Assessing the Potential of Ventilated Facades on Reducing a Buildings' Thermal Load Using Decoupled COMSOL Simulations

A.W.M. (Jos) van Schijndel[1], Chris van Dronkelaar[1]

[1]Eindhoven University of Technology, Eindhoven, Netherlands

Abstract

Solar radiation is a prominent contributor of energy in buildings, and can be transmitted directly into a building through opaque surfaces, but it can also be absorbed by building components (i.e. walls, roofs etc.). Both cause heat addition to the building interior. The application of ventilated facades can help reduce thermal loads during high temperatures and solar radiation, which in effect reduces the energy consumption due to air-conditioning systems. This is a passive cooling technique that could be developed to a greater extent in order to improve indoor climatic conditions and the microclimate around buildings. This study discusses the use and effect of ventilated facades, with an external facade cladding, a sub-structure anchored to the wall surface of the building under solar radiation, while designing facade elements numerically using COMSOL, to create the highest achievable velocity inside the air cavity. The mass air flow inside the cavity, due to buoyancy effects (natural convection) and wind (forced convection), can carry away heat load passively. Results show that energy saving is increased with a ventilated facade over a conventional facade, and is more effective for higher solar radiation and higher air velocity inside the cavity. In the second part of the study it becomes clear that facade elements can be designed in such a way that they increase the air velocity inside the cavity to remove more heat efficiently. An improvement of up to 75% of the air velocity is reached in some parts of the cavity for the implemented design in comparison to the reference case.

Reference

1. Beranek, W. & van Koten, H. (1979). Beperken van windhinder om gebouwen, deel 1. Deventer: Stichting Bouwresearch no. 65, Kluwer Technische Boeken BV.
2. Ciampi, M., F. Leccese and G. Tuoni (2003) "Ventilated facades energy performance in summer cooling for buildings." Solar Energy 75: 491-502.
3. COMSOL. COMSOL Multiphysics 4.2.0.150. (1998-2012).
4. Fluent Inc. Fluent 6.3.26. (2012).
5. Franke, Jörg, et al. (2007) "Best practice guideline for the CFD simulation of flows in the urban environment." COST Action 732 Quality assurance and improvement of microscale meteorological models.
6. Nore, K., B. Blocken and J.V. Thue. (2010) "On CFD simulation of wind-induced airflow in narrow ventilated facade cavities: coupled and decoupled simulations and modelling limitations." Building and Environment.
7. Schwarz, B. (1973) "Witterngsbeansphruchung von Hochhausfassaden." HLH Bd. 24.12: 376-384.
8. Urban, J.B. (2007) The MIT Design Advisor: Simple and Rapid Energy Simulation of Early-Stage Building Designs. Massachusetts.

Figures used in the abstract

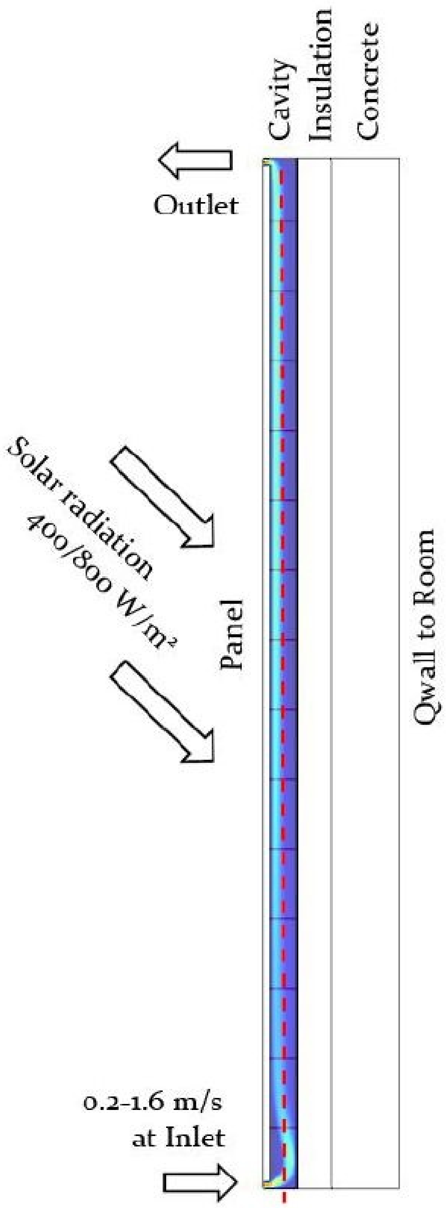

Figure 1: Schematization of the heat balance model.

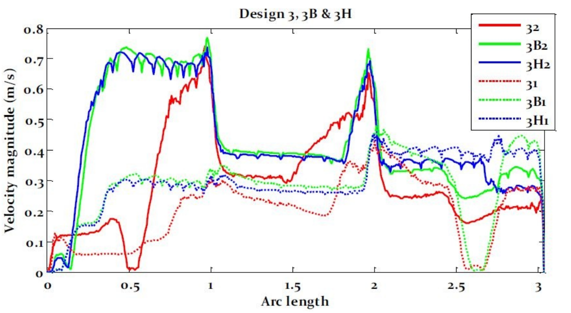

Figure 2: Graphical display of the velocity in the middle of the cavity for design 3, 3B and 3H for upward and downward flow.

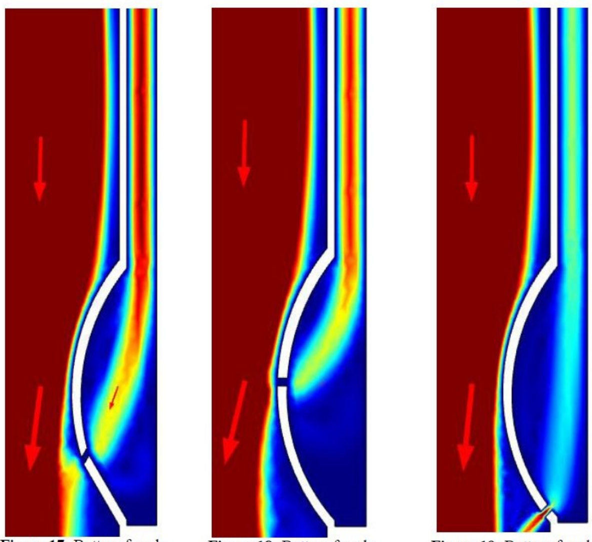

Figure 17: Bottom facade, design 3B. **Figure 18:** Bottom facade, design 3C. **Figure 19:** Bottom facade, design 3D.

Figure 3: Air velocity near construction details design.