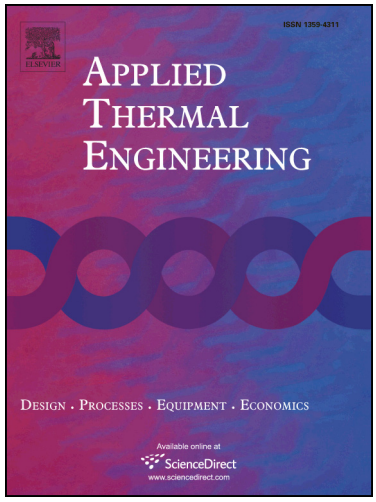

Research Paper

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Tunnel Temperature Fields Analysis under the Couple Effect of Convection-Conduction in Cold Regions

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Abstract: This paper performs a similarity simulation model test with 1:30 geometric scale based on practical horseshoe railway tunnel section to investigate the couple effect of convection-conduction with low inlet temperature airflow. The low inlet temperature is produced by refrigerating system. The results show that the temperature of airflow and surrounding rock drop rapidly at the beginning of the test and then slow down with time; the closer to the entrance of the tunnel, the strongly temperature changes of airflow and surrounding rock will be; temperature of airflow and surrounding rock fluctuate with the changes of inlet temperature, but the fluctuation is hysteretic. Then, the tested results are compared with finite difference calculated results and temperature fields are analyzed under different inlet temperature, ventilation velocities and mechanical ventilation. It can be seen from the results that, tested results agree well with finite difference calculated results; the higher the ventilation velocity and the lower the inlet temperature are, the more rapidly the temperature reduction will be; in the positive ventilation direction, high mechanical ventilation velocity (higher than natural velocity) has adverse effect on freezing damage in tunnel; negative ventilation direction, to some extent, does good to alleviate freezing damage.

Key words: tunnel in cold region, convection-conduction, temperature field, model test

Introduction

Frost damage problem of tunnel could result in structure cracking, water leakage, ice covering and the blocking drains with ice, which will affect the traffic safety seriously in cold-region tunnel. So, the temperature fields of airflow and surrounding rock become an urgent important issue to study to solve the frost-resistant problems in cold-region tunnel. Bonacina et al. put forward a finite-difference method for addressing melting and freezing with corresponding phase changes [1]. Zhang et al. obtained the finite element formulae of three-dimensional temperature fields on cold-region tunnel based on the governing differential equations with phase change [2]. Tan et al.