Best Practice Guidelines for Double Skin Facades

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ABSTRACT

Many modern office buildings have highly glazed facades. Their energy efficiency and indoor climate is, however, being questioned. Therefore more and more of these buildings are being built with double skin facades, which can provide: a thermal buffer zone, energy savings, wind protection with open windows, fire protection, aesthetics, solar preheating of ventilation air, sound protection, pollutant protection with open windows, nocturnal cooling and a site for incorporation of PV cells. However not all double skin facades built during the last years perform well.

A project BESTFACADE was therefore funded by the European Commission to actively promote the concept of double skin facades. An important part of this work is the creation of best practice guidelines for double skin facades, which are outlined in this paper.

KEYWORDS

Energy efficiency, design, double skin façade, glazed façade, office building, simulations.

INTRODUCTION

The potential for energy savings and improvements in indoor climate is often high for modern office buildings. Many modern office buildings may have a lower energy use for heating, but on the other hand often have a higher use of electricity than older office buildings, which is due to a higher energy use for ventilation, cooling, lighting and office equipment. Even in older office buildings the use of electricity has increased, mainly due to office equipment. Especially since the nineties office buildings with glazed facades have been built. The increased use of glazed facades has been enabled thanks to the development of façade construction technology and physical properties of glass during the last decade. There has been and is a growing interest among clients to building and among architects to design glazed double skin facades. The purpose of these double skin facades has often been to reduce the high temperatures in the building behind during the summer and to lower the heat losses during winter compared with a glazed single skin façade. Other benefits are that the double skin façade can provide: a thermal buffer zone, energy savings, wind protection with open windows, fire protection, aesthetics, solar preheating of ventilation air, sound protection, pollutant protection with open windows, nocturnal cooling and a site for incorporation of PV cells.

Why are fully glazed facades being built? Architecturally an airy, transparent and light building is created, where the access to daylight can be higher than in a more traditional office building.

Commercial buildings with integrated double skin facades can be very energy efficient buildings with all the good qualities listed above. However not all double skin facades built in the last years perform well. Far from it, in most cases large air conditioning systems have to compensate for summer overheating problems and the energy consumption badly exceeds the intended heating energy savings. Therefore the architectural trend has in many cases unnecessarily resulted in a step backwards regarding energy efficiency and the possible use of passive solar energy.

Therefore the European Commission funded a project, BESTFACADE, which will actively promote the concept of double skin facades. A best practice guideline for double skin facades will be created. It will be based on a comprehensive survey of double skin facades in Europe. Information on built examples of double skin facades in European office buildings will be collected, investigated and assessed. Using the this guideline designers and investors can avoid application of non relevant concepts of double skin facades performing worse than traditional facades. The investor confidence concerning operating performance, investment and maintenance costs will be increased. A simple calculation method for national guidelines to estimate the energy demand and comfort parameters will be developed. This method will be evaluated using measured and simulated data sets. It will be presented to the relevant CEN committees and could be integrated into the assessment methods of the EPBD.

One of the results up to now (the present) from BESTFACADE, work package 2 on non-technological barriers to double skin facades, is that in many countries the level of knowledge on double skin facades (especially advantages/disadvantages and costs) is insufficient for all target groups, apart from several educational/research institutions working in relevant areas. It was also concluded that there are many existing buildings with double skin facades, but very few of them are documented with regard to energy and environmental performance. The best practice guidelines aim to fulfil this knowledge gap and are outlined below.

METHODS

The best practice guidelines aims at offering, through a multimedia structure, information supporting in the design, choice, implementation and management of energy efficient and healthy office buildings (retrofitting and new construction) with double skin facades. The guidelines will consist of three parts:

Part 1. Fundamentals: The purpose is to provide to the targeted audience common basic scientific, technical and economic knowledge on double skin facades.

Part 2 Applications: The purpose is to provide the targeted audience with detailed practical information in order to design, choose, manage, use and maintain first of all double skin facades but also buildings including double skin facades (case studies - good examples of technical solutions and buildings; potential advantages and

disadvantages with double skin facades, situations where double skin facades can be appropriate, microscopic and macroscopic impacts of double skin facades).

Part 3: Tools: Databases; Review of simulation tools.

The target group will be

- Clients/developers
- Decision makers
- Governmental bodies
- Standardization
- Architects
- Civil engineers
- HVAC managers
- Facility managers

EXTENDED OUTLINE

The guidelines will, as mentioned above, consist of three parts. The planned content is outlined for each part.

Fundamentals

Architectural aspects:
A general description will be made of glass architecture, light, the façade of communication, the sound attenuating façade, and why double skin facades are being built.

Technology:
Double skin façades will be described in general terms. Different types of double skin facades i.e. typology, amount of glazing will be elucidated. Why are double skin facades being built from a technical point of view. Issues such as cleaning, maintenance, fire, and acoustics will be discussed.

Glazing:
Glazing for double skin facades (range of g-values, U-values, daylight transmittance) and other aspects as safety will be presented.

Façade construction:
General information on facades systems and materials (profiles, solar shading etc.) for glazed double skin facades will be given as well as aspects as safety.

Costs:
General economic information and comparison with traditional and single skin glazed facades will be provided. Investment vs. LCC (cleaning, maintenance, energy cost) will be discussed.

Advantages and disadvantages:
Potential non-technological advantages and disadvantages with glazed double skin facades and how to overcome non-technological barriers will be analysed as well as potential technological advantages and disadvantages with glazed double skin facades will discussed.

Scientific aspects:
Level of scientific knowledge will be presented.

Applications

Performance specifications:
Parameters (thermal comfort, visual comfort, energy use etc.) to take into account, and examples on requirement levels will be presented (Carlson 2003).

Design (brief, pre-design and design):
Procedures incl. rules of thumb (glazing, façade construction) for engineers and architects: HVAC aspects, daylight, energy, indoor climate and IAQ aspects, holistic approach, consultant and contractor aspects will be discussed (Blomsterberg 2006).

How to succeed, from brief to operation and maintenance, and when not to apply the double skin façade concept, starting points 30 %, 50 % or 80 % of inner skin glazed (glass area) and the outer skin fully glazed (apart from necessary profiles) will be discussed.

The eight determining areas of influence for highly glazed buildings are (Brunner 2001):
Comfort/daylight: PMV/PPD/ daylight quality, asymmetry/ cold air
Internal gains: equipment/artificial lighting, persons
Ventilation/cooling: air quality, removal of loads
Energy use: heating, cooling
Thermal mass: floor/ceiling, walls/furniture
Solar shading: type/location/material, operation/control
Glazing: U-value/g-value, surface temperature
Boundary conditions: size/orientation, use/outdoor climate

The internal gains must be minimized.

Increasing the glazed area results in increased risk and lowered tolerance for errors. Corner rooms with two glazed facades should be avoided.

U- and g-values have to be chosen correctly. A low g-value is only needed during warm sunny days. The window U-value should be lower than 0.9 W/m²K (in a cold climate). The daylight transmittance should be higher than 50 %. The g-value for the combination of glazing and solar shading should be less than 0.1.

Construction:
How to ensure that no changes of the façade are made compared with the design, which will impair the indoor climate and energy use and/or make the heating, cooling and ventilation insufficient.

Commissioning:
How to ensure that the building is adjusted in an optimal way.

Operation and maintenance:
How to maintain a good indoor climate and low energy use during operation.

Costs:
A simplified LCC approach will be presented.

Case studies:
Case studies (good and not so good examples) with description of technology, energy, thermal and visual comfort performance will be given. For the case studies the energy and thermal comfort (based on questionnaires) performance ranking will be presented. Especially the double skin facades performance will be presented. Predicted performance - examples will be given. The results of a parametric study for a reference building with double skin glazed facades, varying construction and climate will be carried out.

Tools

Tools to be used during the different phases of a building project: brief, pre-design, design, construction, operation will be listed and described briefly.

Simple simulation tools of double skin facades:
Description of and limitations and possibilities with simulation tools will be given i.e. simple calculation methods for glazed double skin facades and examples of tools e.g. WIS.

Advanced simulation tools of double skin facades:
Advanced simulation tools will be summarized using the results from IEA task 34/ annex 43 Testing and validation of building energy analysis tools, subtask on double skin facades.

Building Energy simulations tools:
How to simulate the energy use and indoor climate for a building with a double skin façade, examples on tools e.g. IDA ICE (Poirazis 2005), Parasol.

CONCLUSIONS

There has been and is a growing interest among clients to build and among architects to design glazed office building with double skin facades. These building can be rather energy efficient, but not all of them built during the last years perform

well. Therefore the architectural trend has in many cases unnecessarily resulted in a step backwards regarding energy efficiency. One of the results up to now (the present) from BESTFACADE, work package 2 on non-technological barriers to double skin facades, is that in many countries the level of knowledge on double skin facades (especially advantages/disadvantages and costs) is insufficient for all target groups, apart from several educational/research institutions working in relevant areas. It was also concluded that there are many existing buildings with double skin facades, but very few of them are documented with regard to energy and environmental performance. The best practice guidelines aim to fulfil this knowledge gap and thereby promote the concept of double skin facades, where it is relevant. The guidelines will be finished end of 2007.

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