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Nonlinear spatiotemporal characteristics of wind-rain flow around the trains passing through the tunnel entrance during rainstorms

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ABSTRACT

Tropical storms present a significant risk to the safety of high-speed trains due to the extreme wind and rainfall they bring. This study employs Eulerian multiphase and Shear-Stress Transport k-ω turbulence models for three-dimensional numerical simulations, focusing on wind-rain interactions involving tunnels, embankments, and trains. The reliability of the numerical analysis method for train slipstream pressure is verified by dynamic model test. Based on the scenario of single train running on the embankment and train intersection at the tunnel portal, the train flow around and wake are analyzed successively with different rainfall intensity. The characteristics of nonlinear wind-rain-train flow field are analyzed from the aspects of velocity field, pressure field and turbulent flow. Finally, the mechanism of the influence of rain on the relative flow field is revealed by the spatiotemporal distribution characteristics of rain phase. With the increase of rainfall intensity, the increase of rain phase distribution on the leeward side of the single train strengthened the backflow on the leeward side of the train. Under the condition of the trains intersecting at the tunnel portal, the relatively closed area between the train and the water film weakened the slipstream effect of the train.

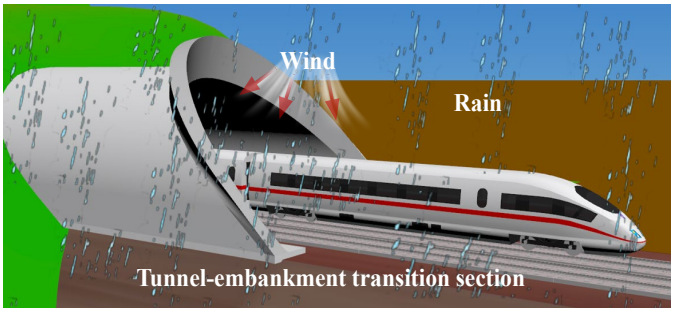

Fig. 1 The high-speed train runs in the tunnel-embankment transition section under wind and rain

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