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Influence of ground effect on flow field structure and aerodynamic noise of high-speed trains

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Key words:

High-speed train, Aero-acoustics, Flow field structure, Large eddy simulation, Toxicity and impact, Rotating wheelsets

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Ground Simulation System

■ **Four different ground simulation systems were set up before the calculation began.**

Short name	Case 1	Case 2	Case 3	Case 4
Full name	Moving ground + rotation wheel	Stationary ground + rotation wheel	Moving ground + stationary wheel	Station ground + stationary wheel
Ground moving speed (km/h)	350	0	350	0
Wheel rotation speed (rad/s)	1817.2	1817.2	0	0

Table. 1 The case of Ground Simulation System

Meshing

- The number of body grids was about 110 million.

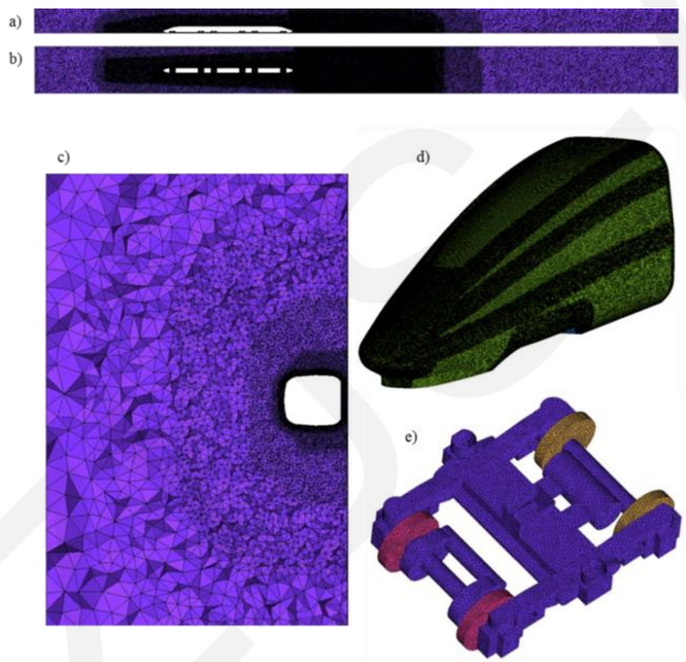


Fig. 1 Grid distribution: a) longitudinal symmetry plane; b) on the same elevation as the tip of the nose; c) a cross section of the tail-flow type shoulder; d) streamlined area; e) bogie.

Analysis of flow field characteristics

- Section a is a y-equivalent plane running through the calculation domain and the wheel pair.
- Section b is the z iso-surface penetrating the calculation domain.
- Line 1 is along the x direction and penetrates the calculation region.

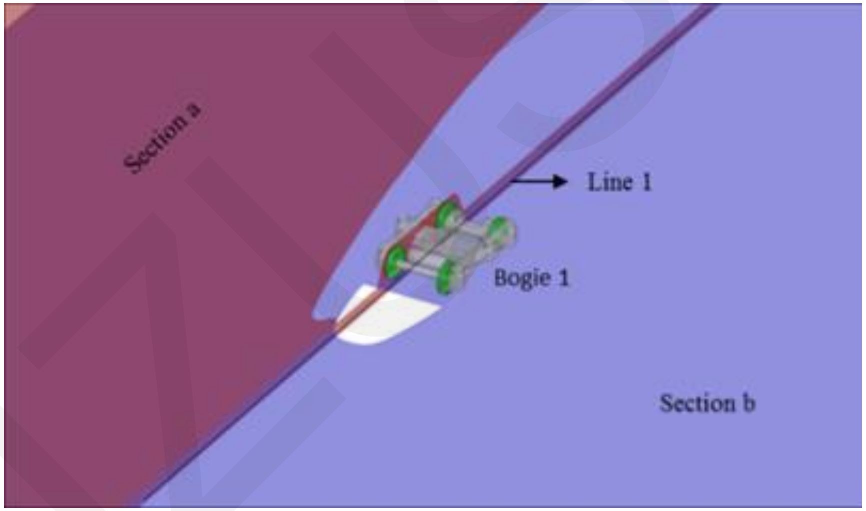
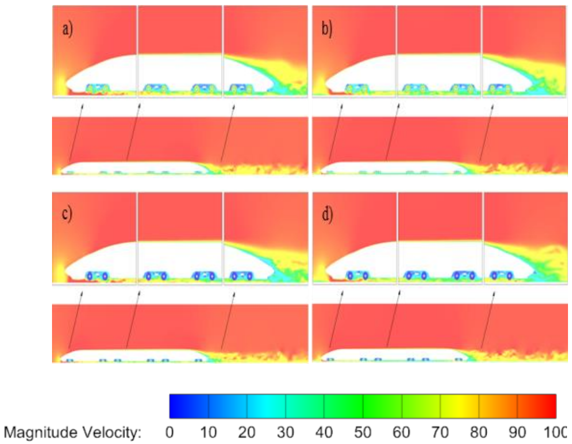
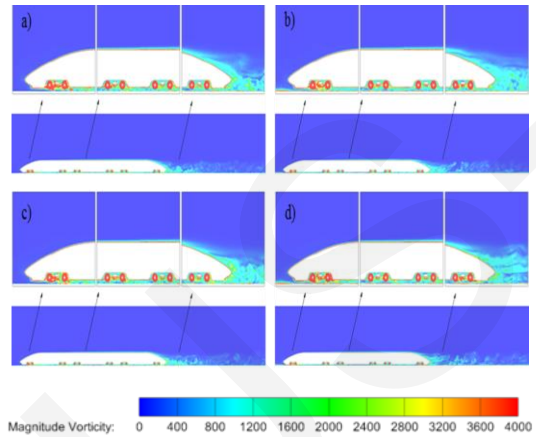


Fig. 2 Sketch map of the section

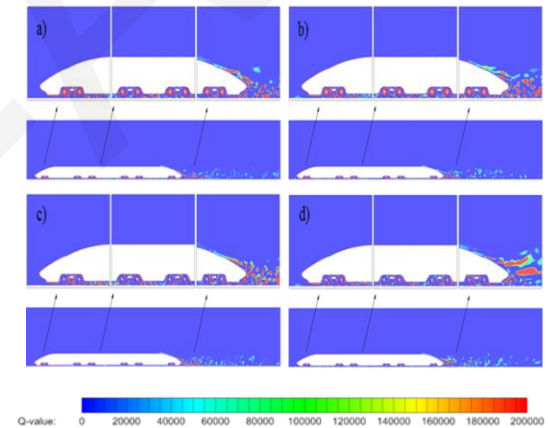
Analysis of flow field characteristics



(a) Velocity magnitude



(b) Vorticity magnitude



(c) Q value

Fig. 3 Difference analysis of flow field structure characteristics.

Far field radiation noise

■ To study the characteristics of high-speed train radiated noise

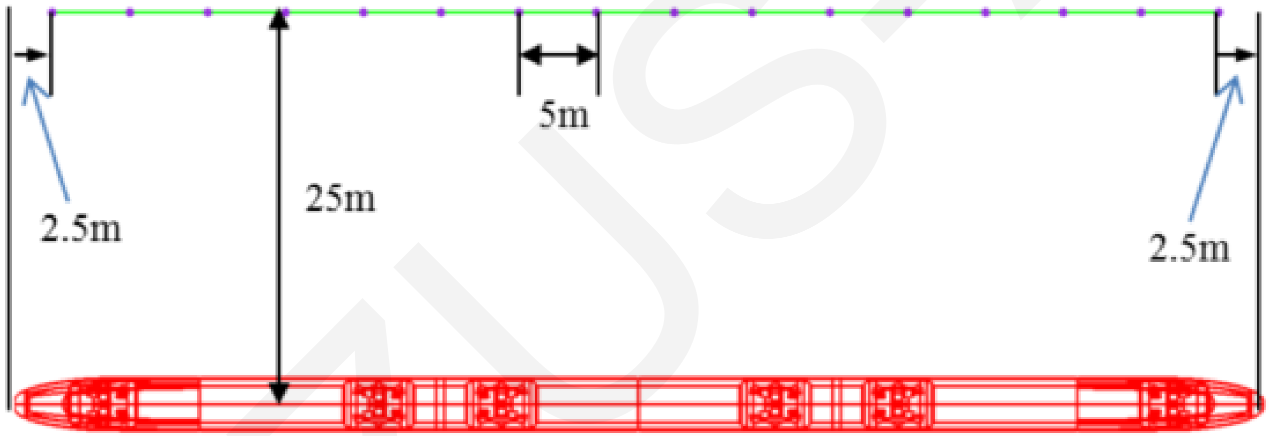


Fig. 4 The location of the measuring points

Far field radiation noise

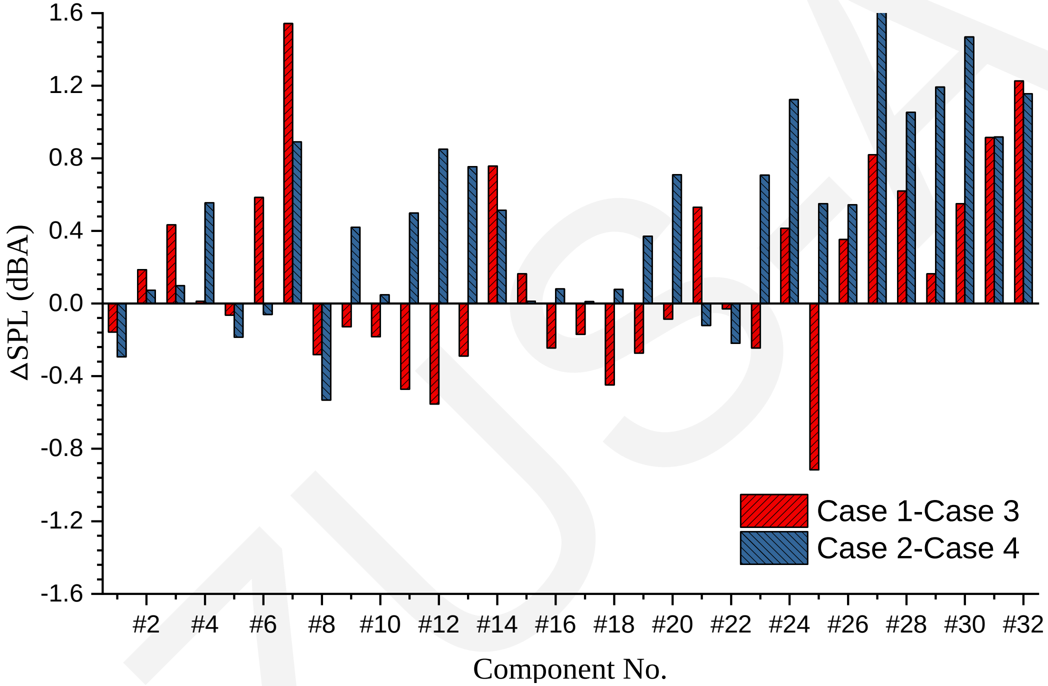


Fig. 5 Histogram of the difference in $SPL_{average}$ between the "rotation wheel" and "stationary wheel"

Far field radiation noise

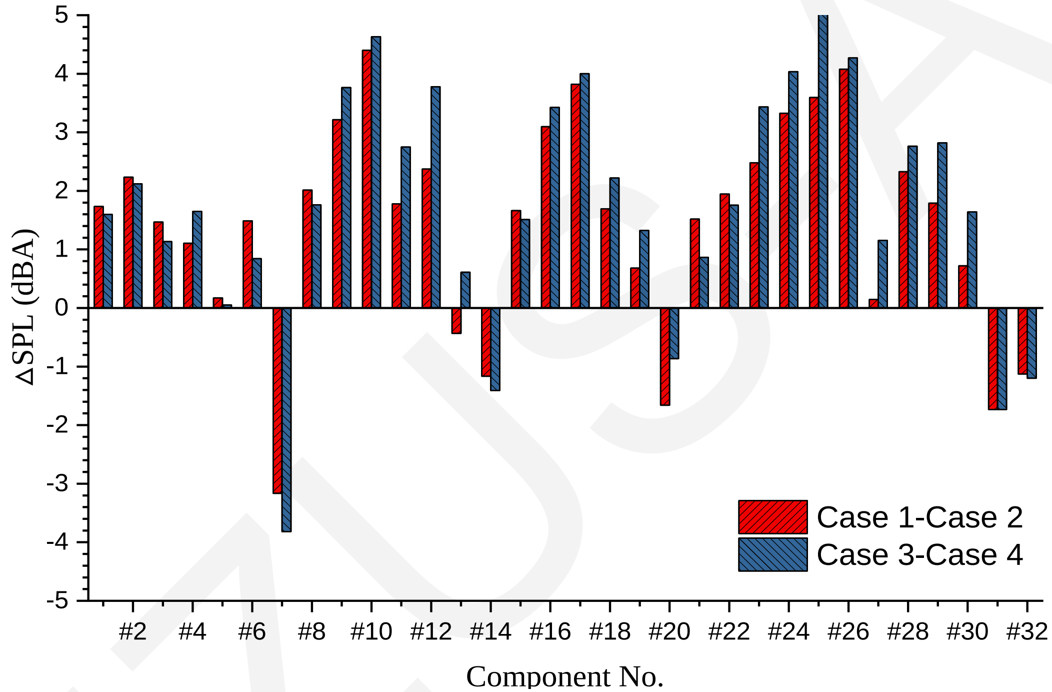


Fig. 6 Histogram of the difference in $SPL_{average}$ between the "moving ground" and "stationary ground".

Conclusions

- **Moving ground and rotating wheel pair are the main factors affecting the aerodynamic acoustic performance of train bottom.**
- **The influence of rotating wheel on the vehicle equivalent sound source power is not more than 5%, and the influence of moving ground on the vehicle equivalent sound source power is more than 15%.**
- **The average impact of rotating wheel on vehicle radiation sound pressure level is 0.3dBA, and the average impact of moving ground surface on vehicle radiation sound pressure level is 1.8dBA.They mainly affect aeroacoustic performance below 100Hz.**