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Draught comfort in a slot-ventilated room at various inlet aspect ratios

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Abstract

Slot-ventilated rooms are widely used in comfort type HVAC (Heating, Ventilation, Air Conditioning) systems, where the air inlet is usually a simple slot-diffuser. The geometry of the slot is often expressed by the aspect ratio (AR), which is an important designing parameter of the room air distribution in ventilation systems. Aspect ratio of the slot-diffuser is the non-dimensional ratio of the slot's length and width. This AR value can influence room airflow characteristics, including draught comfort. Previously, the effect of inlet aspect ratio on a slot-ventilated room's draught environment was not investigated. In this article, the influence of various aspect ratios was investigated on a slot-ventilated model room's draught comfort, using Fanger's DR model. The investigations included air velocity and temperature measurements in a full-scale single (or cellular) office model room and the measured data were evaluated with statistical methods.

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Keywords: slot-ventilated room; draught; aspect ratio

1. Introduction and theory

People spend most of their life in closed spaces so it is important to provide acceptable microclimate parameters. Slot-ventilated rooms, like single – cellular – offices are widely used in HVAC designing practice, where the

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primary direction of the air inlet is often vertical. In these ventilated spaces a linear slot-diffuser is commonly used as the air inlet. This diffuser is usually located next to a wall surface as it is shown in Fig. 1. The main advantage of such slot-diffuser placement is that supply air is injected outside of the occupied zone of the room, so the draught risk can be decreased in the space [1], [2], [3].

Nomenclature

A_0	air inlet cross-section, $A_0=L_0s_0$, m^2
Ar_0	inlet Archimedes number, 1
AR	aspect ratio of the slot diffuser, m/m
DR	Draught Rate, %
ΔT_0	temperature difference between the air inlet and the occupied zone, °C or K
h	horizontal distance of the slot diffuser from the wall, m
L_0	slot diffuser’s length at the air inlet, m
n	sample size (number of measurement points), pcs
ν_0	kinematic viscosity of the supply air, m^2/s
R	correlation coefficient, -
Re_0	inlet (slot) Reynolds-number, 1
s_0	slot diffuser’s width at the air inlet, m
t_0	inlet air temperature, °C
T_0	absolute inlet air temperature, K
t_{mean}	mean air temperature in the room, °C
Tu	turbulence intensity, %
v_0	inlet air velocity, m/s
V_0	inlet volume flow rate, m^3/s
v_{mean}	mean air velocity in the room, m/s
v_{RMS}	RMS (Root Mean Square) air velocity in the room, m/s

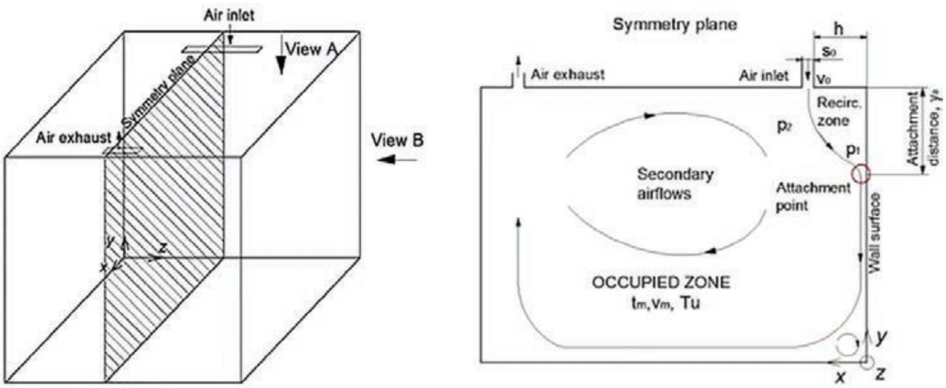

Fig. 1. Sketch of the investigated slot-ventilated room

In Fig. 1 it can be seen that supply air flows out from the slot-diffuser and a negatively pressurized recirculation zone appears between the injected air jet and the wall. The injected air jet, which is the primary airflow, induces secondary airflows in the room. These primary and secondary airflows create an air distribution system [2] Due to the Coanda-effect, the injected air jet bends towards the wall and adheres to the surface at the attachment point. After the attachment point, the injected air jet flows along the wall surface as a wall air jet and ventilates the room [4], [5]. Technical report CEN CR 1752 relates to the cellular offices [s1]. The ratio of the slot-diffuser’s length and width gives the non-dimensional aspect ratio:

$$AR = L_0/s_0 \quad (1)$$

The inlet (or slot) Reynolds-number can be calculated as:

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