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Analysis of the emergency ventilation performance parameters for a road tunnel

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Abstract

A fire in a road tunnel contaminates the ventilation air in the underground space and creates unfavourable conditions for life. Saving lives during tunnel fires is an internationally recognized problem that many scientists around the world are working on. Critical velocity and smoke backlayering in the fresh air jet are important technological parameters for fire ventilation. The international recommendations on emergency ventilation design stipulate that the critical velocity (in particular, its numerical value of 3.0 m/s) can be used to predict the underground spread of toxic substances and to exclude backlayering in road tunnels of almost all types. Nowadays, this statement should be supplemented by the results of new studies, to which we have generally given a new impetus and which note that underground fires generate the dynamic pressure higher than that produced by tunnel fans. Based on CFD modelling results, the present work concludes that even at a critical velocity of 4.5 m/s, in case of a 50 MW fire, jet fans can no longer influence the ventilation flow because their power is restricted due to the resistance caused by the fire. It can be considered established that the critical velocity as an important technological parameter can be definitely used in fire ventilation designs for the fire power of up to 30 MW and the maximum tunnel slope of 3%. The present paper gives new research results for the following different cases: 1) when it is possible to develop life-saving emergency ventilation designs with existing classical knowledge; 2) when existing knowledge is no longer sufficient for emergency ventilation designs and new research results are needed to develop a new approach to the problem.

Keywords: tunnel ventilation, fire, critical velocity, backlayering length, lifesaving.

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