Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 132 (2017) 484–489

Energy Procedia

www.elsevier.com/locate/procedia

11th Nordic Symposium on Building Physics, NSB2017, 11-14 June 2017, Trondheim, Norway

Optimized facade design - Energy efficiency, comfort and daylight in early design phase

Matthias Haase[a]* and Steinar Grynning[a]

[a]*SINTEF Building and Infrastrucutre, Høyskoleringen 7b, 7491 Trondheim, Norway*

Abstract

Multi-functional and advanced building envelopes can provide step-change improvements in the energy efficiency and economic value of new and refurbished buildings, while improving the wellbeing of building occupants.
The scope of this work was to analyze the performance of different window configurations on indoor climate and to identify the most effective strategies for improvements.
This work investigated different strategies to improve thermal comfort in a case study by optimizing the responsiveness of the building skin by applying control strategies for cooling with natural ventilation and the use of automatically controlled shading devices.
This case study of a single-family house is located in the mountainous region of Norway. The results focus on summer temperatures and overheating, and daylight levels in the different rooms. Four rooms were found to be most critical for overheating during summer and the results confirm large number of hours with operative temperatures above 27˚C in these zones. The results show that several rooms show high temperatures in summer, even with sun protection glass (type 2 and 3) and external screen (type 4 and 5). Cooling by natural ventilation by opening windows shows good results and proved to be effective in providing good summer comfort conditions. This has implications for the design and especially the choice of glazing and shading in residential buildings.

Peer-review under responsibility of the organizing committee of the 11th Nordic Symposium on Building Physics.

Keywords: Type your keywords here, separated by semicolons ;

* Corresponding author. *E-mail address:* Matthias.haase@sintef.no

1876-6102 © 2017 The Authors. Published by Elsevier Ltd.
Peer-review under responsibility of the organizing committee of the 11th Nordic Symposium on Building Physics
10.1016/j.egypro.2017.09.666

1. Introduction

Multi-functional and advanced building envelopes can provide step-change improvements in the energy efficiency and economic value of new and refurbished buildings, while improving the wellbeing of building occupants. They therefore represent a significant and viable contribution to meeting the EU 2020 targets [1]. Advances in building performance design of nZEB, buildings that produce more energy than they use, clearly show the need for more focus on the building performance design which minimizes total energy needs in the operation of the building and with minimal material use.

In highly insulated and airtight residential buildings, a dedicated outdoor air ventilation system with a balanced mechanical ventilation system with heat recovery is used for providing air. The need for window ventilation is supposed to be substantially reduced or even eliminated [2; 3]. Changes in heating and ventilation strategy and require a thorough investigation and evaluation of the impact on the indoor climate, which comprises of the indoor air quality and thermal comfort. Recent studies found that there are higher temperatures in new residential buildings [3].

A central role can be dedicated to the building skin that needs to be to the highest degree responsive to their environment. This requires new approaches of adaptive building skins that instead of providing static performance parameter are able to adapt the physical properties and in that way optimize the overall performance of the building. One option for adaptation could be the use of automatically controlled shading devices that control heat fluxes through the window in dynamic way [4]. But also opening windows to allow for ventilative cooling can be considered a dynamic adaptive strategy [5; 6; 7]. Previously reported results confirm that shading of windows and opening windows can help to reduce discomfort during summer periods [11].

1.1. Objectives

The scope of this work was to analyze the performance of different window configurations on indoor climate and to identify the most effective strategies for improvements. The main focus was put on controlling solar shading and natural ventilation. For a single-family house, for different glazing types and different external screens operative temperatures and daylight levels needed to evaluated.

2. Methodology

This work investigated different strategies to improve thermal comfort in a newly designed single-family house by applying a responsive and adaptive building skin based on:

- Use of automatically controlled shading devices
- Applying control strategies for Natural ventilation

Daylight factors (DF) will not be affected as they are calculated for deactivated screens (overcast sky). It will however still reduce daylight availability in the zones since the screen is activated as a solar shading. The effect of daylight availability has been calculated. The hourly illuminance values for a 80 cm high working surface were plotted for each zone.

Table 1. Areas of building elements and their thermal properties.

Building element	Area, A [m^2]	Thermal transmittance, U [W/(m^2 K)]	Heat loss, U*A [W/K]	% of total
walls	299.56	0.13	39.63	27.04
roof	99.21	0.15	15.01	10.24
floor towards ground	87.17	0.07	6.16	4.20
floor towards outside	6.65	0.10	0.66	0.45
windows	63.04	0.83	52.54	35.85
doors	4.53	1.09	4.91	3.35
thermal bridges			27.64	18.86