities to Reduce Rolling Noise

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The rolling noise generated from conventional railways is generally defined as the sound emitted from wheel and rail due to the vibration of these two components caused by minor irregularities in between when a wheel rolls on a rail. As an important countermeasure to reduce railway noise, therefore, the rail top and wheel surface shall properly be smoothed to remove irregularities. In this newsletter, we introduce a technique to control rail top irregularities and keep rolling noise at an appropriate level.

It is said that rolling noise is caused by the vibration of rail, which is dominant in the frequency range from 800 to 1,000 Hz. It is required, therefore, that the characteristics of rail top irregularities be correctly assessed which affect this frequency range. We apply power spectrum density analysis to rail-top irregularities by employing the maximum entropy method (MEM) that provides a comparatively stable solution with a small quantity of data. Figure 1 shows power spectra obtained before and after rail grinding. There are no dominant components in rail top irregularities with the amplitude of irregularity spectrum becoming smaller as the waveform becomes shorter. Figure 1 also shows a definite effect of rail grinding to reduce the power spectrum about 10 dB. The equation in the Fig. 1 averages the power spectra in the section where it is assumed that the rail is properly ground and shows the satisfactory condition of rail top irregularities ensured by the present rail grinding technique.

To properly depress rolling noise, however, it is not practical to directly measure rail top irregularities in the order of μm. As a means of indirect management, it is conceivable to monitor rolling noise based on under-floor noise or by using axle box accelerometers.

Figure 2 shows the under-floor noise of a revenue service train that ran in a rail-ground section from which Fig. 1 was given. The average under-floor noise was about 105 dB(A) and 95 dB(A) before and after rail grinding, respectively. The difference in between is almost the same as that in the power spectra pictured in Fig. 1. This means that under-floor noise can be chosen to monitor the condition of rail grinding. An exception in Fig. 2 where the effect of rail grinding is not seen is the place of road crossing.

Figure 3 shows the results of a trial wavelet analysis, which is now in the limelight as a time-frequency analyzing technique, to utilize axle box accelerometers. It has been confirmed that places of abnormal rail top irregularities can correctly be detected by this analysis. We will compose a system to inspect rail top irregularities on the basis of this method.

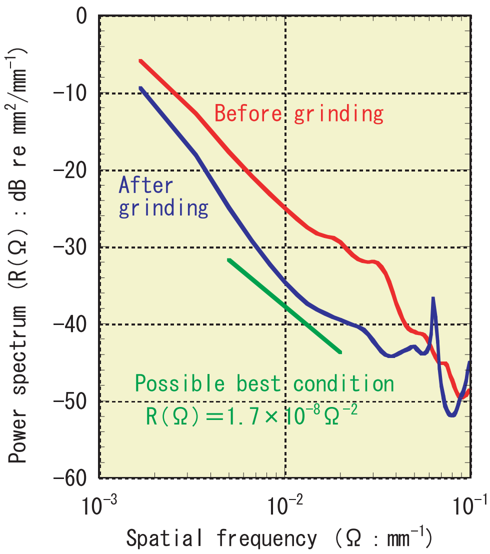

Figure 1. Power spectra of rail top irregularities.

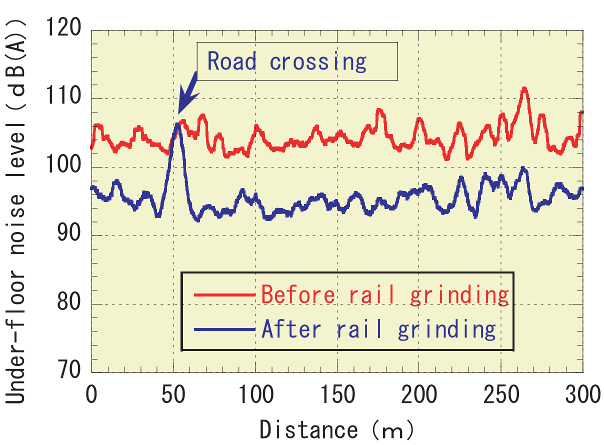

Figure 2. Measurement of under-floor noise (at 110 km h⁻¹).

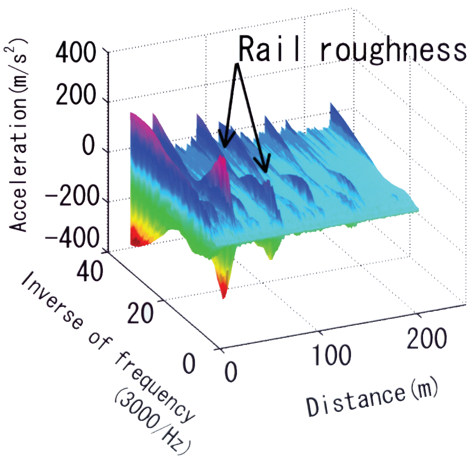

Figure 3. Example of the results of wavelet analysis (at 270 km h⁻¹).