Numerical Investigation of the Effect of various High Speed Train Roof Configurations on Aerodynamic Noise

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Abstract

For high-speed trains, the aerodynamic noise becomes an essential consideration in the train design for speeds over about 300 km/h. In this paper, flow characteristics and noise contributions of three typical high-speed train roof configurations are investigated at 1/10 scale, namely roof cavity, ramped cavity and side insulation plates types. For the numerical investigation, the Improved Delayed Detached-Eddy Simulation (IDDES) turbulent model is used for the flow field and the Ffowcs Williams & Hawkings aeroacoustic analogy is used for far-field acoustic prediction. Simulations were carried out for a simplified train body with the above mentioned roof configurations, where two simplified DSA350 pantographs (one retracted and one raised) are located. The flow field shows that a highly unsteady flow occurs downstream when the train roof has a cavity or ramp cavity due to flow separation at the cavity trailing edge, while vortical flow is generated by the side insulation plates. For the ramped cavity configuration, moderately high pressure fluctuation appears on the outside of the insulation plates in the upstream region due to unsteady flow generated by the upstream edge of the plate. The raised pantograph, roof cavity, and ramped roof cavity are shown to be the dominant contributors to the total noise. When the retracted pantograph is located in the ramped cavity roof, its noise contribution is less important. Furthermore, the insulation plates generate tonal components in the spectra.

Keywords: *Aerodynamic, Aeroacoustics, CFD, High-speed train, Cavity flow*

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