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Numerical Study on Slipstream-Induced Snow Drifting and Accumulation in the Bogie Region

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Extended Abstract

As a convenient means of transportation, high-speed trains (HSTs) are widely operated all over the world. Due to its large aspect ratio, it will cause special air flow by the motion of HSTs, which is called slipstream. In some high-latitude snowy countries or areas, HSTs usually operate in a low-temperature snowy environment, and the slipstream will cause the movement and redistribution of the surrounding snow. The phenomenon of snow accumulation in the bogie region can raise a series of problems, such as operational safety risk, running stability of HSTs and discomfort of passengers[1]. Over the past several years, relevant investigations, experiments[2] and numerical studies have been undertaken to figure out the cause of snow accumulation in the bogie region. In terms of numerical research, the conventional method adopted unsteady Reynolds-averaged Navier-Stokes (URANS) equations coupled with the discrete phase model (DPM) to capture the snow particles trajectory in the bogie region. For continuous phase (air), it utilizes the way that there is incoming air flow in front of a stationary HST model (similar to the wind tunnel mode).

For the scene of slipstream stirring up the snow on the ballast bed, a moving train is considered to be able to better simulate the phenomenon, which is closer to the real condition. In numerical simulation studies of train aerodynamics, sliding mesh or dynamic mesh techniques are often utilized to realize the motion of HSTs[3]. Besides, the discrete phase model is also coupled with the sliding mesh approach to investigate the particle movement in previous study. It proves that the sliding mesh technique can be used to develop the particle tracking model. Based on the sliding mesh technique, this paper presents a novel snow accumulation simulation method reproduce the actual scene of a moving train with stationary ground (MTSG). A snow particle tracking model is established. The snow with specific depth on the ballast bed is simulated by the designed numerical strategy. The relative motion among the HST-snow-ground is achieved by utilizing a moving HST. The sweeping process of the slipstream on the snow surface is fully considered. The conventional numerical method has utilized the way that snow particles drift with the incoming flow around a stationary train with moving ground (STMG). The comparisons between the STMG and MTSG are conducted, including the flow field, snow distribution and accumulation features. The results show that similar flow field around the HST is captured by the two methods. The MTSG predicts more dispersed snow distribution in the Bogie 2 region than the STMG. The total mass of accumulated snow on bogies and cavities obtained by MTSG is 18.31% more than that derived from STMG. The presented method achieves the relative motion among the HST-snow-ground and the sweeping process of the slipstream on the snow surface is fully considered. In engineering applications, it provides a feasible method to explore the snow accumulation phenomenon of HSTs in more scenes, such as the intersecting of two HSTs.

References

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