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Editorial

Special Issue on Aerodynamic Noise Research of High-Speed Trains

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Trains have gained immense popularity as a fast and efficient mode of transportation [1]. However, the pursuit of high speeds poses significant challenges in terms of train aerodynamics, particularly in reducing both aerodynamic resistance [2] and aerodynamic noise [3]. As aerodynamic noise becomes the primary source of noise when the train speed exceeds 300 km/h, it has become a bottleneck in the design of new high-speed trains. The noise generated by high-speed trains not only affects passenger comfort, but also has detrimental effects on the environment and nearby communities. Consequently, the study of the aerodynamic noise of high-speed trains has become an important research topic in recent years. The objective of this research field is to develop effective measures to reduce the noise levels generated by trains while ensuring that the trains' efficiency and safety are maintained.

This Special Issue brings together some research achievements related to the aerodynamic noise reduction in high-speed trains. In general, these contributions encompass several areas, such as the multi-objective shape optimization of the streamlined train head, the optimization of the pantograph shape and structure, a discussion around pantograph fairing and platform sinking, and the aerodynamic noise of high-speed maglev trains. Together, these studies shed light on the innovative approaches to mitigate aerodynamic noise and enhance the overall performance of high-speed train systems.

According to the recent research on the aerodynamic noise of high-speed trains, it is widely recognized that in addition to aerodynamic drag, aerodynamic noise has become another key limiting factor for further increasing the speed of trains. High-speed trains possess a distinct characteristic of a large slenderness ratio and complex operating environment. In [4], a multi-objective shape optimization approach was introduced for streamlining the train head. The train's streamlined nose was parameterized using spline curves, and a radial basis function neural network was developed to predict the optimization objectives. With the help of multi-objective shape optimization, the aerodynamic resistance of a train can be reduced by up to 4.5%, and its dipole noise source can be reduced by up to 3.9 dB. The proposed method greatly reduced the aerodynamic drag and noise of high-speed trains.

The pantograph is an essential electrical component installed on the roof of a high-speed train to collect electrical energy from the overhead catenary. However, the absence of effective protective isolation measures for pantograph noise has a significant impact on the surrounding environment's noise pollution. Excessive aerodynamic noise will lead to limitations on railway operation due to environmental assessment requirements. Therefore, shape optimization of the pantograph has attracted much attention. In [5], a noise reduction approach for the pantograph's shape was proposed that uses an open upper and lower arm rod and an airfoil-shaped bow head structure. The airfoil bow head reduces the vorticity intensity and vortex structure scale size, thus reducing the intensity of the radiated noise by about 1.2 dBA. In addition, the application of waviness to the surface of the pantograph rod or the usage of a contact strip with a hexagonal cross-section can reduce the pressure level

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on the surface of the pantograph, thus achieving noise reduction [6]. The implementation of wavy rods effectively reduces the panhead noise, while modifying the shape of the contact strip into a hexagon helps suppress vortex shedding. Combining the strip modification and wavy rods, the total noise intensity can be reduced by about 3.0 dB. In [7], it was proposed that adding pantograph fairing and platform sinking can also achieve improved noise reduction. Pantograph fairing mainly decreases the noise in the frequency band above 1000 Hz. Furthermore, optimizing the shape of the pantograph sinking installation platform can further enhance noise reduction in the pantograph region [8]. Compared with a pantograph installed on a flat roof, the pantograph with a sinking platform exhibits a reduction in aerodynamic drag by 5.22% and a noise reduction of 1.45 dBA.

As the next generation of high-speed transportation systems are developed, the issue of aerodynamic noise in high-speed maglev trains has garnered significant attention. Particularly for maglev trains operating at higher speeds, the combination of high-speed maglev trains with partially vacuumed pipelines enables low aerodynamic drag and a low noise level. In [9], the statistical energy method was proposed as an analytical tool to assess the internal noise characteristics of high-speed maglev trains, which can be used to guide the aerodynamic design of high-speed maglev trains in a tube.

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