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Investigation into external noise of a high-speed train at different speeds

Key words: External noise, Source identification, High-speed trains, Sound exposure level, Pass-by noise

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Noise source identification

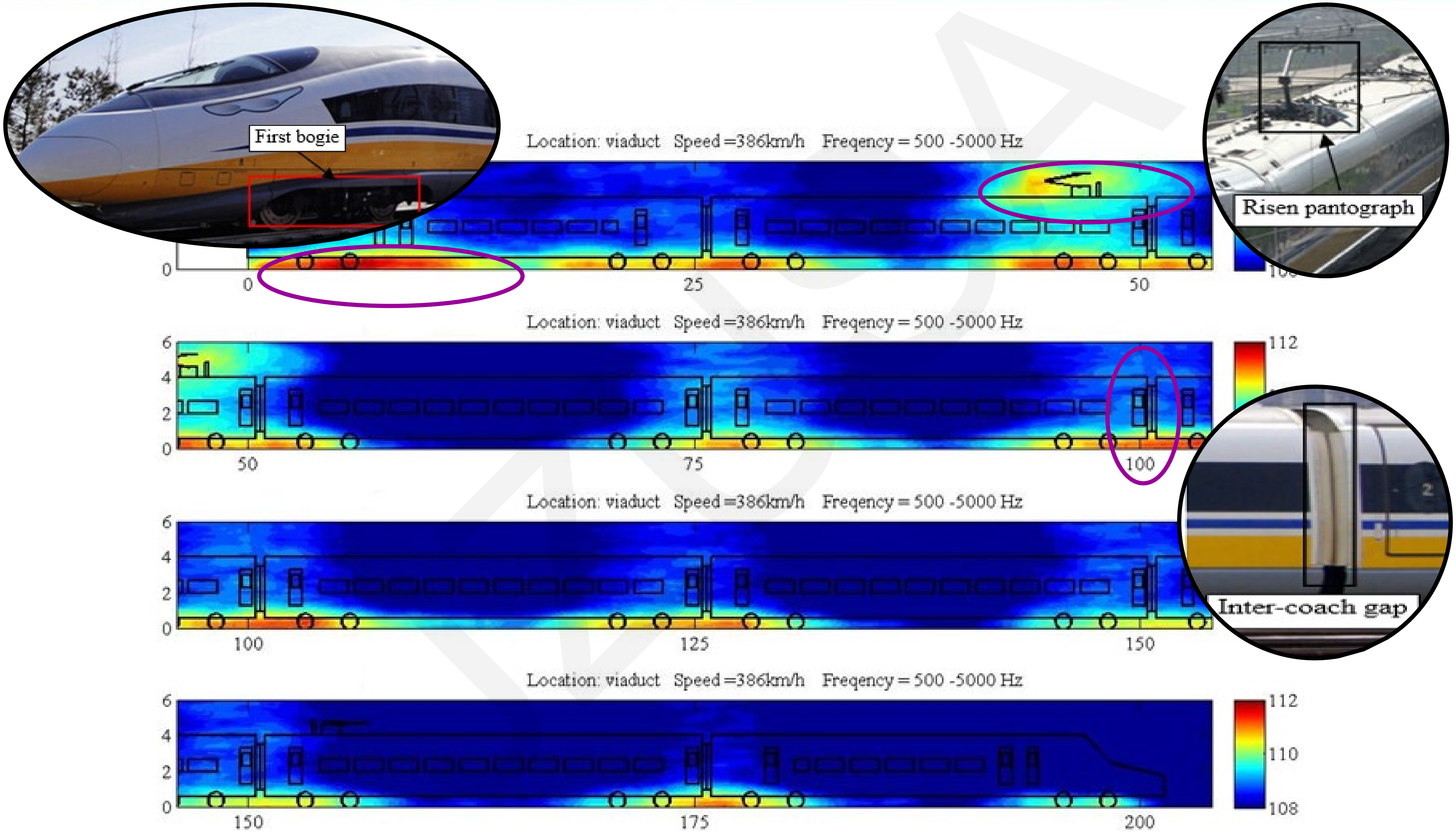

Fig. 1 Noise source distribution of a high-speed train traveling at 386km/h

Sound exposure level

$$\mathrm{SEL} = 10\lg\left(\frac{1}{T_0}\int_0^T \frac{p_A^2(t)}{p_0^2}dt\right) = 10\lg\left(\int_0^T \frac{p_A^2(t)}{p_0^2}dt\right)$$

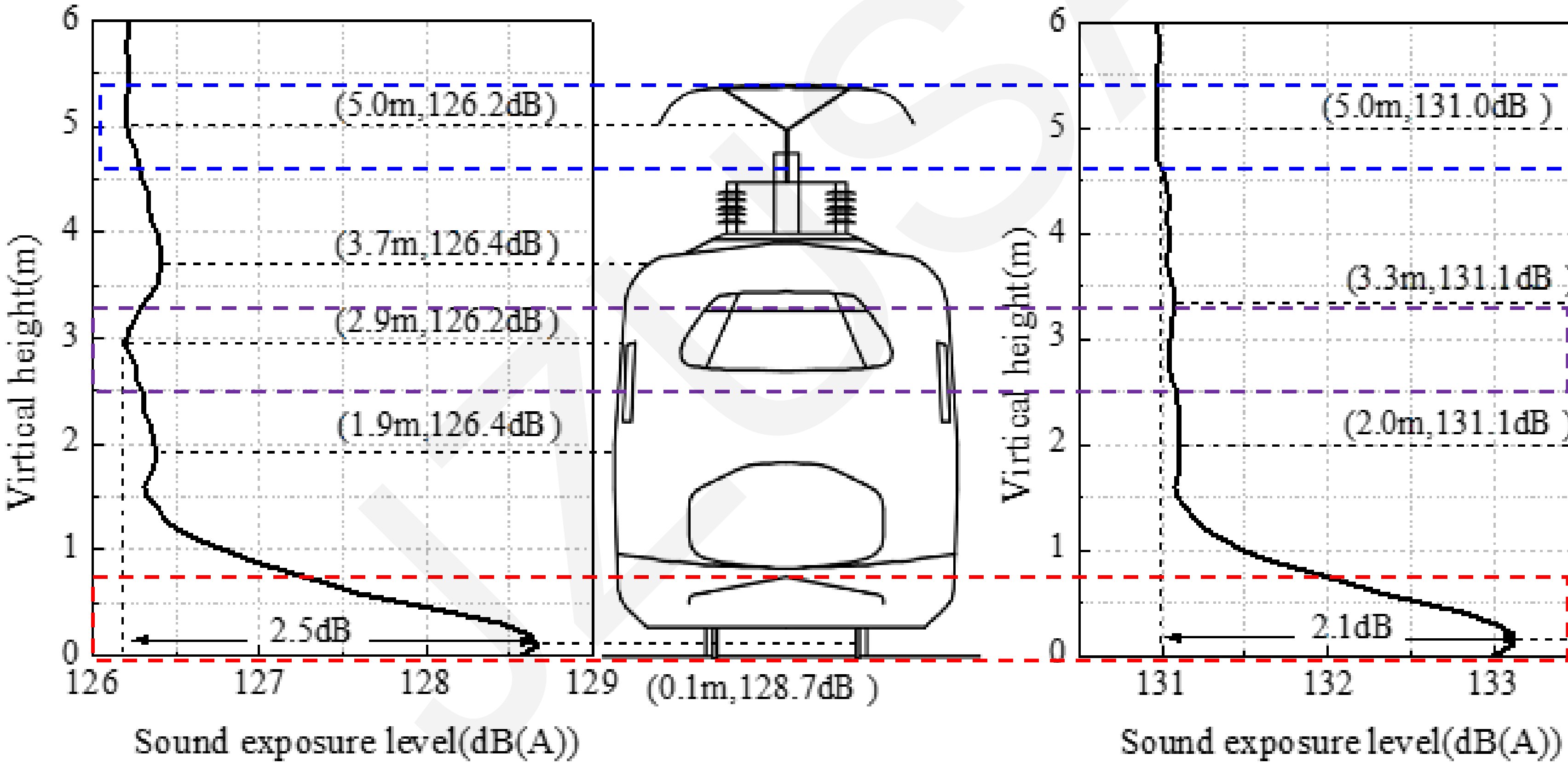

Fig. 2 The SEL distribution at 271km/h and 386km/h

Pass-by noise

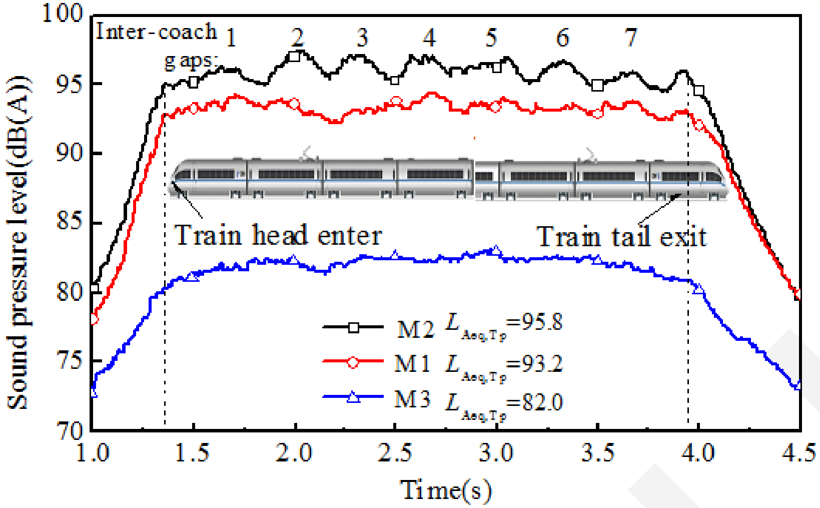

Fig3. Time histories of the sound pressure levels

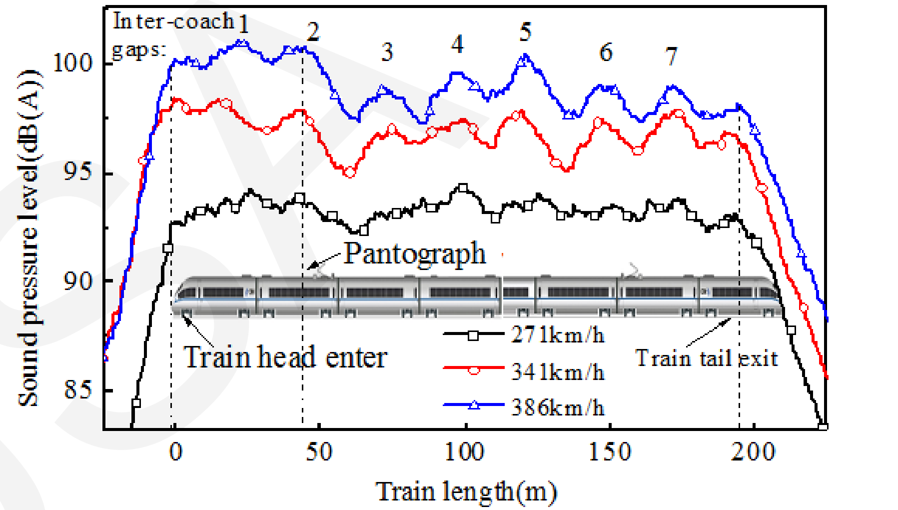

Fig4. Time histories of the sound pressure level at M2

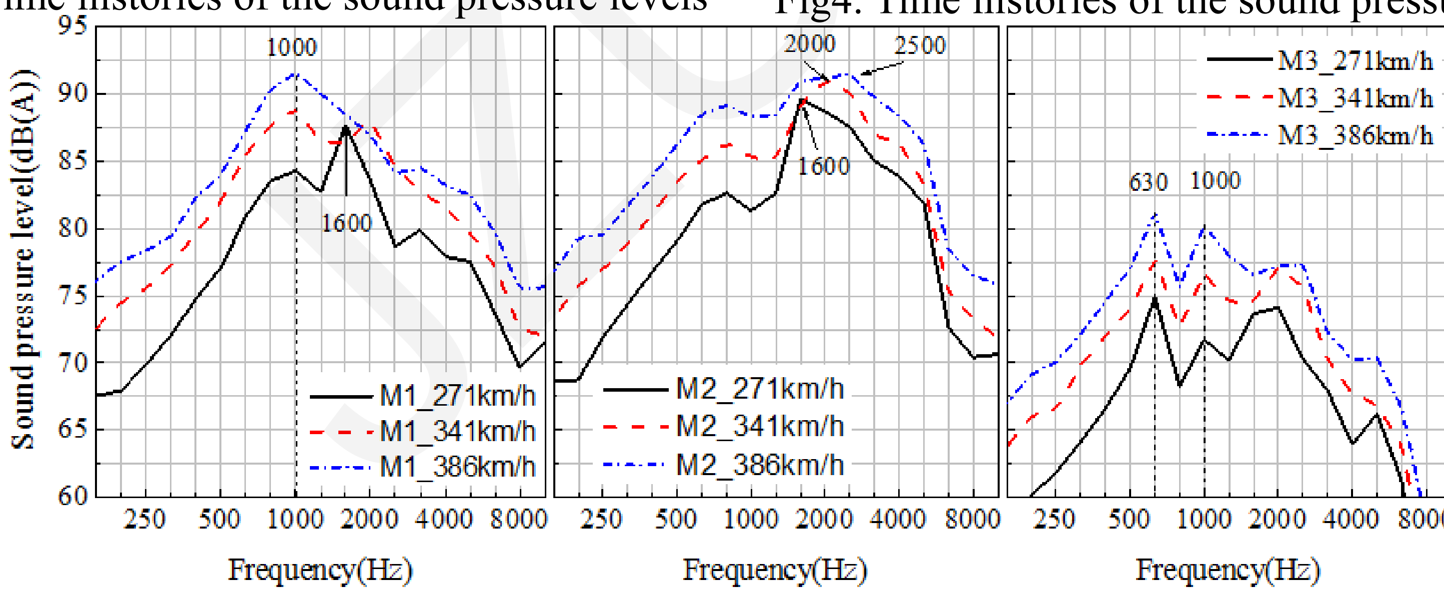

Fig.5 Frequency characteristic of three field points at the different speeds.

Exterior noise behaviors

$$L_{\mathrm{Aeq,T_p}}(v) = A[\log 10(v)]^2 + B\log 10(v) + C$$

⇩

$$L_{\mathrm{Aeq,T_p}}(v) = B\log 10(v/v_0) + L_{\mathrm{Aeq,T_p}}(v_0)$$

The transition speed for which aerodynamic noise becomes as important as the rolling noise, which generally is considered to lie around 300 km/h (Krylov, 2001; Mauclaire, 1990), is not clearly observed.

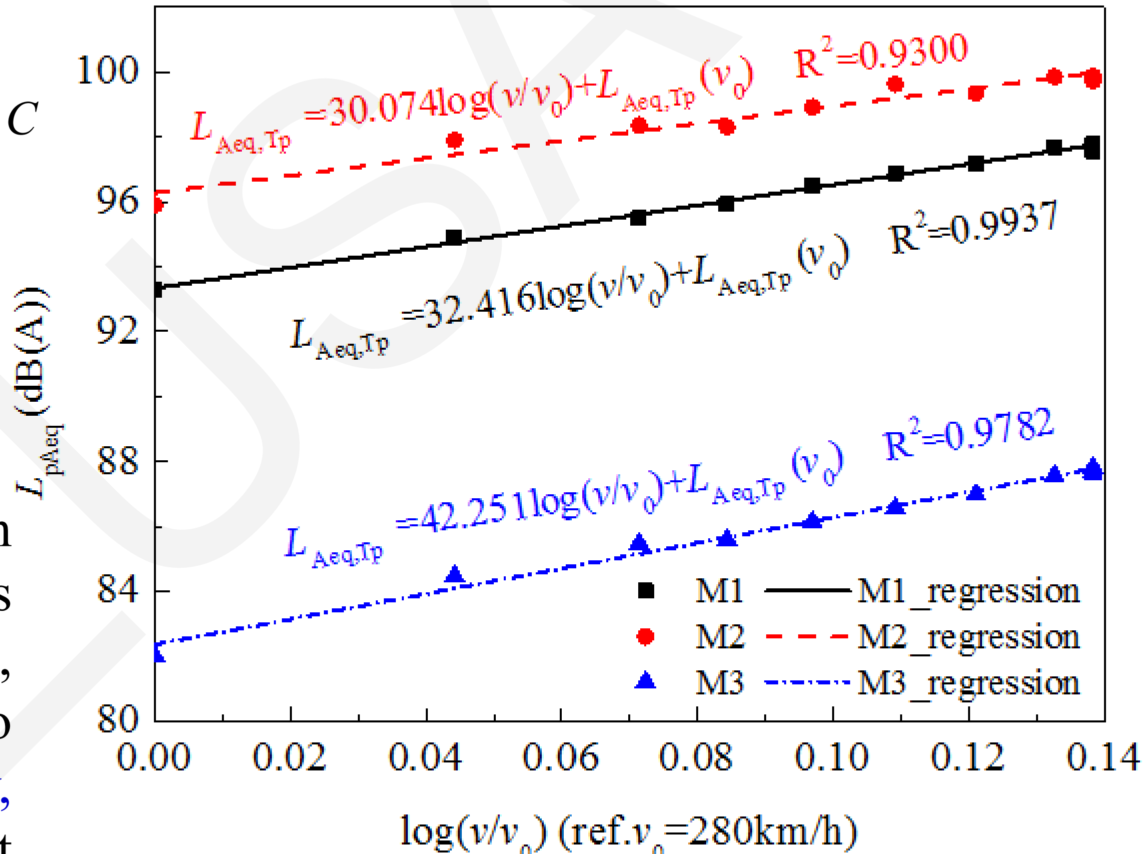

Fig. 6 Linear regressions of the measured data from 280 km/h to 390 km/h

Conclusions

- Exterior noise identification of the high-speed train shows that main noise originates at three areas: the wheel/rail systems (or bogies), the pantograph, and the inter-coach gaps. The wheel/rail area produces the dominant rolling noise and the aerodynamic noise caused by airflow around the bogie. The pantograph and the inter-coach gaps of the train mainly generate aerodynamic noise. For speeds below 386 km/h, the SEL of the wheel/rail area is the greatest in the frequency range below 3150 Hz, while the SELs of the three noise sources are quite similar for larger frequencies.
- Along the vertical train height, maximum noise levels are found in the wheel/rail area. At distances far from the central track line, the wheel/rail rolling noise still makes a greater contribution than the aerodynamic noise for the entire train velocity range analyzed.
- The measured results at all field points show that the noise components from 630 Hz to 2500 Hz, which are typically attributed to wheel/rail rolling noise, always dominate. Therefore, it is suggested that the design of low-noise high-speed trains and exterior noise control should be focused on the control and reduction of this type of noise