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Aerodynamic characteristics and carbody dynamic stress analysis for high-speed trains passing through a tunnel under crosswinds

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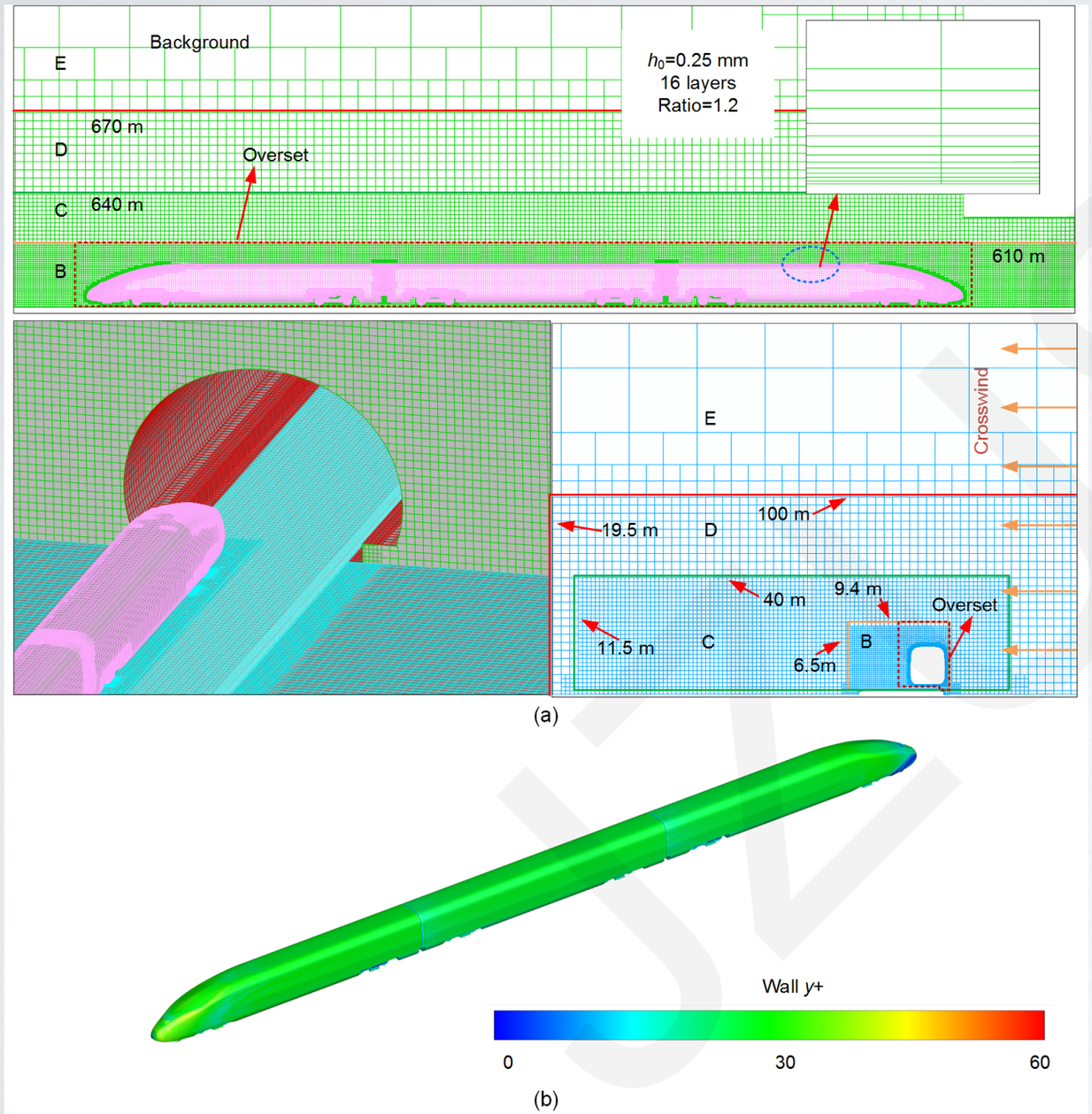
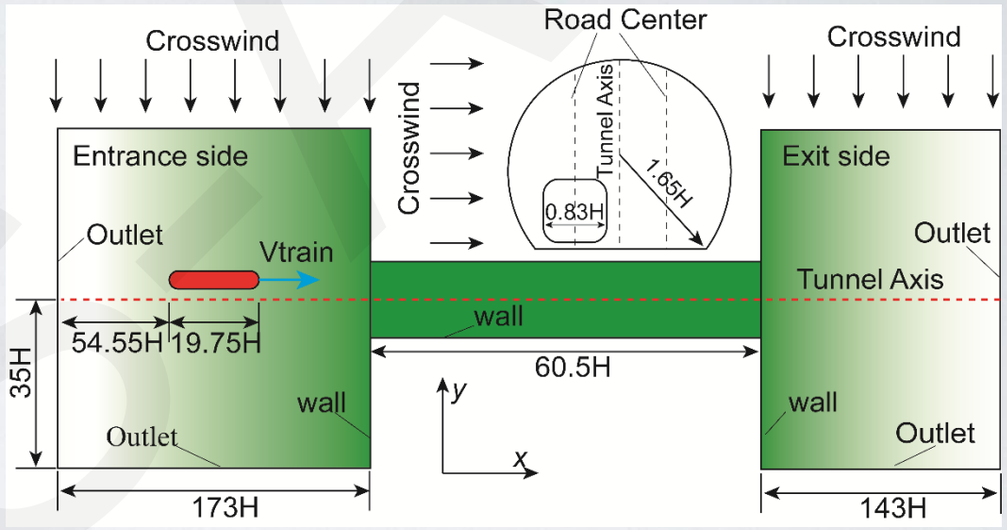
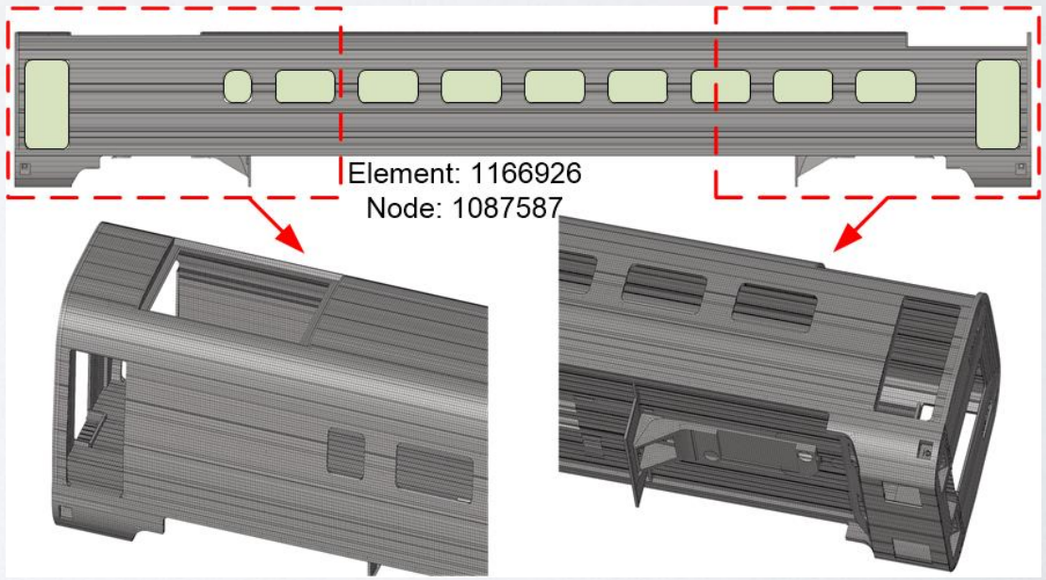
Simulation models

➢ Aerodynamic model

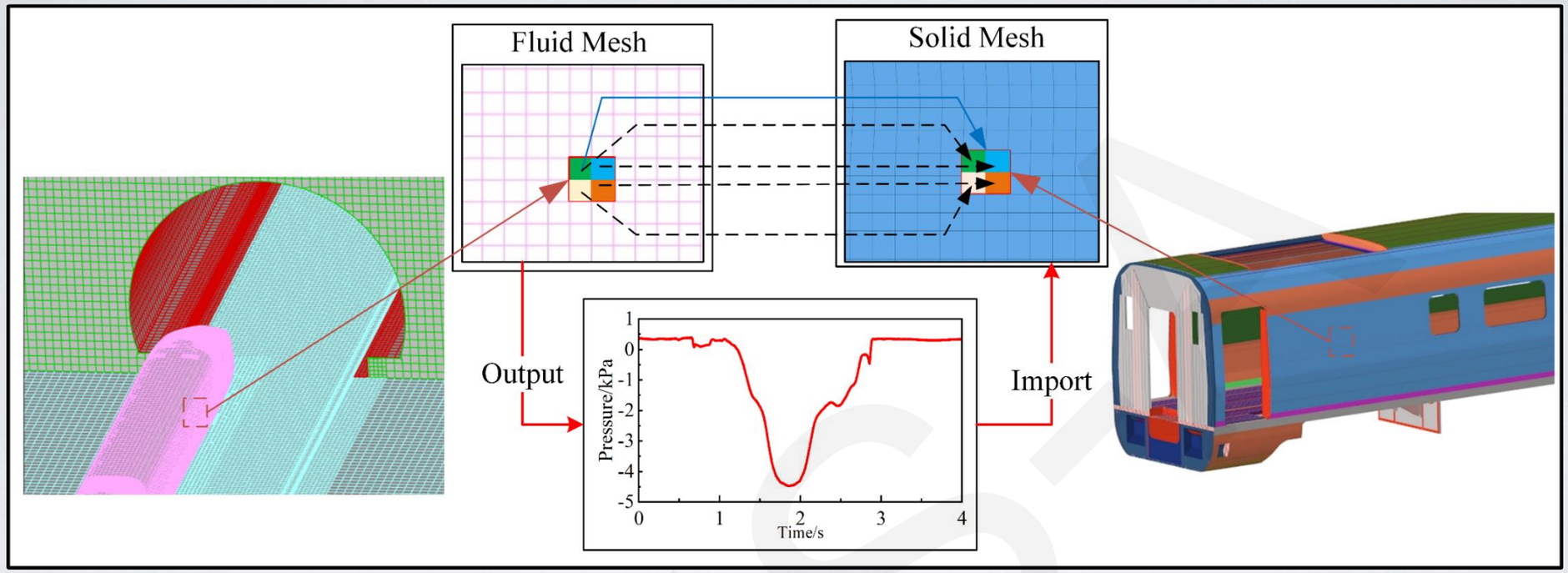




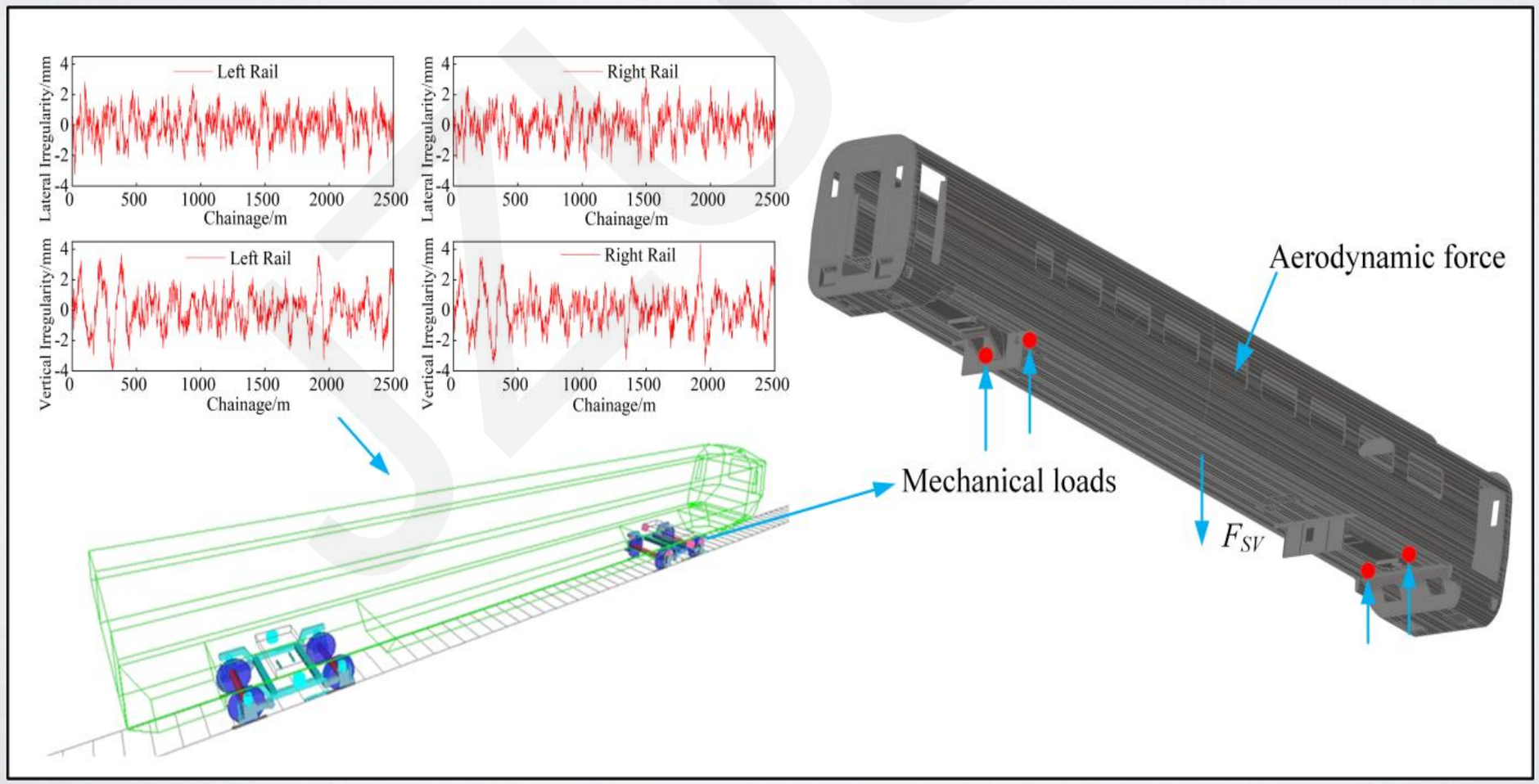
➢ FE model



Aerodynamic load transmission methods

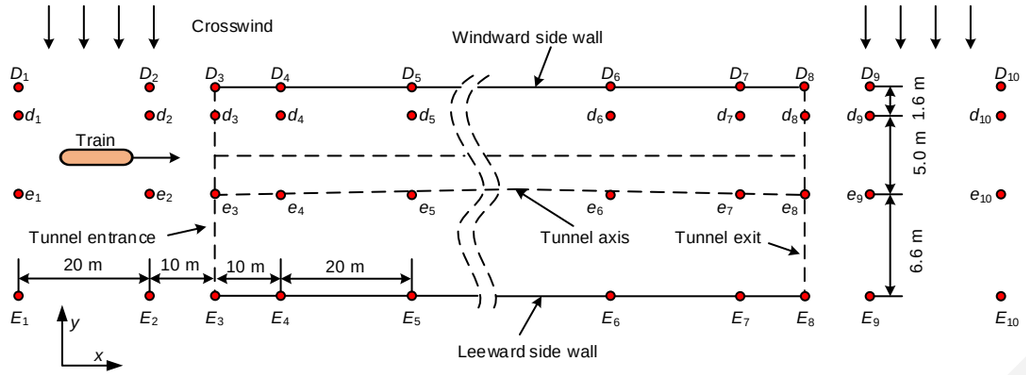


Coupled loading method

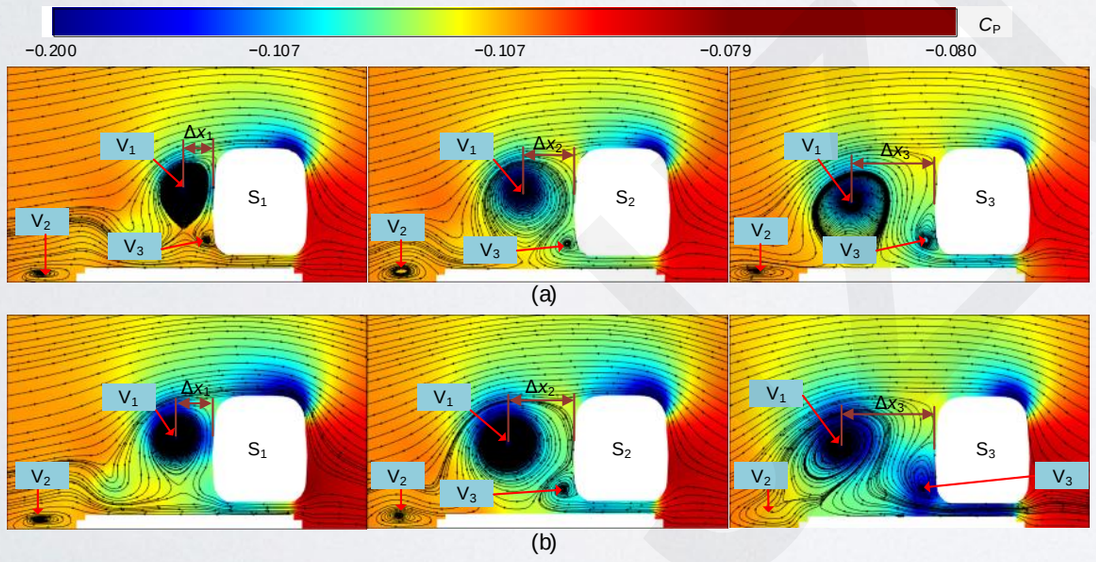


Analysis of the train–tunnel–crosswind interaction mechanism

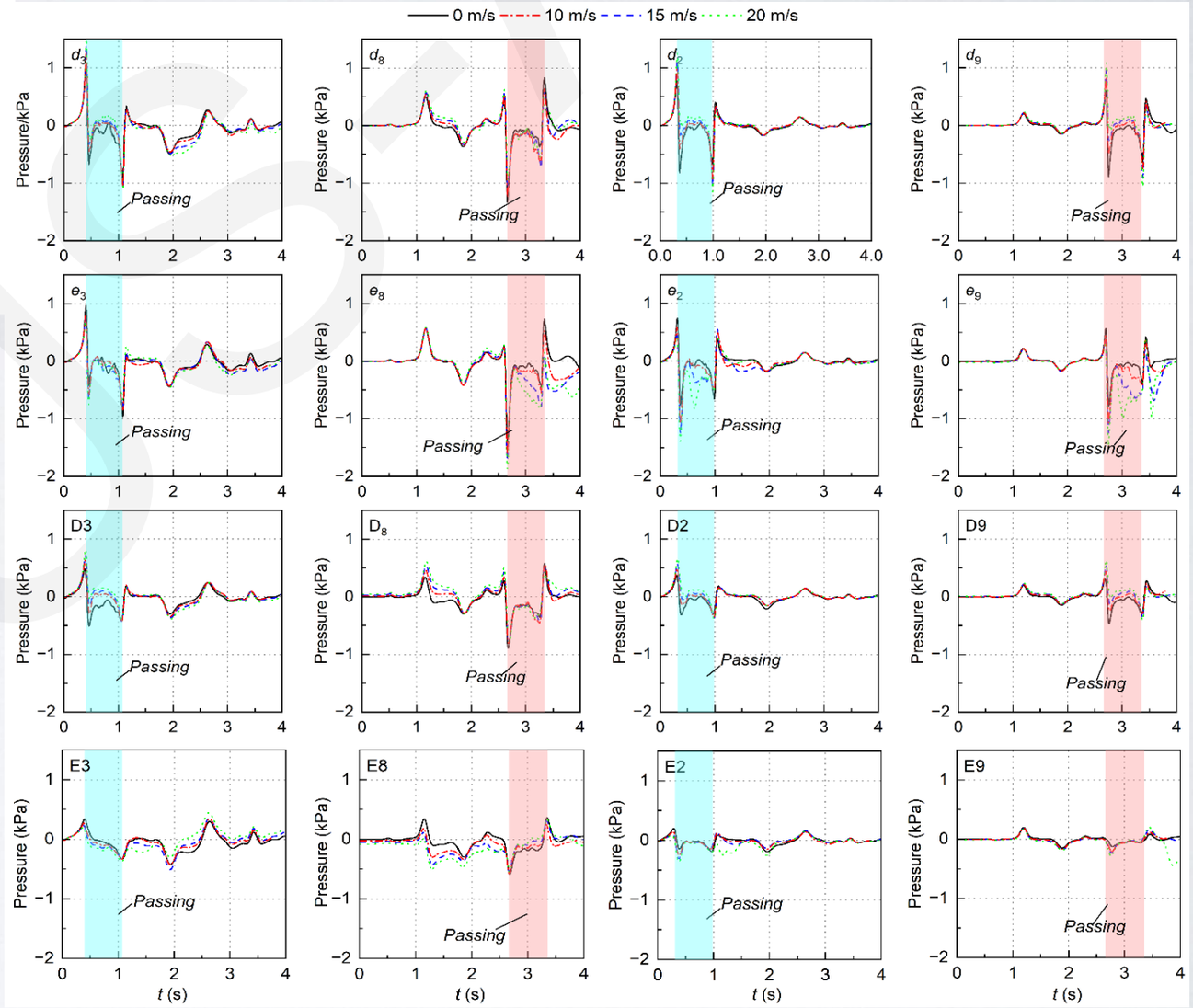
- Measurement points



- Flow field structure

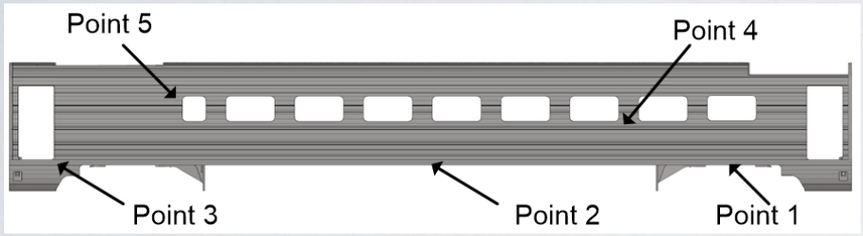


- Pressure variation curves at measurement points around the tunnel entrance and exit

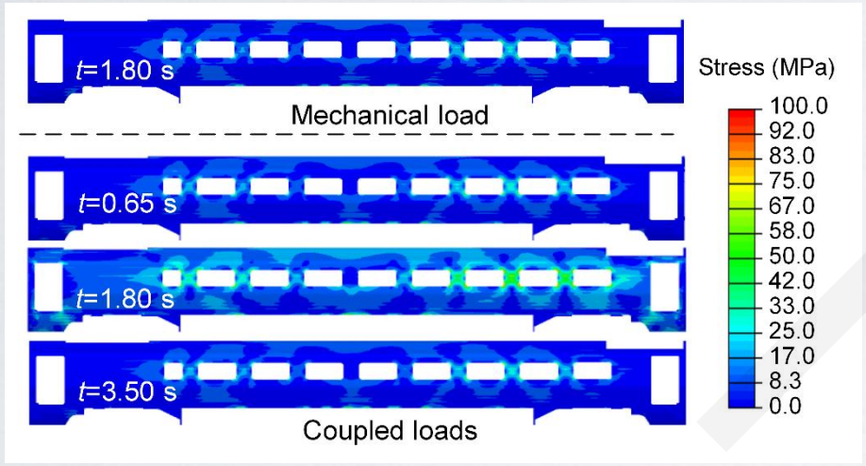


Contribution of the aerodynamic load to the structural stress of the carbody

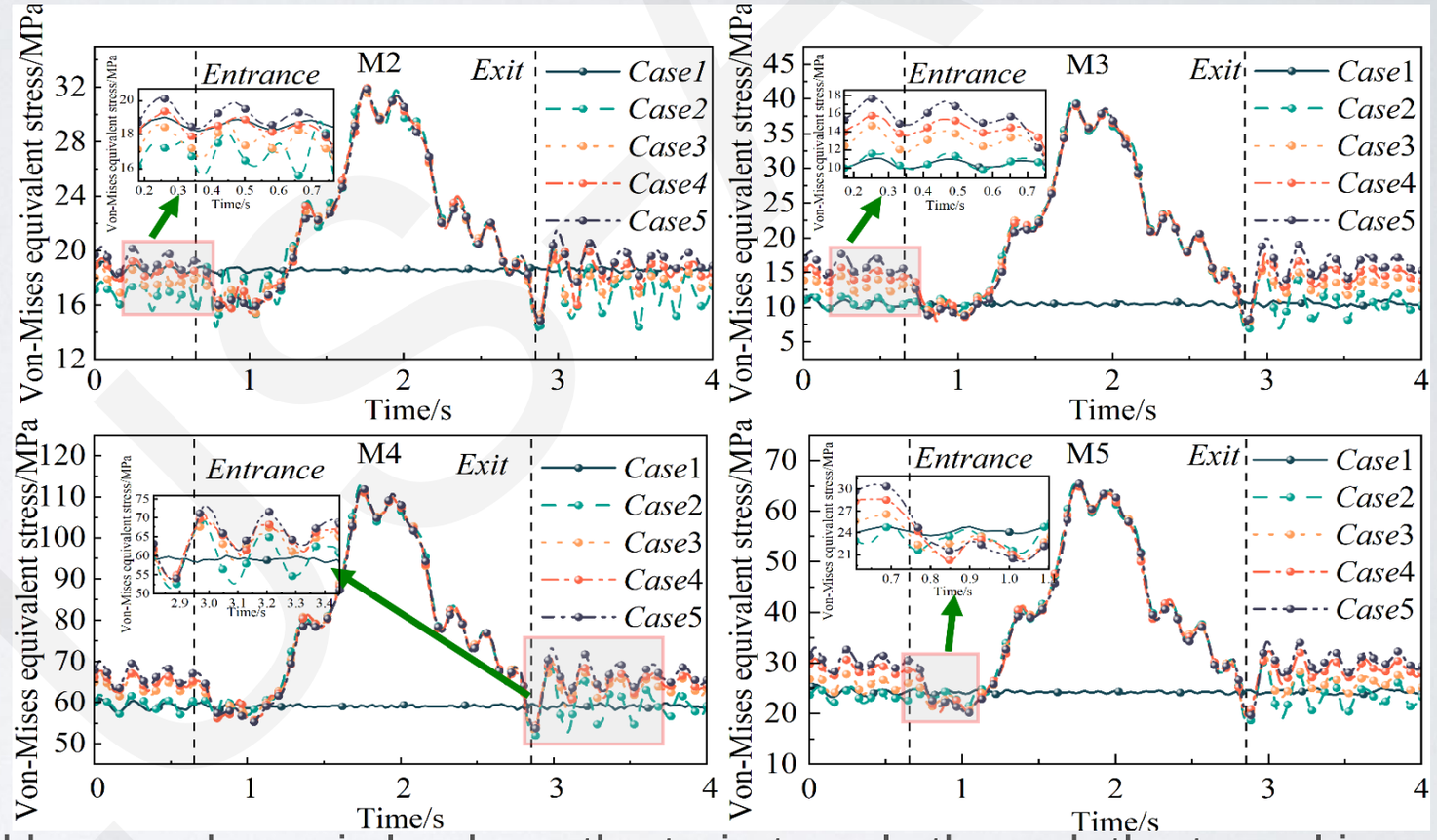
- Location of carbody points of interest



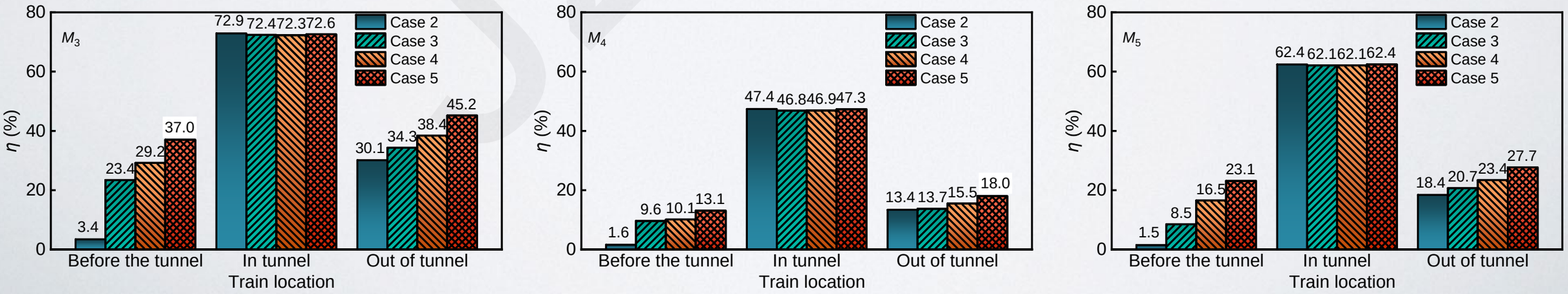
- distribution in the carbody under different operating conditions



- Time course of stress at the points of interest under different working conditions



- Dynamic stresses on the carbody caused by aerodynamic loads as the train travels through the tunnel in various crosswinds



Perspectives and Research Priorities

Research Priorities:

- Aerodynamic characteristics of a train passing the tunnel
- Further study on the coupling mechanism of aerodynamic loads, track excitation, and carbody structural response under crosswinds
- Elucidate carbody dynamic stress evolution and resonance mechanisms under crosswinds

Many details of high-speed train (HST) aerodynamic-structural interactions in tunnel-crosswind environments remain unclear: coupling of aerodynamic excitation and track vibration, dynamic stress distribution of key carbody components under extreme crosswinds, unsteady vortex impact on pressure wave transmission, and carbody fatigue damage from aerodynamic resonance. In-depth exploration with high-precision multi-field coupling simulation will fill gaps, supporting carbody optimization, track design and real-time speed adjustment to enhance HST safety in mountainous windy areas.