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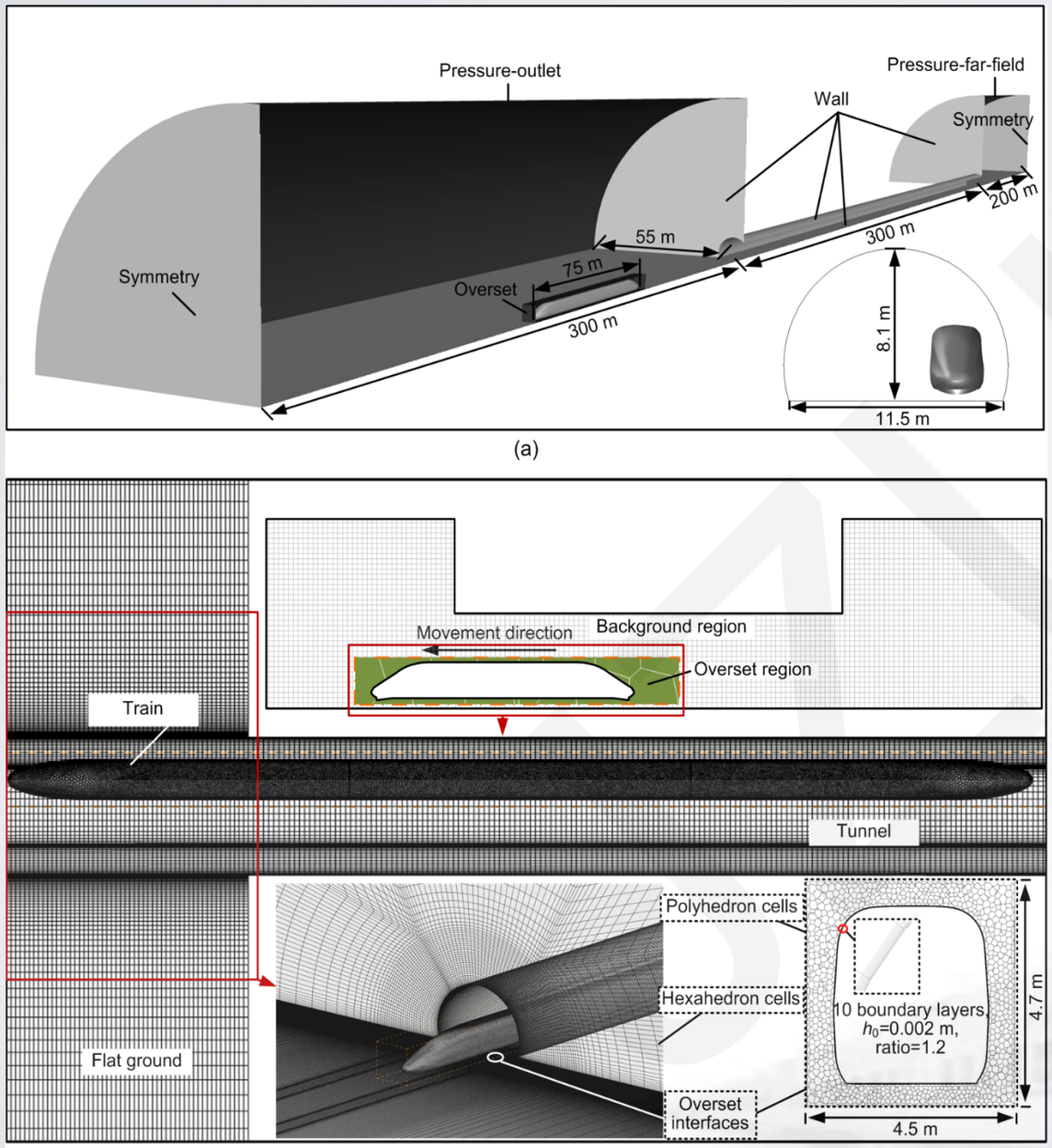
Dynamic performance of a high-speed train exiting a tunnel under crosswinds

Key words:

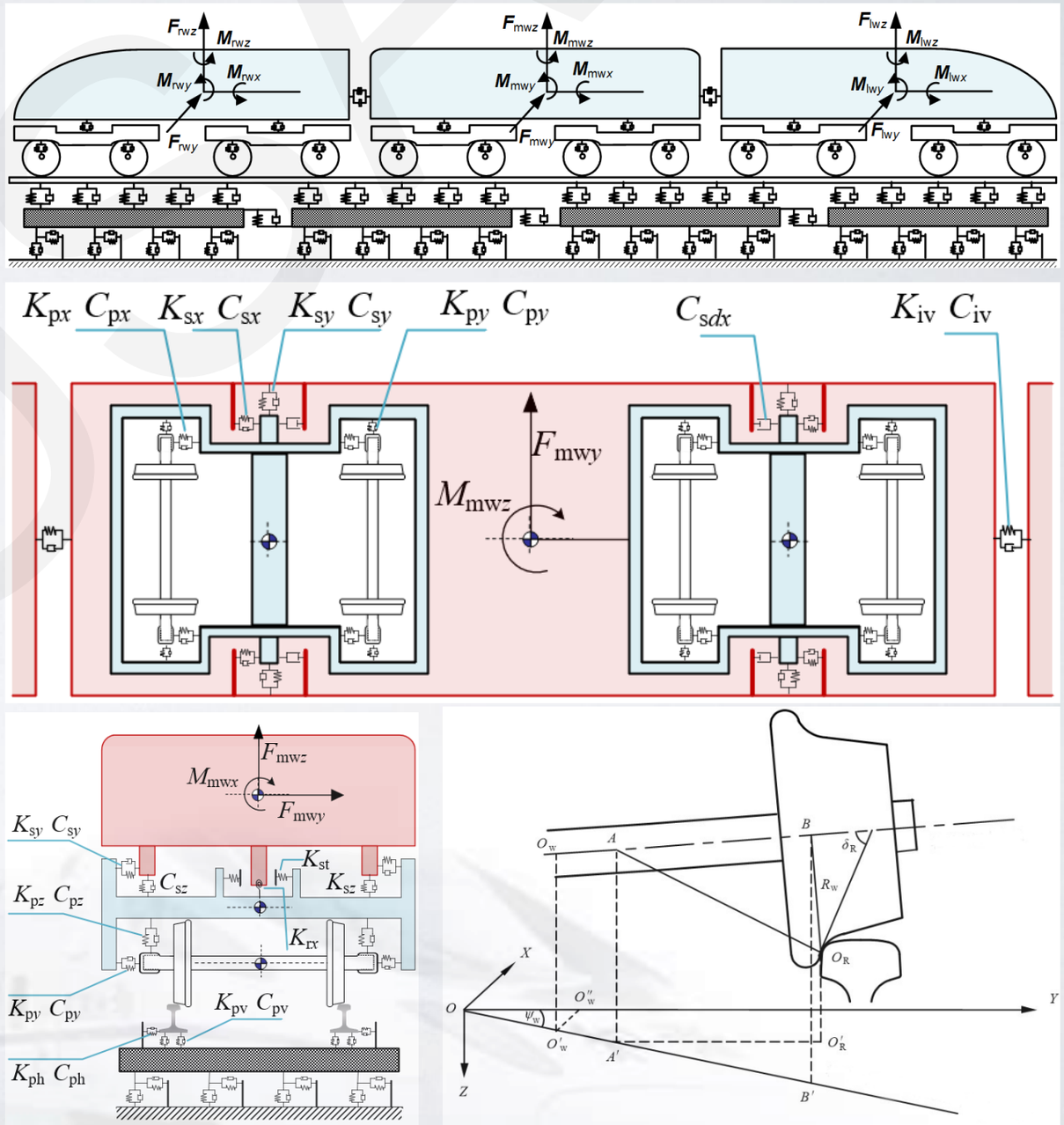
High-speed train, Aerodynamic characteristics, Dynamic performance, Crosswind, Numerical simulation method

Simulation models

- Aerodynamic model

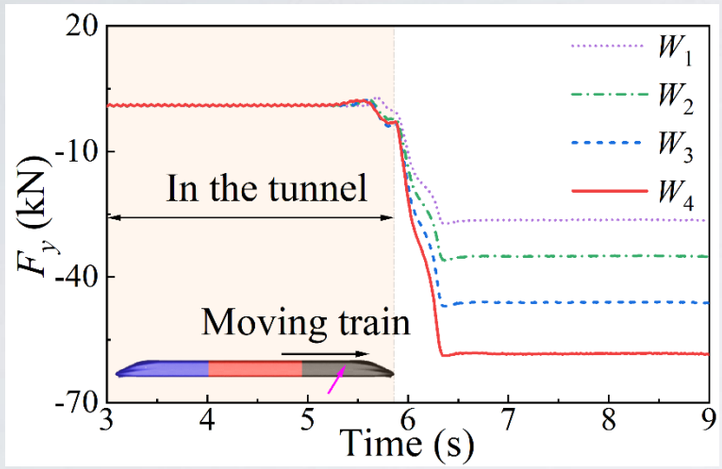


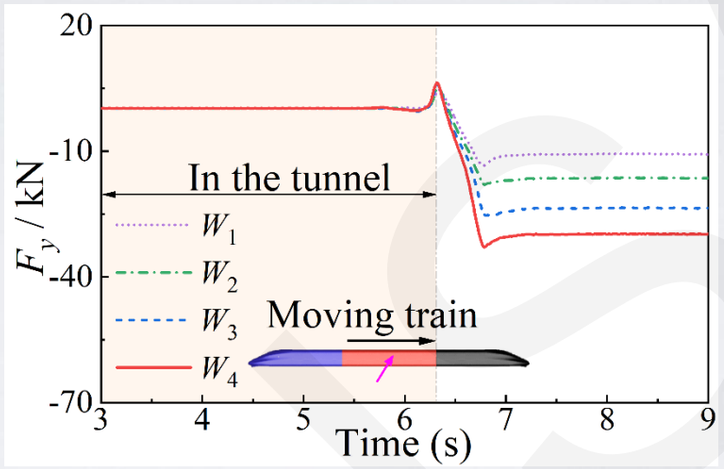
- Train-track coupled dynamic model

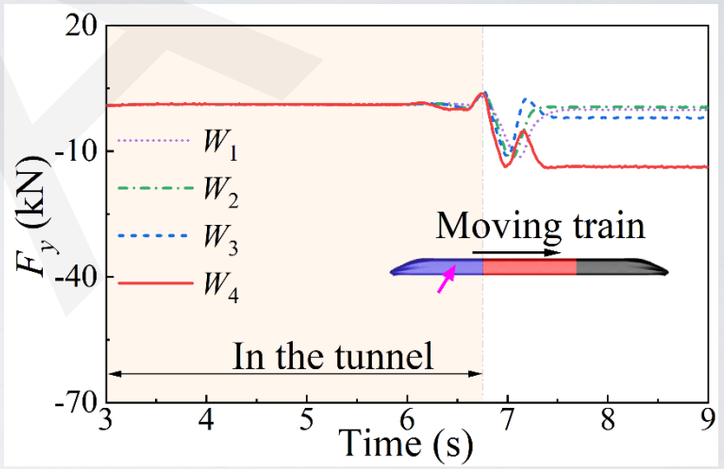


Influences of crosswind velocities

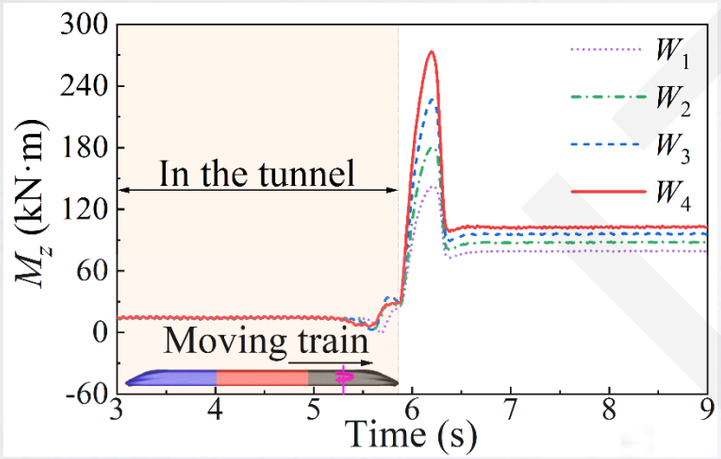
- Comparison of side forces

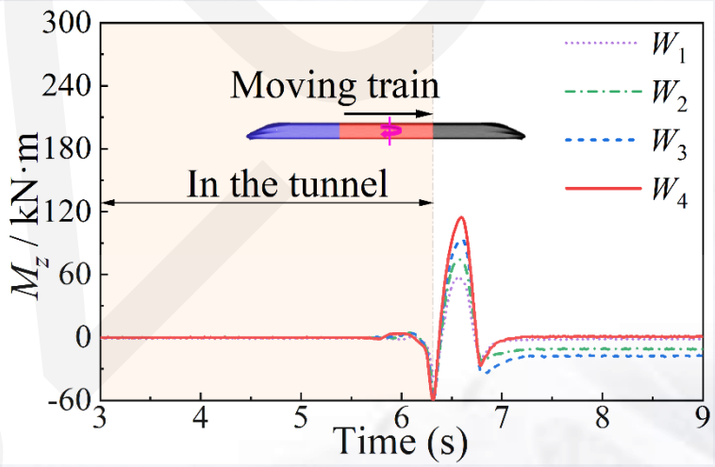


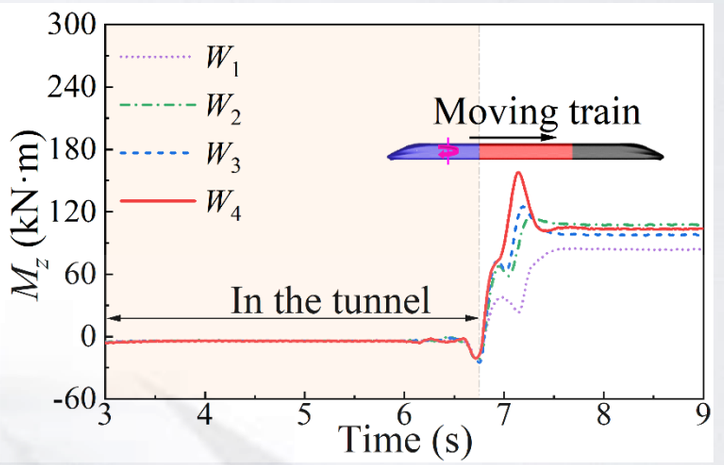




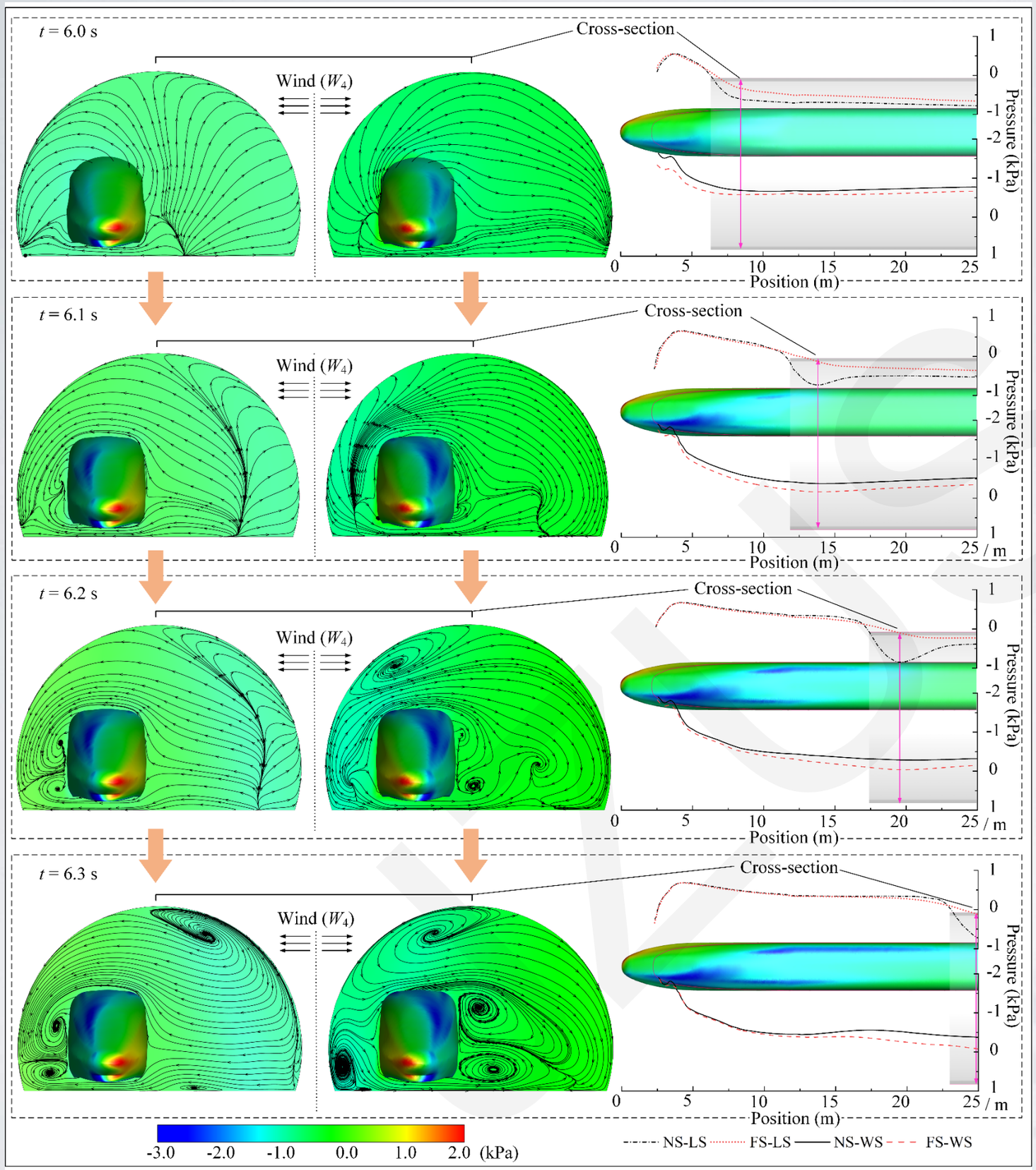
- Comparison of yawing moment

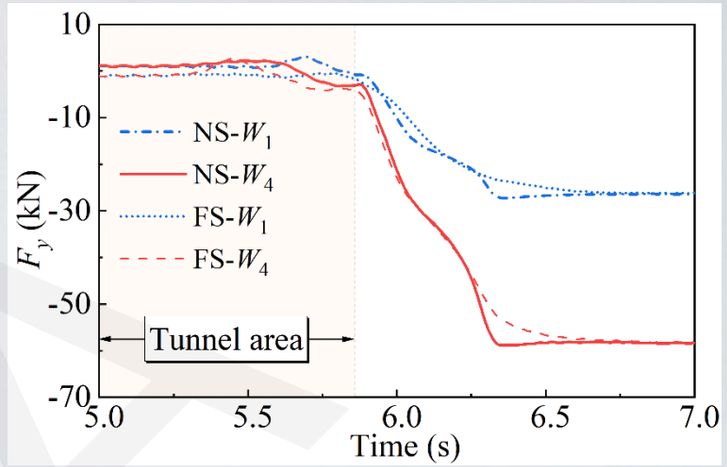




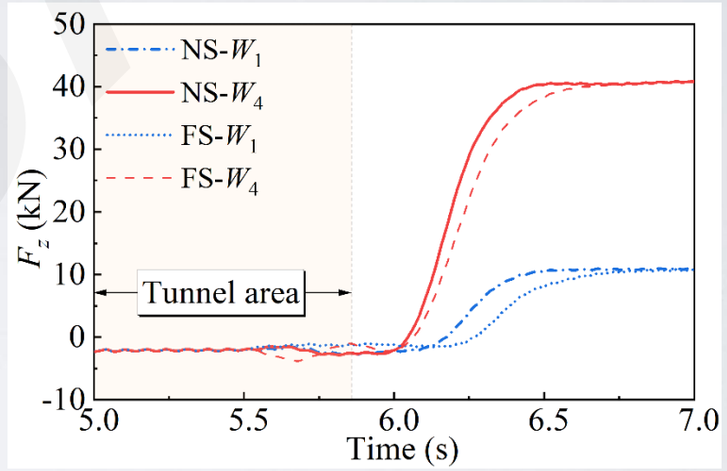


- The head vehicle was exposed to the severest sideward impact.
- Significant additional yawing moment was applied to the vehicle when exiting the tunnel subjected to the crosswind.

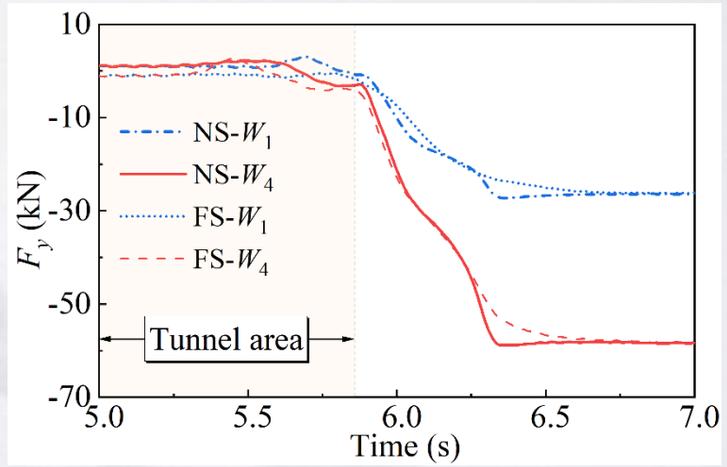




(a) Side forces



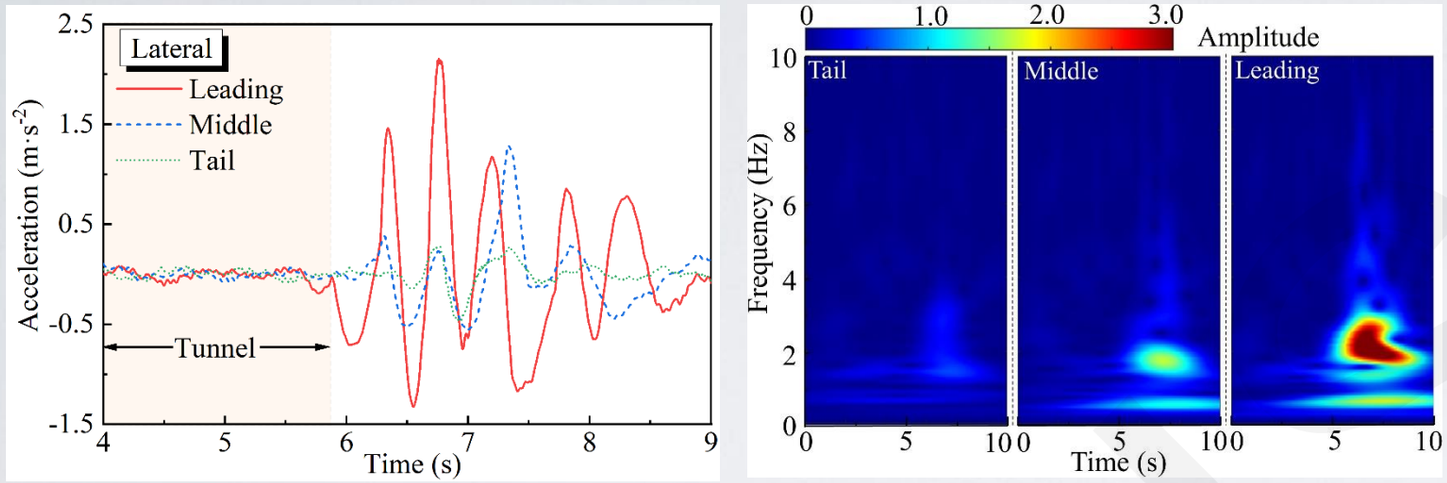
(b) Lift forces



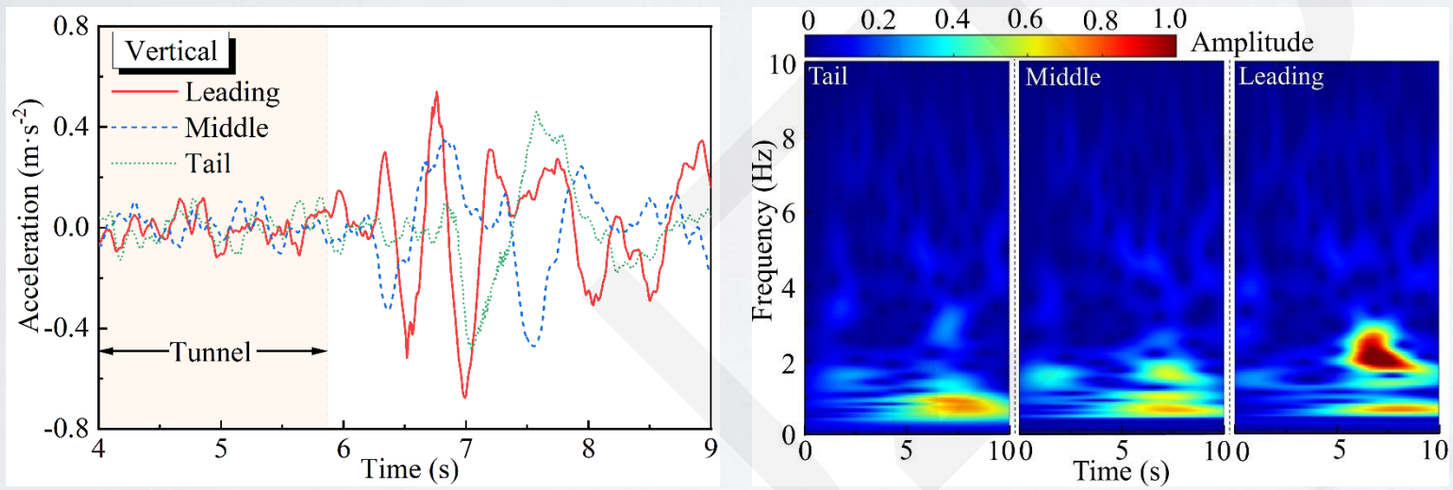
(c) Yawing moments

➢ Crosswind coming from the near-wall side leads to severer aerodynamic impacts.

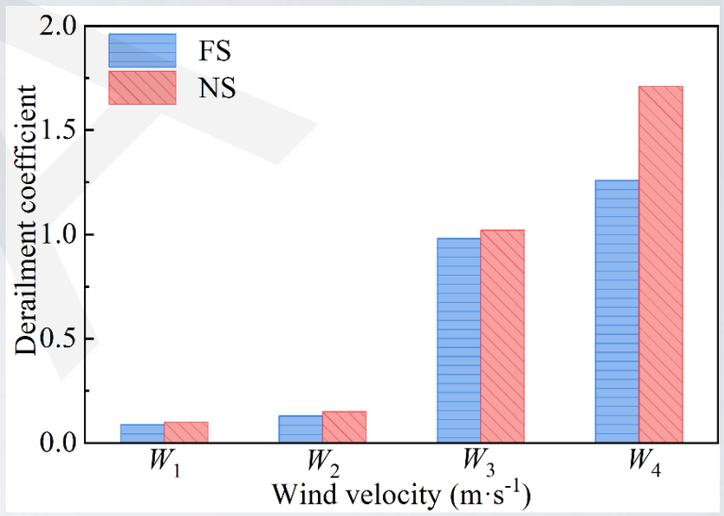
Dynamic performance of vehicles



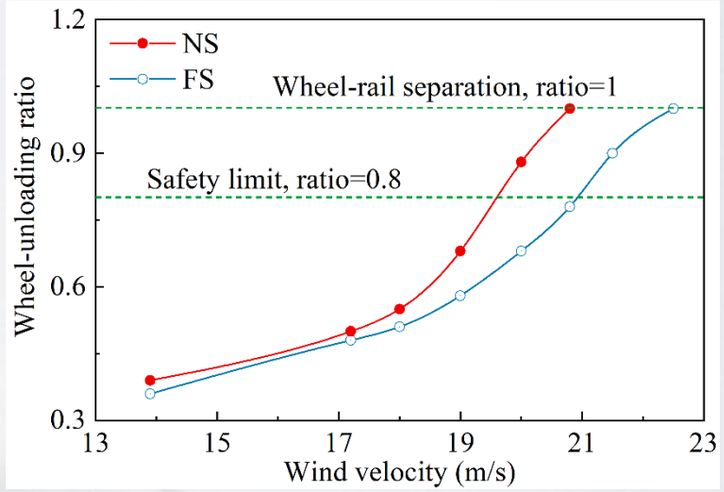
(a) Lateral acceleration and its time-frequency distribution



(b) Vertical acceleration and its time-frequency distribution



(a) Derailment coefficient



(b) wheel-unloading ratio

- Sudden changes in aerodynamic loads result in a low-frequency vibration of car bodies within the frequency range of 0.5–3.0 Hz.

- Running safety of the train worsen rapidly as the wind velocity exceeds 19 m/s.

Perspectives and Research Priorities

Research Priorities:

- Aerodynamic characteristics of a train exiting a double-track tunnel.
- Dynamic performance of a train suffering from the sudden-changed aerodynamic load.
- Running safety of the train exiting a tunnel subjected to crosswinds.

The dynamic performance of the train exiting a tunnel subjected to crosswinds remain poorly understood, including the influences of crosswind direction on the aerodynamic characteristics of the train passing through the tunnel exit, the dynamic response and running safety of vehicles affected by sudden-changed aerodynamic loads. As such operational scenarios became more common with the construction of mountain railway in progress, awareness of the potential risks associated with trains exiting tunnels under crosswind conditions becomes increasingly important.