Experimental simulation of alternating aerodynamic load induced by tunnel passing of high-speed train

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Abstract

Tunnel passing in high speed produces aerodynamic load on railway train, which brings about fatigue failure on the car-body, and damages passenger comfort due to interior penetration of the alternating wave. Experimental simulation of the alternating load remains a challenge concerning its accuracy and reliability. In this work, experiment approaches in terms of air compression and air suction were developed, in an attempt to simulate the air pressure variation when the train runs through tunnels. Pros and cons of the introduced methods were analyzed by theoretical calculation and numerical simulation, and further validated in experimental tests. It is revealed that in air compression means of eccentric wheel and stepping motor propulsion, pressure amplitude in simulation both exceeds that in theoretical calculation due to temperature change from piston movement. The deviation between tests and theoretical values climbs up as the pressure wave cycle rises. The stepping motor propulsion is recommended in scaled simulation for human ear comfort because of its equal peak and valley span, but suggests insufficient engineering feasibility in full size vehicle tests. However, the air suction performs excellently through internal and external loading utilizing the valve controlling strategies. By simulating the pressure wave obtained from in-transit vehicle tests, the relative deviation of the extremes between simulation and vehicle tests is within 5.0%. Research outcome indicates that the proposed method provides an important experiment means for passenger comfort and car-body fatigue behavior research.

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