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Influence of various angles of the venetian blind on the efficiency of a double skin facade

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Abstract

The present study analyses the effect of solar protection arrangements on thermo-aeraulic regime inside a double-glazed facade coating (DFC), forced ventilated channel and under imposed working conditions. The facade has been considered being with "full South" guidance, exposed to normal solar radiation, with constant intensity. The "Venetian blinds" protection type has been investigated in optimum assumptions on the basis of previous researches [9], with regard to its positioning at 1/4th of the width of the channel, near exterior glazing and forced ventilation, under constant flow rate of 1260 m^3/h. The opening angle of the blinds, as the sole variable parameter, has been amended in succession between 0° and 90°. Solar protection influence analysis has been carried out by numerical simulation, with the specialized computing program ANSYS-Fluent, laying down, for each opening angle of blinds, variation diagrams of air streams temperatures and velocity along the width and along front panel channels.

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Keywords: Façade channel; solar protection; blinds angle; radiation; numerical analysis

1. Introduction

Recent technological developments have entailed glass as a highly used material for buildings envelope, due to its multiple and complex functions which transform glazing in an active component regarding from thermal, optical and electrical points of view [1].

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As far as functional-constructive point of view, double glazed façade arose out of the necessity of protecting a curtain wall by placing in front of it a glass surface. The envelope thus formed influences on the thermo-aeraulic behavior of the hole building – directly or indirectly - based on the connection manner applied between the two glazed surfaces and with inside and outside environments, and also, based on the ventilation solution chosen for the intermediate channel [2].

The two transparent glass elements, placed at a certain distance, form a channel where an air flow circulates [3] and inside which, as applicable, a shading system can be integrated, in order to control the heat quantity acquired from solar radiation [4, 5].

The main function of this system is to improve thermal protection during winter, by passive recovery of the solar energy and exhaust excessive heat accumulated during warm season [6].

The special importance of this system as far as buildings energy efficiency is concerned justifies the technical and scientific interest for thoroughgoing study and acknowledgment of functional outlines and solutions improvements.

In this regard, in the specialized literature are presented results of studies and researches carried out by teams of specialists all over the world that clarifies many of the issues of great interest, such as:

- recommended functional organizational design, geometry and dimensions;
- ventilation methods and functional scenarios;
- energy and comfort efficiency;
- calculation models;
- experimental testing on small scale or natural models and others.

Analyzing behavior of DFC equipped with solar protection is important as it allows identification of various phenomena that influence on system's efficiency [7, 8].

Thermal-aeraulic behavior of the façade depends equally on the geometry of the façade, the characteristics of its components, the ventilation system and the air flow regime inside the façade channels [5].

The main objective of the study was to determine, by numerical modeling, the optimum opening angle of solar protection type venetian blinds blades in relation to dynamic insulation efficiency (ε).

As in a previous study [9], in which the optimum position of the blinds inside the façade channel had been analyzed, resulting that, during summer conditions, maximum efficiency is achieved when blinds are closer to exterior glazing, the present study was developed taking into consideration the above mentioned conclusions.

Numerical analysis has been elaborated for a double glazed façade having the characteristics accordingly with experimental setup, Table 1, inside the laboratory of Building Services Engineering Department, Technical University "Gheorghe Asachi "of Iasi – Fig. 1 [10].

Table 1. Thermo-physical properties of components

Component element	Density ρ [kg/m^3]	Specific heat cp [J/kg·K]	Thermal conductivity λ[W/m·K]	Absorption index, a	Refractive index, τ	Reflection index, r
exterior glazing	2 500	670	5.3	0.11	0.82	0.07
air	1.225	1 006.43	0.0242	0	1	0
racks steel	8 030	502.48	43	0.65	0*	0.35
blinds aluminum	2 719	871	202.4	0.76	0*	0.24
interior glazing	2 500	670	1.4	0.18	0.69	0.13

*during simulation, solar protection has been considered as semi-transparent surface with refractive coefficient assimilated with the corresponding percentage of free surface resulted for the blades angle.

Main characteristics of the model are:

- dimensions- 2.1 m height, 1.5 m length, 30 cm channel width;