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Effect of side track height on aerodynamic characteristics of a high-speed high-temperature superconducting maglev train under crosswind

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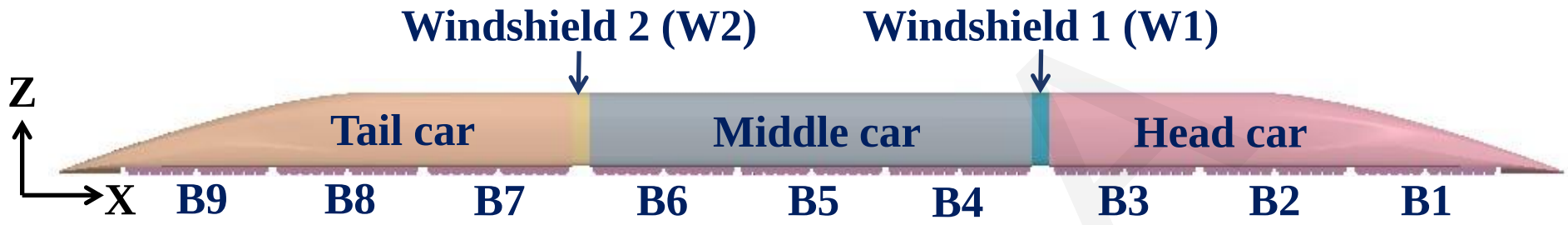
Geometry Model



U-shaped track

Permanent magnet eddy current brake

Safety support wheel track

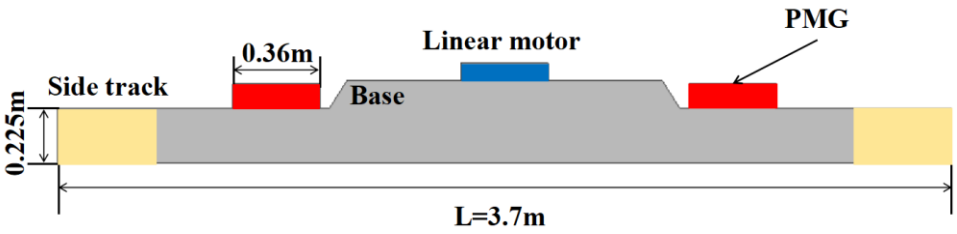
Positioning system for linear motor

Permanent magnet guideway and it supporting structures

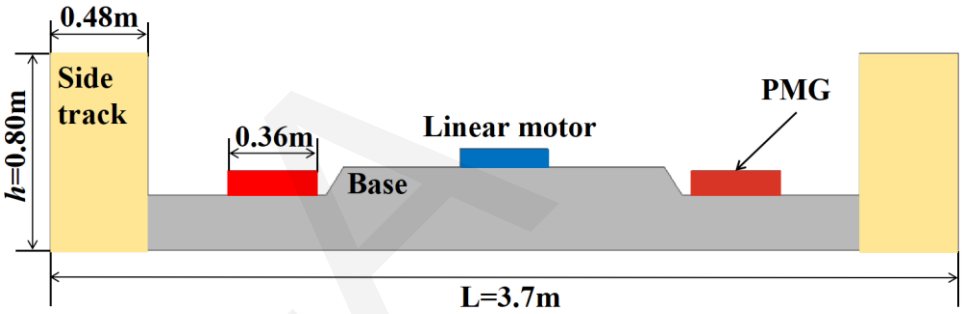
Linear motor system

- **HTS maglev train model, vehicle prototype, test line, and U-shaped track**

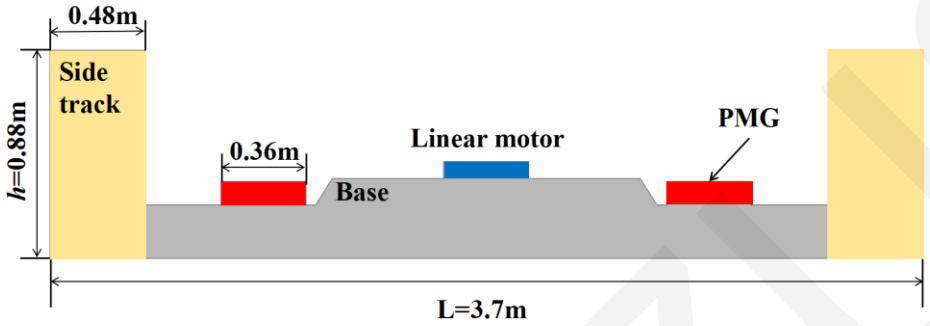
Different Calculation Conditions



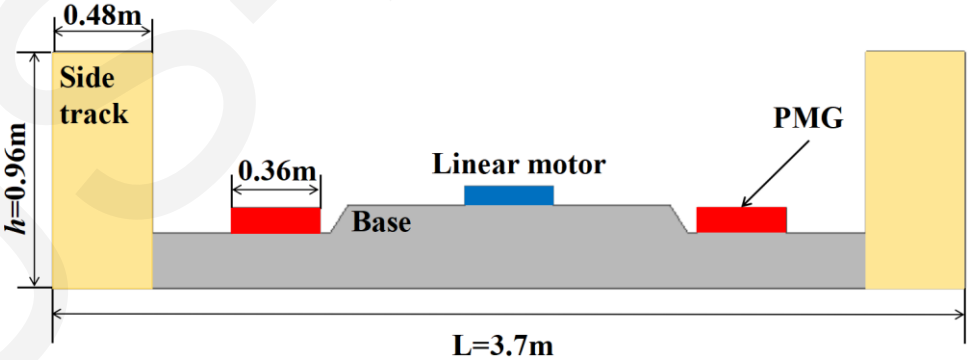
No Track (NT)



Track height=800mm (WT-800)

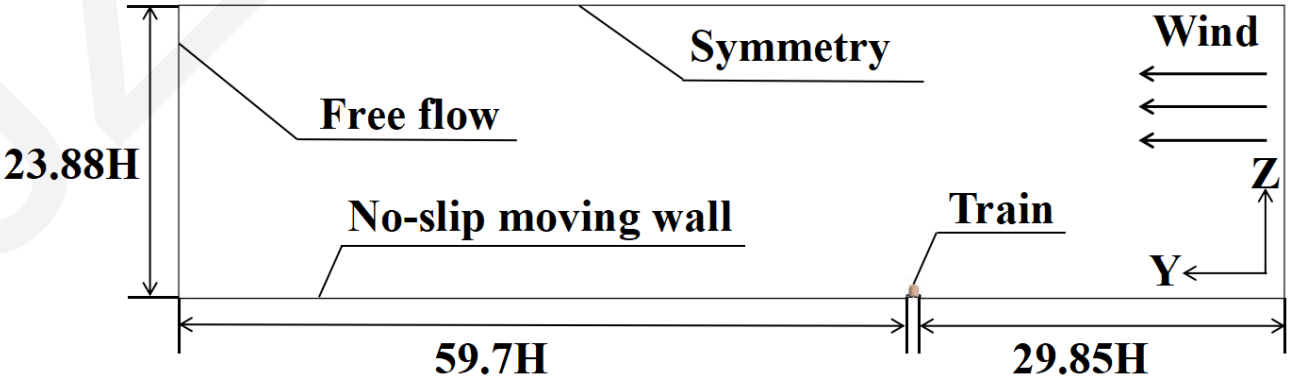


Track height=880mm (WT-880)

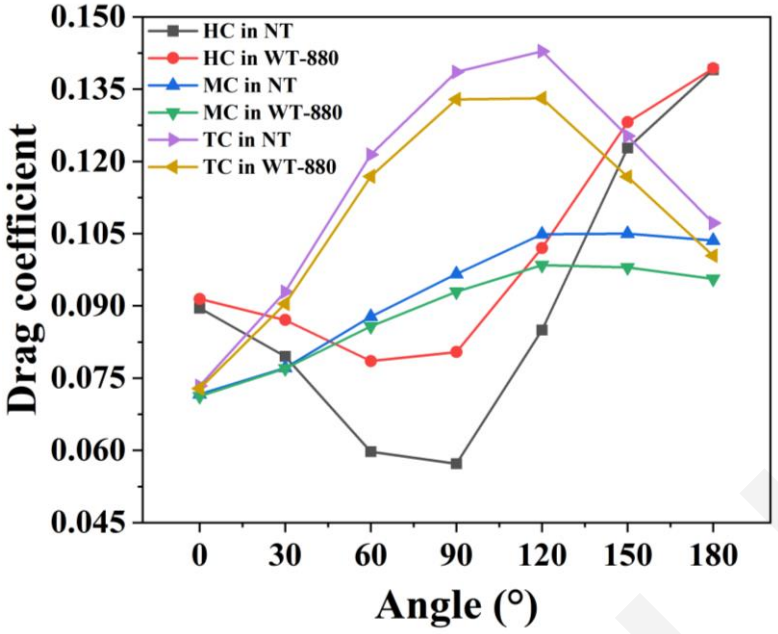


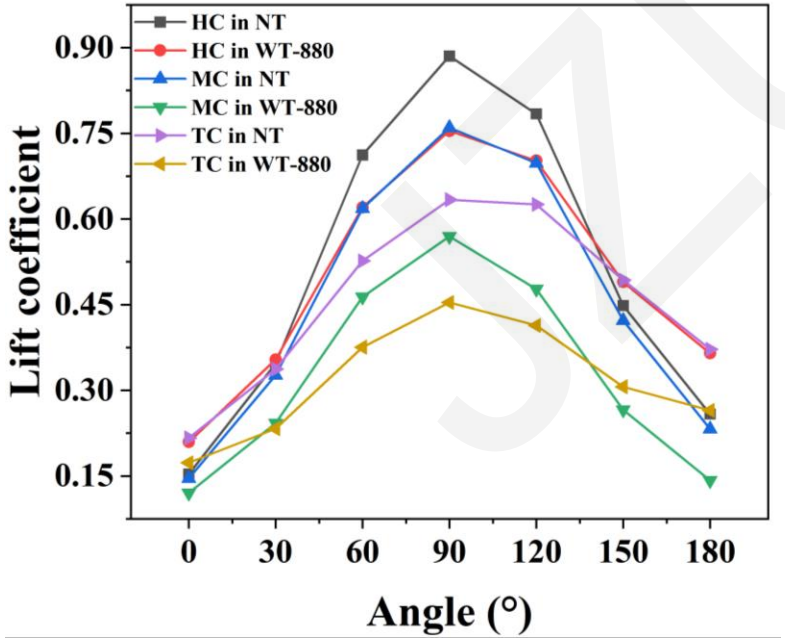
Track height=960mm (WT-960)

Computational domain

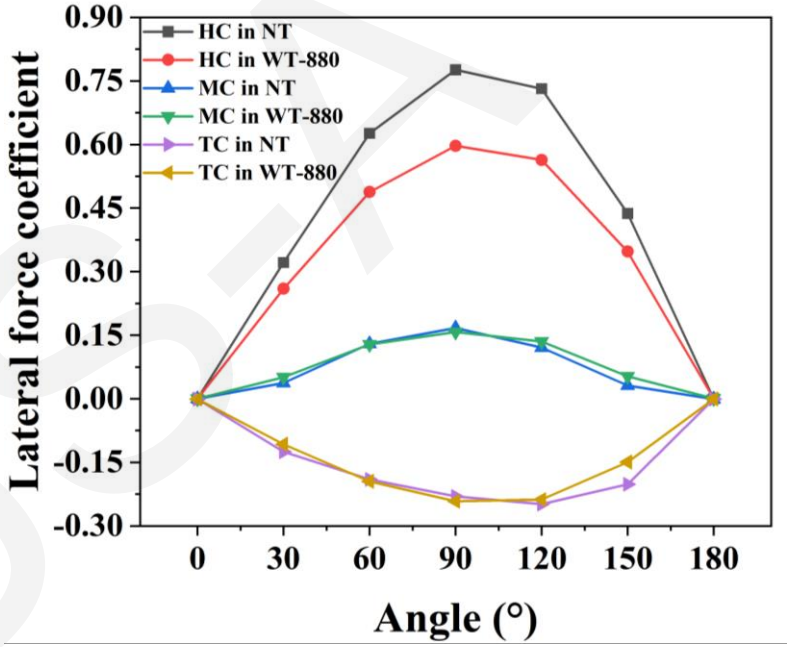


NT and WT-800





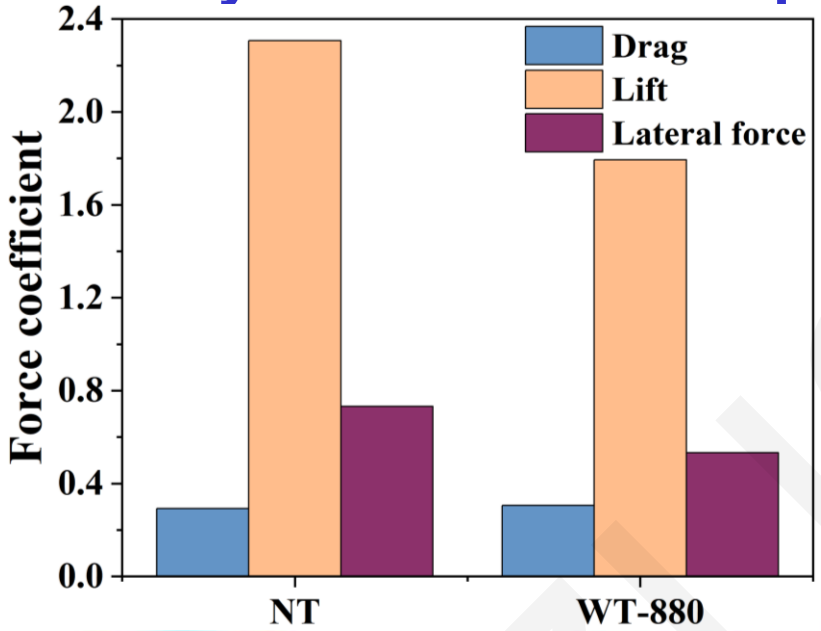
■ Different wind direction angles

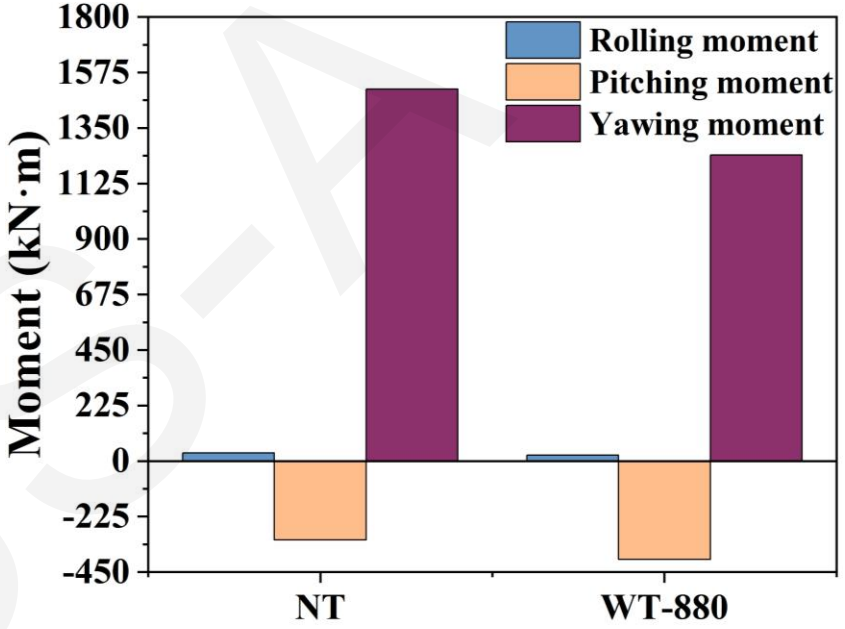


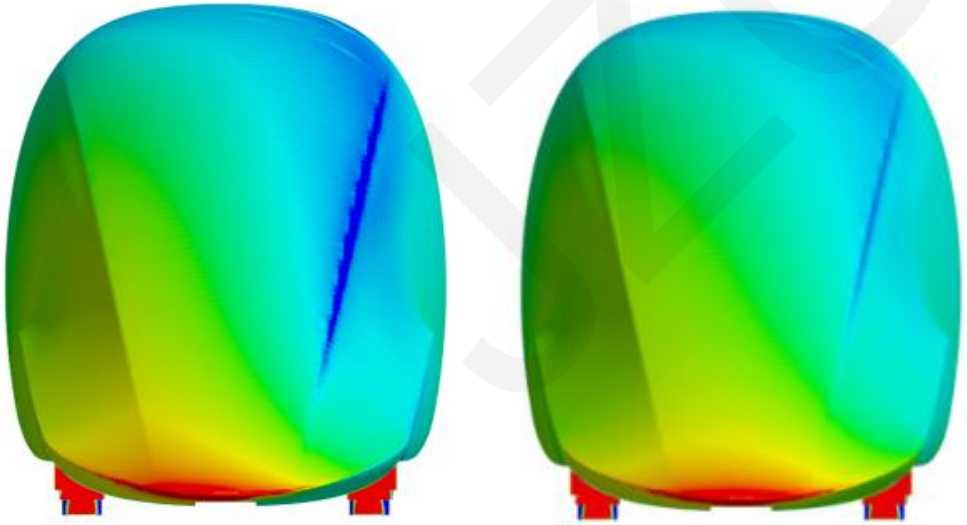
- **The presence of the U-shaped track can effectively minimize the negative influence of crosswind on the head, middle, and tail car of the train.**
- **When the wind direction angle approaches 90 °,the aerodynamic noise characteristics are the most severe.**

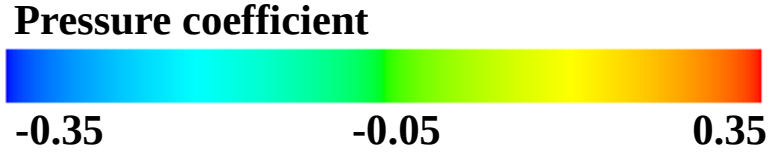
NT and WT-800

■ Aerodynamic loads and pressure distribution







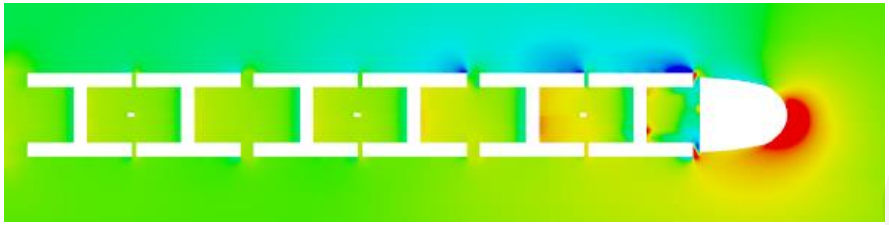


Front surface pressure (NT) Front surface pressure (WT-880)

NT and WT-800

- The bottom of the head car

Pressure distribution



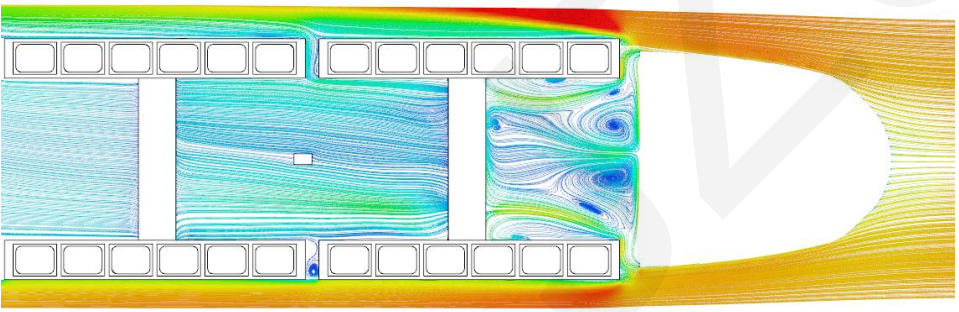
NT

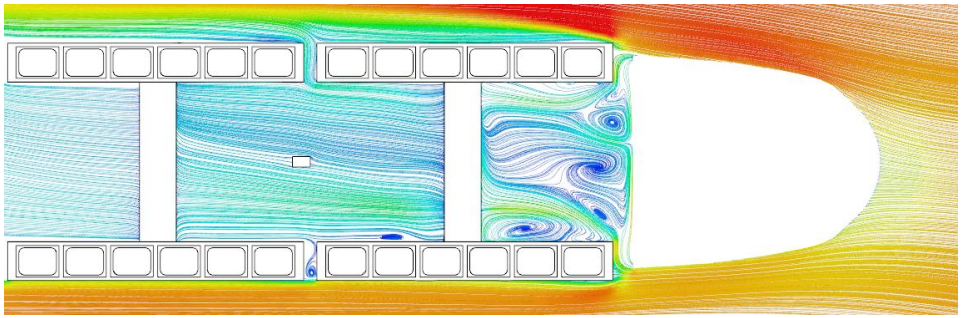
WT-880

Pressure coefficient

-0.25 0 0.25

Flow field





NT

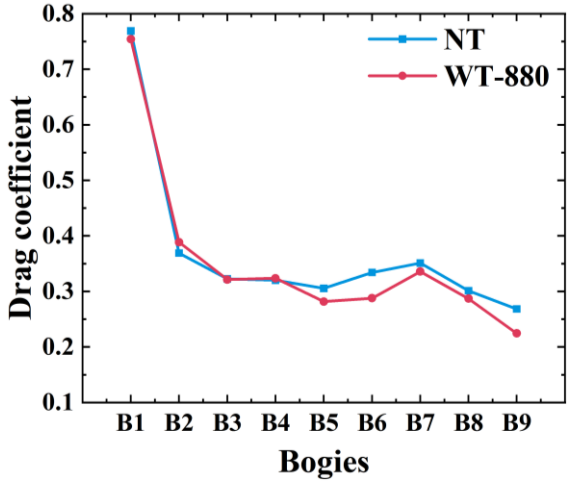
WT-880

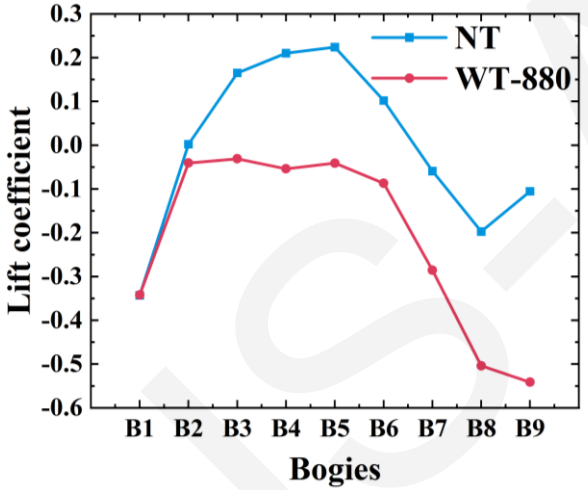
Velocity (m/s)

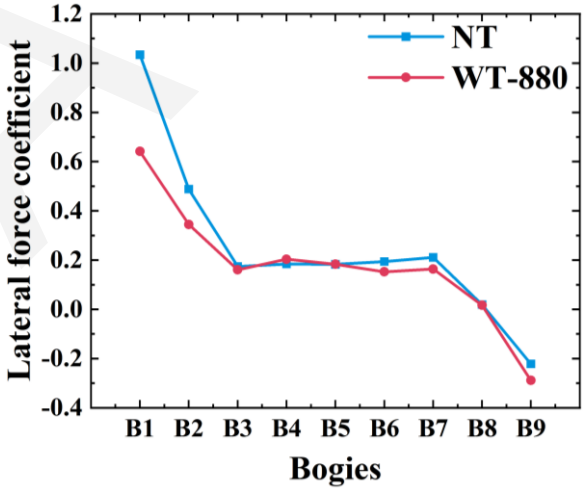
0 39 78 117

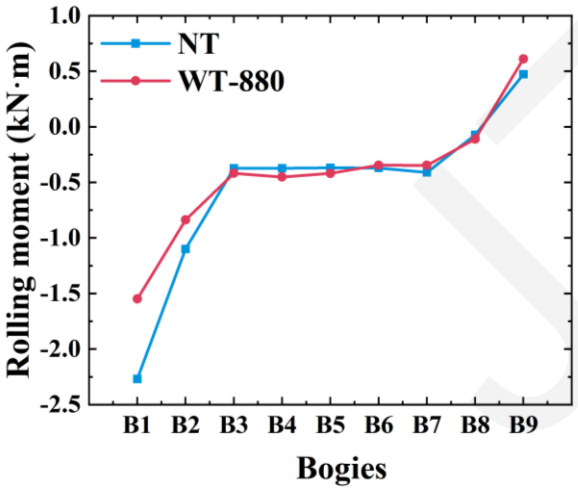
NT and WT-800

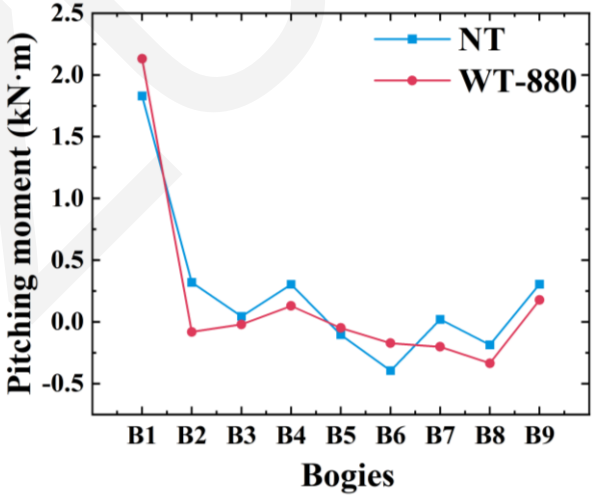
■ Aerodynamic characteristics of the suspension bogies

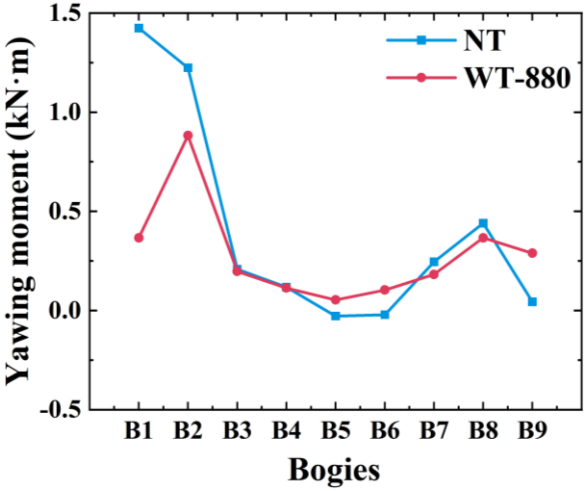








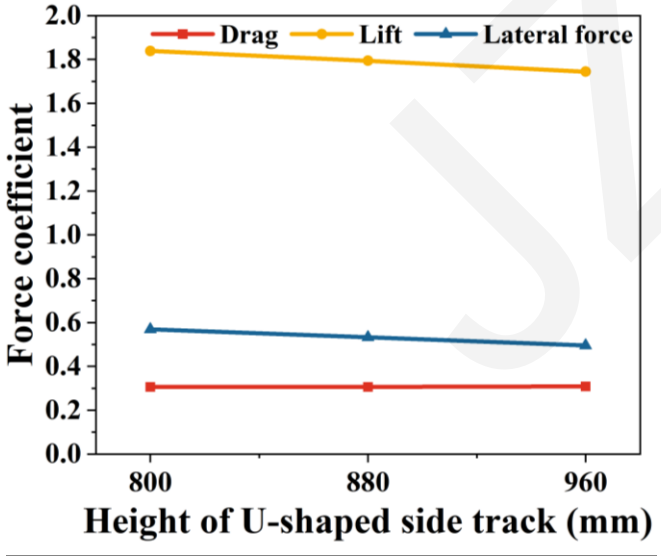




- **The presence or absence of the U-shaped track has the most significant impact on the train's B1 bogie.**

Different Side Track Height

The force coefficient of the train with different side track heights			
	Drag	Lift	Lateral force
800 mm	0.3060	1.8385	0.5690
880 mm	0.3064	1.7939	0.5326
960 mm	0.3082	1.7443	0.4958
the rate of change from 800 mm to 960 mm	0.7%	-5.1%	-12.9%
the rate of change from 880 mm to 960 mm	0.6%	-2.8%	-6.9%



- The increase in the side track height has a relatively beneficial impact on the train's lift and lateral force, while the negative impact on drag is relatively minor.

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Conclusions

- The U-shaped track effectively reduces resistance between the middle car and tail car, while also decreasing lateral forces on the front car.
- The B1 bogie at the train's bottom exhibits suboptimal aerodynamic performance, which can be significantly improved by implementing the U-shaped track design.
- As the side rail height increases from 800 mm to 960 mm, both lateral forces and lift are notably reduced.
- Therefore, in practical applications, it is recommended to adopt a 960 mm side rail height to optimize the train's aerodynamic performance.

相关论文：

1.Numerical investigation of aerodynamic features and flow structure of a high-speed high-temperature superconducting maglev train under crosswind based on reduced-order methods. Journal of Fluids and Structures. 2025,1(37),104367. DOI:10.1016/j.jfluidstructs.2025.104367

2.Contribution of suspension bogies' aerodynamic loads to the dynamic characteristics of a high-temperature superconducting maglev train running under crosswind. Journal of Applied Fluid Mechanics. 2025,18(6) ,1617-1638. DOI:10.47176/jafm.18.6.3084