Best practice for double skin facades - The BESTFACADE project

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ABSTRACT

This document aims to present the progress and the outcome of the research on double skin façades that is being carried out within the European 'BESTFACADE' project. Double skin facades have become an important architectural element in office buildings over the last 15 years. The demand for natural and hybrid ventilation in commercial buildings is increasing due to growing environmental consciousness while at the same time energy consumption for buildings has to be reduced. An advanced façade should allow for a comfortable indoor climate, sound protection and good daylight levels, while minimising the demand for auxiliary energy input. Double skin facades are analysed within the European 'BESTFACADE' project (Best Practice for Double Skin Facades) that receives partial funding from the Intelligent Energy Europe Program of the European Community. The project started in January 2005 and runs for 3 years.

1. THE 'BESTFACADE' PROJECT

The aim of the 'BESTFACADE' project is to promote the concept of well-performing double skin facades. A double skin facade can provide a thermal buffer zone, solar preheating of ventilation air, energy savings, sound protection, wind protection with open windows and nocturnal cooling. Commercial buildings with this system can be very energy efficient with all the good qualities listed above. However not all double skin facades built in the last years perform well. The consortium consists of twelve partners from seven European countries, and aims to study the implications of the different climatic regions on the performance and application of double skin facades. The BESTFACADE project is structured into six work packages. In the first part of the project the State of the Art on double skin facades in the participating counties is documented. A centralized information system database containing performance data on double skin facades built in the European Union is established. Additionally, the non-technological barriers that promote or prevent the application of the system are analyzed and strategies to overcome these barriers are presented. The information and outcome of the first part is implemented into the progress of the research: A best practice guideline of double skin facades is being developed including information on built examples of double skin facades of European office buildings. A simple calculation method to estimate the energy demand and comfort parameters of the system is developed.

2. STATE OF THE ART

The state of the art of double skin façades in different countries and climatic regions is evaluated and a coherent typology of double skin façades is developed. In order to collect information on built double skin façade examples on a comparable data in the different European countries, questionnaires were developed asking information on the double skin façade building (address, design team, information on the room heating and cooling system), information on the façade (geometry, type and costs), and information on measured and simulation data about temperatures in the façade gap and indoors, shading, control of ventilation, different control strategies and costs. In total, the collected data concerns 27 buildings that are located in different European countries. In summary, double skin facades can be classified according to three different criteria which are independent of one another and are based not only on the geometric characteristics of the façade but also on its mode of working. These are: Type of ventilation, Ventilation mode of the cavity, Partitioning of the façade. Regarding the type of ventilation, this refer to the ventilation of the façade cavity and one must distinguish between the three following types of ventilation: natural, mechanical or hybrid ventilation.

The ventilation mode refers to the origin and the destination of the air circulating in the ventilated cavity. Different configurations can be met: outdoor air curtain (the air introduced into the cavity comes from the outside and is immediately rejected towards the outside), indoor air curtain (the air comes from the inside of the room and is returned to the inside of the room or via the ventilation system), air supply (The ventilation of the façade is created with outdoor air. This air is then brought to the inside of the room or into the ventilation system), air exhaust (the air comes from the inside of the room and is evacuated towards the outside) and buffer zone (the double façade is made airtight).

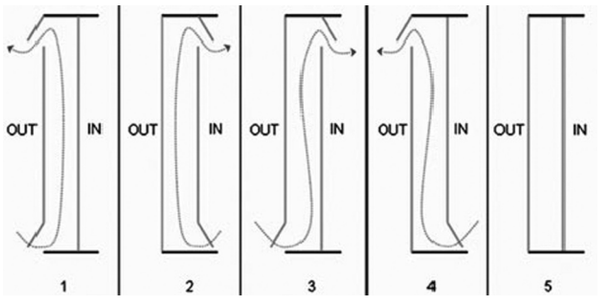

Figure 1: The ventilation mode: the origin and the destination of the air circulating in the ventilated cavity

The partitioning of the cavity gives the information on how the cavity situated between the two glazed façades is physically divided. The following partitioning can be met: ventilated double window, ventilated double façade partitioned per storey with juxtaposed modules, corridor-type ventilated double façade, and 'shaft-box´ ventilated double façade.

The selection of double skin facades depends on the climatic characteristics of the country. Within Bestfacade project three climatic areas are covered: "The Nordic region" that is represented by Sweden, » the Temperate region" with Austria, Belgium, France and Germany "The Mediterranean region" with Greece and Portugal. For example, the simplest and most common system solutions in Sweden entail that the façade is only ventilated to the outside. Most of the time this means that the office building behind has a traditional heating, cooling and ventilation system. On the other hand, for the climate of Greece, control of solar gains in the building design is important during the summer period. Therefore airtight double skin facades may lead to overheating during the summer months if there is no appropriate façade design, not correct building orientation and not adequate provision of shading. Naturally ventilated facades are the best option in Greece.

A centralised information system database containing details and performance data collected from a survey of double skin façades built in the European Union is established. The database contains references of articles, books, proceedings, diploma and PhD thesis about double skin facades. These documents are sorted and evaluated by their authors, keywords, language and publication type, with the objective to make it as easy as possible to find a special document or documents about a special aspect of double skin facades. The main function and advantage of this database is the possibility to get an efficient overview about the literature, ranked by keywords and their relevance in this document.

This information system, like all other dissemination material, is available on the website of the project: www.bestfacade.com.

Figure 2: Main menu of the Bestfaçade literature database (www.bestfacade.com)

3. NON TECHNOLOGICAL BARRIERS

The non-technological barriers to the application of double skin facades are analysed in work package 2. These non-technological barriers are more difficult to overcome than technological barriers as they are not objective and differ from country to country. A questionnaire was developed in order to define the non-technological barriers and the factors that hinder or, in some cases, promote the development of double skin facades in the different countries. The questionnaire forms the basis for a 'SWOT' analysis. 'SWOT' analysis is a methodology that analyses the barriers and limitations of a product in the market. It is a means to identify the advantages and disadvantages of the product by comparing it with product of similar use and thus to rate the range of its applicability.

The investigated barriers concern aspects as legislation, financial aspects, institutional aspects sociological-behavioral aspects, educational aspects and institutional aspects. The analysis aims at a broad approach, however, there is not always easy to summarize the advantages and disadvantages of double skin facades in a questionnaire. The results showed that due to the high number of different double skin facade concepts, some elements and legislation issues can be positive in a specific double skin facade design, and not for other.

It can be concluded that many 'non-technological barriers' prevent the application and development of double skin facades in the European market mainly because of the lack of legal standardized schemes, the lack of knowledge regarding the design, performance, construction of the system, the lack of documented data on the built double skin façade buildings and the lack of financial support from the government and regional institutions. Although the benefits that double skin facade could provide in the energy and environmental performance of buildings via an appropriate design, it seems that their use is offset by the use of conventional façade systems because of the above mentioned reasons and because of its increased investment cost.

The research also shows the need for the dissemination of knowledge on the system, the documentation of best practice examples and the reduction of the construction cost. Further to the analysis, strategies to overcome these barriers are suggested. The proposed strategies are based on the answers of the questionnaires. It is suggested to follow a policy that will be distinguished into two stages: the pre-assessment and post-assessment stage.

In the pre-assessment stage the policy aims at providing the different target groups with all the necessary information on DSF to be able to define and check the performance of the system. Additionally, the pre-assessment policy aims at introducing homogenous legal schemes and simple calculation methods concerning double skin facades in all countries based on the EN standards. The pre-assessment policy suggests the dissemination of the EN standards 13830 'Product Standard - Curtain Walling' and prEN 13119:2004 that currently is the official legal document for double skin facades in use that specifies the characteristics of the system and provides technical information on the varying performance requirements throughout Europe. According to prEN 13119:2004, a double skin façade is defined as: 'a curtain wall construction comprising an outer skin of glass and an inner wall constructed as a curtain wall that together with the outer skin provide the full function of a wall'. The EN standards list the façade specifications according to the requirements of the Construction Products Directive (CPD) leading to the CE marking for curtain walling, that is in enforcement since the year 2005. However, the majority of the countries that participate in the BEST-FACADE project were not aware of the legal scheme. Reliable documentation of good built double skin examples is important. Dissemination of the double skin facade buildings can be performed in various ways, through seminars on national level, education at university level, through the internet and publication of best practice examples in journals and the distribution of a best practice guideline with illustrations of built examples.

The post-assessment policy includes all actions that have to be taken into consideration after the double skin facade dissemination in order to support the product in the market. An appropriate marketing from the involved associations is essential. The documentation of double skin facade best practice examples including real data of their energy and environmental performance along with operational and investment costs is necessary to increase reliability of the product and awareness among the target group. Finally, public support and support from the government is always important in developing the double skin facade market; funding also is an essential motive for the promotion of the system.

4. BENCHMARKS AND CERTIFICATION

A benchmark system is developed and is made available on the webpage of the project. This benchmark allows the users and the operators of buildings with double skin facades to compare their energy consumption levels with others in the same group, set future targets and identify measures to reduce energy consumption.

The energy benchmarking studies enable to identify different performance between double skin façade buildings and also to compare double skin façade buildings with single skin buildings. One of the aims of benchmarking

is to identify 'best' practice examples based on existent double skin façade buildings and to disseminate this information to architects, promoters and façade designers. Benchmarks are established making use of the clustering analysis methodology. The buildings that are analyzed within work package 1 (State of Art), are classified by their energy performance and the type of primary energy that is used to fulfill the buildings' energy needs. This sample is divided into groups according to similar characteristics or energy demanding behaviors and according to their energy consumption data.
Also a certification method for double skin facades is being discussed and under what circumstances this could be connected with the EPBD certification.

5. SIMPLE CALCULATION METHOD

Currently the assessment of the thermal behaviour and the energy-efficiency of naturally ventilated double skin facades is only possible by using complex simulation tools, which allow interconnections between fluid dynamics, energy balances and optical transport mechanisms. The performance assessment of mechanically ventilated double skin facades is slightly easier but still requires simulation tools. Because of the interaction of separate calculation results, extensive iterations are often necessary. This makes it impossible to have reliable predictions on energy efficiency and impacts on comfort in the early design stage.
Therefore an assessment method is developed, which can be integrated in the assessment methods of the EPBD, offers sufficient accuracy of the thermal behaviour and the energy performance of the system and can be used during the design stage. Similar to the standardised approach for the winter gardens, trombe walls and the ventilated building envelope parts of the ISO 13790, annex F, a monthly balanced calculation procedure is developed and evaluated based on sensitivity studies. With this method the thermal and visual behavior and the energy performance of the facade can be calculated with adequate accuracy for assessments of potentials. A prediction of the efficiency of the facade technology can be derived. By that the energy efficiency and quality of the facade could be European-wide certified where required. This calculation procedure should harmonise with the currently developed CEN-Standards for the implementation of the EPBD. The main work consists of the approximation of the airflow in the facade interspace and the adaptation of the utilisation factor of the solar gains to the different facade systems. The results of the developed method will be compared to results from other simulations. A review on the existing standards and calculation methods is carried out in order to investigate their applicability and usability in the development of the simple calculation tool of double skin façades. The existing approaches concern different standards and guidelines like: prEN/ISO 13790, the German standard DIN V 18599, the WIS approach, EN 13830, prEn13947, ISO 15099, ISO 18292. A detailed analysis of the existing approaches showed that the German standard DIN V 18599 can give a useful extension for double skin facades. The air flow rates have been analysed for different facades types and the BESTFACADE calculation method forms the basis for a simple calculation tool. The simple tool can be used for giving first indications on the impact of different façade types on the heating, cooling and lighting energy demand.
The calculations can be made for the three climatic regions that are covered in the BESTFACADE project.
The calculation tool is also developed as an interactive usable internet tool and is available on the website of the project: www.bestfacade.com.

Figure 3: Title page of the BESTFACADE information tool (www.bestfacade.com)

6. BEST PRACTICE GUIDELINES

A design guide including best practice examples is being developed within work package five of the BESTFACADE project.
The best practice guidelines aims at offering informa-

tion supporting in the design, choice, implementation and management of energy efficient and healthy office buildings (retrofitting and new construction) with double skin facades. The target group is architects, decision makers, governmental bodies, engineers, clients, facility managers, and façade suppliers. The design guide will allow the target group to design, choose, manage, use and maintain double skin facades.
In the design guide, information on technical issues concerning double skin facades can be found. Case studies, good examples of technical solutions and buildings are described. Potential advantages and disadvantages with double skin facades, situations where double skin facades can be appropriate, microscopic and macroscopic impacts of double skin facades will be published. Also, technological and non-technological barriers to the application of the system are analysed and strategies to overcome these barriers are presented. The energy demand and consumption for heating, ventilation, cooling and lighting of buildings with different facade types is compared and appropriate control strategies are included. Non energy related issues like acoustics, aesthetics, fire protection, moisture, corrosion, durability, maintenance and repair are discussed. Also a review of available simulation tools and their ability to model the complex system of a double skin facade is presented. The simple calculation method is also described (see chapter 5).

7. DISSEMINATION

The project results can be found in the website www.bestfacade.com .The website is developed in three languages: English, French and Dutch. It includes information on double skin façade system regarding its history, typology and technical description. Also it presents the objectives of the BESTFACADE project and the partners that participate in the project. Finally, the reports that include the results of the research carried out within the different work packages can be downloaded from the website.
Additionally, the project results are presented in national and international conferences. Also CD-ROMS are available including information on the BESTFACADE project.

8. CONCLUSION

The BESTFACADE project actively promotes the concept of well-performing double skin facades, which are well integrated into the building. Studies showed that the energy consumption of buildings with double skin facades can vary extremely.
The project analyzed technological and non-technological barriers to the application of double skin facades and suggested barriers in order to overcome these barriers. It also presented advantages and disadvantages of double skin buildings compared with buildings with conventional facades. A benchmarking system is developed in order to rate double skin façade buildings with others in the same group and with single skin buildings. A simple (pre-design) calculation method is developed in order to assess the impact of double skin façades on energy use for heating, cooling and lighting in different climatic regions. The project will offer information supporting the design of energy efficient and healthy office buildings equipped with double skin facades. The purpose is to provide the targeted audience with common basic scientific, technical and economic knowledge on double skin facades. Apart from this fundamental knowledge detailed practical information in order to design, choose, manage, use and maintain double skin facades will be published. Using these information and guidelines designers can avoid the application of not well functioning concepts of double skin facades resulting in increased energy consumption and poor indoor climate. With the best practice guidelines the knowledge and confidence concerning performance, investment, operation and maintenance of double skin facades will be increased.

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