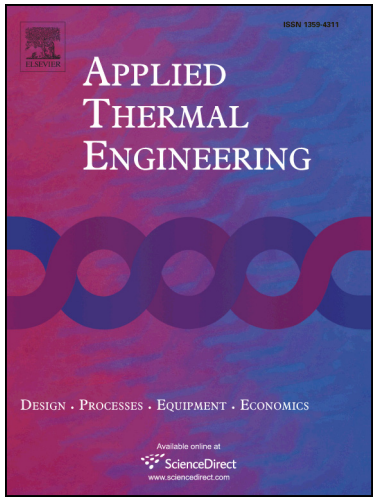

Research Paper

Numerical investigation on the effect of ambient pressure on smoke movement and temperature distribution in tunnel fires

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Numerical investigation on the effect of ambient pressure on smoke movement and temperature distribution in tunnel fires

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Abstract: A series of simulations are conducted in a full scale road tunnel to explore the effect of ambient pressure on smoke movement and temperature distribution in tunnel fires. Once a tunnel fire occurs, beyond the radial and transition stage, the smoke gradually transforms into a one-dimensional spread stage where the characteristic of smoke movement is important for the safe evacuation and smoke control. Firstly, based on the transverse temperature difference and dimensional analysis, the range of one-dimensional spread stage for different conditions is analyzed. Secondly, the variation of longitudinal smoke temperature with ambient pressure is explained. Taking the temperature rise at the starting position of one-dimensional spread stage as a reference, a uniform correlation of longitudinal smoke temperature extended to low pressure conditions is proposed. Finally, the correlation is compared with previous experimental results at normal pressure.

Key words: Ambient pressure; Tunnel fire; Smoke movement; Temperature distribution

Nomenclature

c_p	specific heat capacity (kJ kg^{-1} K^{-1})
H	tunnel height (m)
L	distance from the fire source center to the starting position of one-dimensional spread stage (m)
P_0	ambient pressure（kPa）
$\dot{Q}$	heat release rate (kW)
ΔT_x	temperature rise at x meters from the reference position (K)
ΔT_{max}	the maximum temperature rise beneath the tunnel ceiling (K)
ΔT_{st}	temperature rise at starting position of one-dimensional spread stage (K)
T_0	ambient temperature (K)
x_{st}	starting position of one-dimensional spread stage (m)
ρ_0	air density (kg m^{-3})