External-Noise Reduction Technologies for Series E5 and E6 Shinkansen Trains





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1. Overview

Along with the expansion of the Shinkansen network, travel time needs to be shortened, making it necessary to increase maximum Shinkansen operating speed. A major issue is the reduction of wayside noise where standard values are the strictest in the world. We developed new mitigation measures for noise from pantographs and the lower part of cars, each of which contributes greatly to maximum noise level. By using these measures, Series E5 "Hayabusa" and Series E6 "Komachi", which are new generation Shinkansen trains, were able to operate at a higher maximum speed.

2. Technical features

In order to find which noise sources are to be reduced, we conducted running tests up to 360 km/h using a Series E2 commercial train and estimated the contribution of each noise source to the overall noise level. The measurement results show that the noise level of the E2 train running at a speed of 360 km/h rises by approximately 6.5 dB over that of 275 km/h. It was also found that noise from pantographs and the lower part of cars (including rolling noise, aerodynamic noise from around bogies, etc.), in that order, have the greatest effect on maximum noise level in Series E2 running at 360 km/h, while noise from the upper part of cars, concrete-bridge and train nose contribute less to maximum noise level, as shown in Fig. 1 (a). We thus developed mitigation measures mainly for noise from pantographs and the lower part of cars.

For reducing pantograph noise, we proposed the combination of three measures: 1) new low-noise pantograph with a cantilevered main arm, 2) pantograph-noise insulation plate, 3) running by use of only one pantograph per trainset (Fig. 2, aiming for further diffraction attenuation effect by hiding the folded pantograph behind noise insulation plates). For better current collection while using only one pantograph, we developed a multi-segment slider (Fig. 3) having fractionated contact strips; this is quite effective in keeping pantograph in contact with the overhead wire.

In order to control noise from the lower part of cars, a sound-absorbing panel was developed with the aim of absorbing the noise from the lower part of cars through a propagation process of multiple sound reflections between car body and noise barrier.

Running tests were conducted using FASTECH360, experimental trains of JR-East, implementing the measures for pantograph noise and sound-absorbing panels described above and several measures for other sources (bogie side cover, circumferential diaphragm, etc.). The result shows a total noise reduction of approximately 5 dB compared with the noise level of Series E2, as compared between Fig. 1 (a) and (b). That is, the combination of the newly developed measures enables Shinkansen trains to operate at a higher maximum operating speed, suppressing wayside noise.

3. Summary

The noise reduction technologies mentioned above are used for new-generation Shinkansen trains, Series E5 (Fig. 4) and E6; operating at a speed of 320 km/h, the highest in Japan.

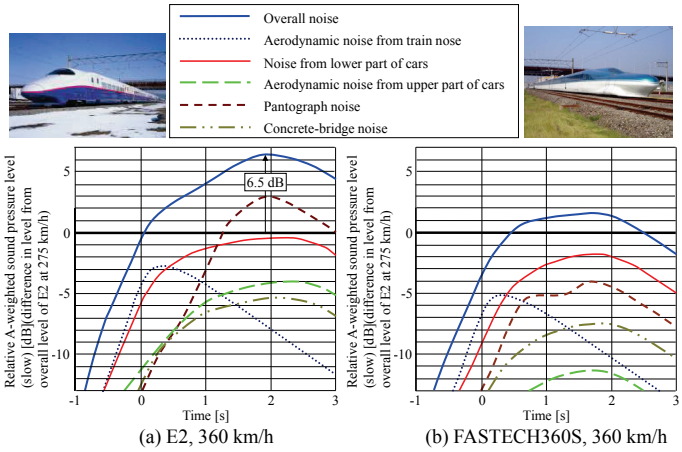

Fig. 1 Contribution of each noise component to overall noise level in Series E2 and FASTECH360S at 360 km/h (with noise barrier)

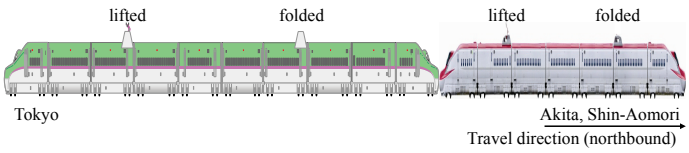

Fig. 2 Use of pantographs (with Series E6 and E5 connected)

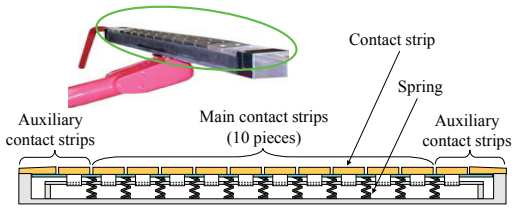

Fig. 3 Multi-segment slider

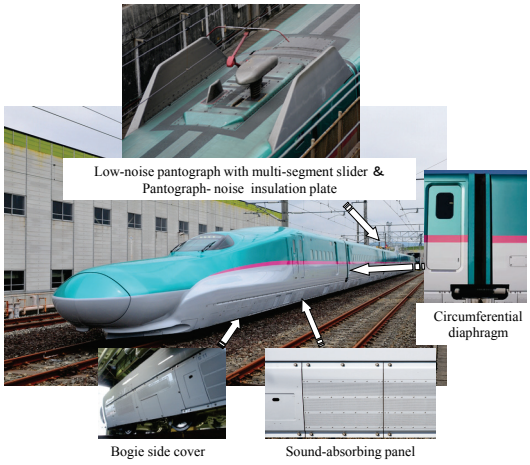

Fig. 4 Noise reduction technologies for Series E5

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