State of the Art of Double Skin Facades in Europe
The results of WP1 of the BESTFAÇADE Project

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ABSTRACT

The project BESTFAÇADE accumulated the state of the art of double skin façades in seven European countries (Austria, Belgium, France, Germany, Greece, Portugal and Sweden). 28 façades of different buildings in all partner countries of BESTFAÇADE have been analysed. Most of the buildings are offices buildings followed by schools and service buildings. Nearly all of the buildings have mechanical ventilation systems and both heating and cooling are performed mostly by air heating/cooling systems. The types of façades are mainly multi-storey and corridor types, in Belgium juxtaposed modules are frequently used. The façade gaps are mostly naturally ventilated (except for Belgium, where the indoor air is led by mechanical ventilation via the gap to the centralized air handling unit). The shading is performed mainly with Venetian blinds located in the gap. The cleaning of the outer shell is done via a cradle or a lifting platform, the glazing of the gap is mainly cleaned from the gap or from the interior. Unfortunately not so much measured date of energy demand and temperatures in the gap and the rooms behind are available. The cost of DSF are significantly higher compared to conventional façades.

KEYWORDS

Double Skin Facades, Analysis, European project

INTRODUCTION

Innovative façade concepts are today more relevant than ever. Double skin façades (DSF) have become an important and increasingly used architectural element in office buildings over the last 15 years. They can provide a thermal buffer zone, solar preheating of ventilation air, energy saving, sound, wind and pollutant protection with open windows, night cooling, protection of shading devices, space for energy gaining devices , such as, PV cells, and differentiated aesthetical qualities, which is often the main argument.

Commercial and office buildings with integrated DSF can be energy efficient buildings. However not all double skin façades 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 often exceeds the intended heating energy savings. Therefore this architectural trend has, in many cases, resulted in a step backwards regarding energy efficiency and the possible use of passive solar energy.

The project BESTFAÇADE, sponsored by the Energy Intelligent Europe Program of the European Union, and led by MCE-Anlagenbau, Austria, accumulated the state of the art of 28 double skin façades in seven European.

OPPORTUNITIES AND RISKS OF DSF

Compared to traditional office buildings, especially with large glazed façades, office buildings with double skin façades can have the following potential advantages:

- Individual window ventilation is almost independent of wind and weather conditions, mainly during sunny winter days and the intermediate season (spring and autumn)
- Reduced heating demand thanks to preheating of outdoor air
- Night cooling of the building by opening the inner windows is possible if the façade is well ventilated
- Improved security thanks to the two glazed skins
- Better sound proofing from external noise sources e.g. at locations with heavy traffic, mainly during window ventilation
- More efficient exterior (intermediate) solar shading, as the shading can be used also during windy days

Potential problems with office buildings with double skin façades can be:

- Poorer cross ventilation and insufficient removal of heat from the offices rooms during windless periods, when ventilation is mainly provided for by natural ventilation
- Hot summer/spring/autumn days can lead to high temperatures in office rooms as a result of window ventilation
- Higher investment cost
- The office floor area can be reduced
- Risk of sound transmission via the façade cavity from one office to another with open windows
- Cleaning can result in additional cost
- The energy saving potential has often been overestimated
- Fire protection can be more difficult depending on the type of façade.

LOCATION AND TYPE OF THE DSF BUILDINGS

Figure 1 shows the locations the 28 façades of different buildings in all partner countries of BESTFAÇADE, which have been studied using a standardized questionnaire. This comprises data on location, information about the building and the façade, construction and air flow in the façade as well as maintenance and cost. The main results of this work are shown in the following.

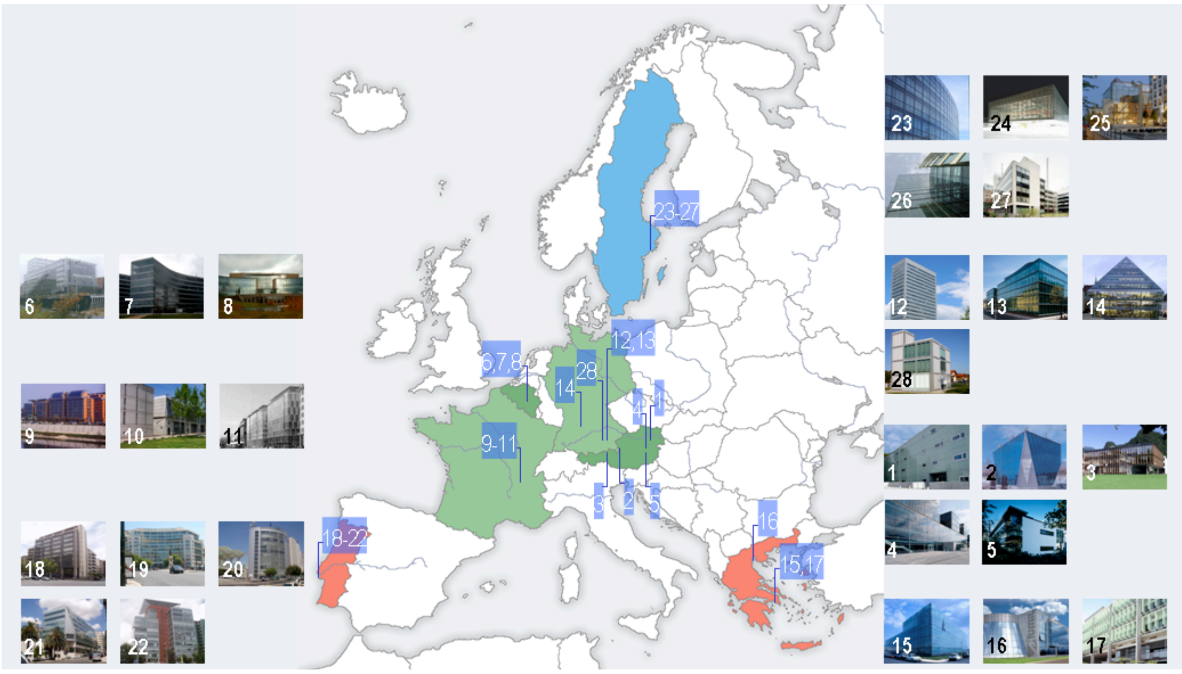

Figure 1 Analysed buildings within the BESTFAÇADE project

Most of the buildings analyzed were non-public office buildings followed by public schools and services. None of the buildings were equipped with a DSF in a renovation process and there is no clear main orientation of the façade, as it is mainly an architectural element.

ENERGY RELATED ASPECTS AND COSTS

The types of façades are mainly multi-storey and corridor types, in Belgium juxtaposed modules are frequently used. The façade gaps are mostly naturally ventilated (except for Belgium, where the indoor air is led by mechanical ventilation via the gap to the centralized air handling unit). Most of the façades have bottom and top openings in the outer shell of the façade which can be closed during winter and opened in summer (Figure 2). For the inner shell only half of the analyzed façades have openings (mainly windows, sometimes the windows are bypassing the gap). If present, they are, of course, closable. Depending on the ventilation concept sometimes problems with condensation are reported when warm and wet exhaust air is ventilated into the gap and meets the cold inner surface of the outer glass pane.

The shading is performed mainly with Venetian blinds located in the gap. The cleaning of the outer shell is done via a cradle or a lifting platform, the glazing of the gap is mainly cleaned from the gap or from the interior. Nearly all of the buildings use mechanical ventilation systems for the building and both heating and cooling are performed mostly by air heating/cooling systems (see Figure 3). As heat source district heating followed by electricity and gas/oil is mainly used.

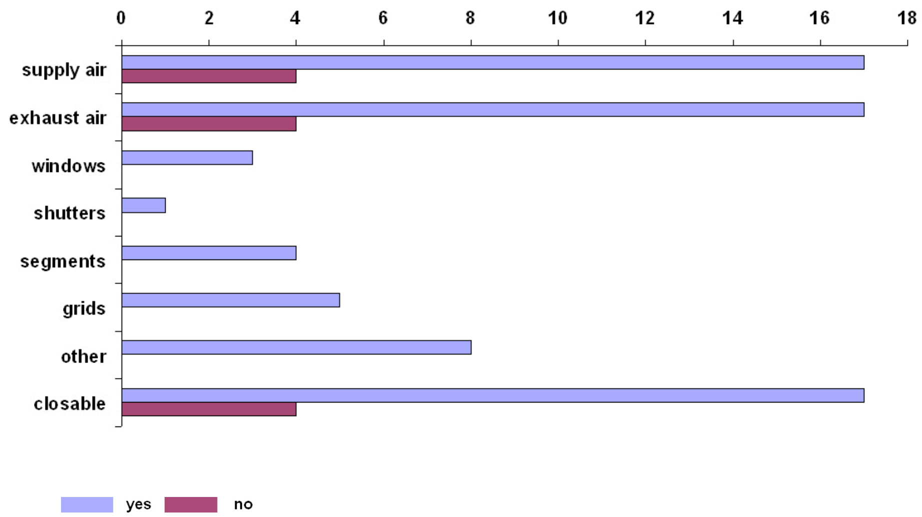

Figure 2 Ventilation openings in outer shell of analysed façades

Unfortunately not so much measured data of energy demand and temperatures in the gap and the rooms behind are available, because building managers are not easily willing to give away such sensible data.

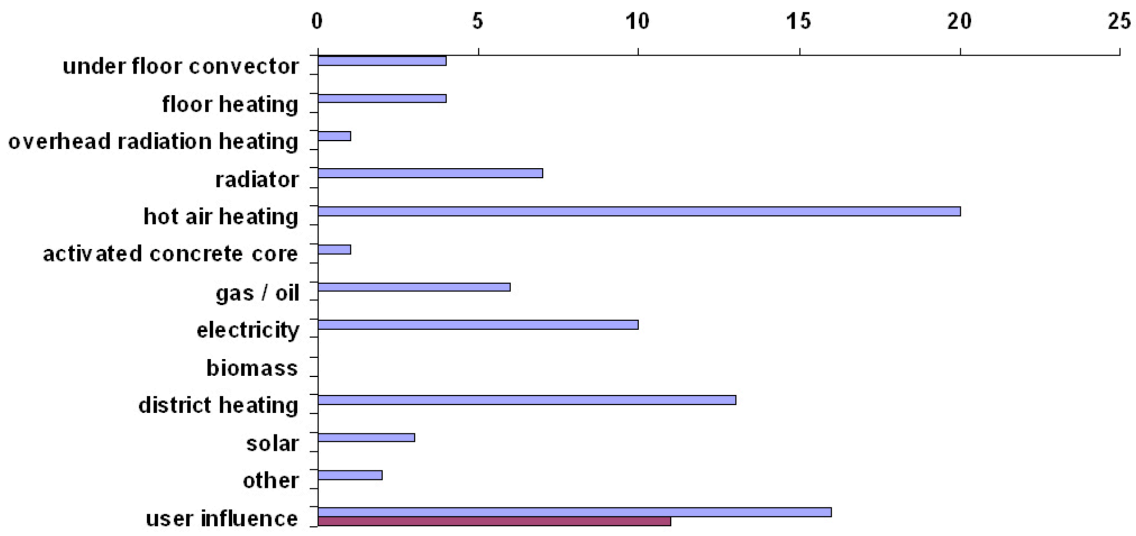

Figure 3 Types of room heating devices and used energy source of BESTFAÇADE buildings

The cost of DSF are about 20 – 80 % higher compared to single glazed facades and about 100 to 150 % higher compared to opaque façades with windows. Therefore there have to be significant benefits in the HVAC system cost or the operating cost of DSF to make them more attractive compared to conventional façades.

Figure 4 shows costs of facades that were collected from different publications on double skin façades. Due to the wide range of technical possibilities and economic boundary conditions also a wide range of such cost is reported.

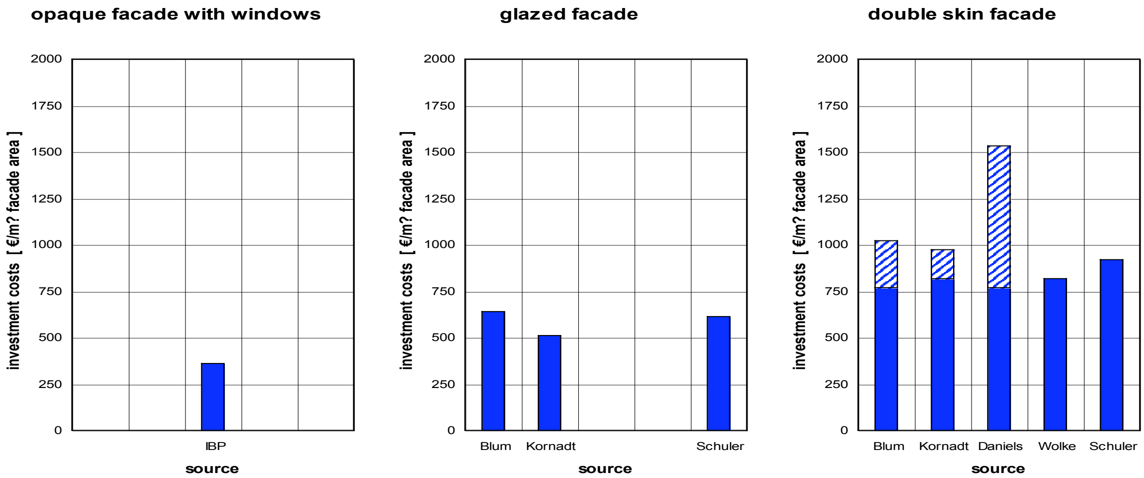

Figure 4 Cost of DSF compared to conventional façades. The blue and white fields show the range of cost mentioned in Blum (1998), Daniels (1997), Kornadt (1999), Schuler (2003) and own data.

OTHER ASPECTS

Acoustics can be one of the main reasons to apply DSF - e.g. with traffic noise. In many cases DSF can reduce sound transmission from the outside due to additional shell. On the other hand depending on the type of DSF problems of noise transmission from room to room by the gap is reported. This can be reduced by choosing the appropriate partitioning system or by the implementation of acoustical absorbers in the gap.

Aesthetics are often the main aspect for the application of DSF. They give depth and a kind of "crystal image" to the façade.

Fire protection is a serious item with DSF. Fire brigades have to destroy two shells to be able to help the building users in case of fire, also the flashover of a fire from one storey to the next can be facilitated by DSF depending on the partitioning system. The façade manufacturers have found solutions for the second problem and in the case where the gap is separated between the storeys the problem is smaller than in conventional façades. Some types of DSF such as "multi storey DSF" must not be applied to high buildings.

Durability - Due to the fact that most DSF are kind of prototypes, difficulties have been reported with unproved durability - especially with pane fixtures (those problems may refer to Conventional Glazed Facades, CGFs too) and mechanically driven shutters or lamellae. Since DSF are a rather new development there has been no scientific in-situ long-term analysis of a bigger group of façades. On the other hand problems with the durability of examples of the façade type are not known.

The maintenance of the façade consists of cleaning and repair. The cleaning for double glazed façades has to be done at four levels (instead of two): inner and outer side of the external façade and inner and outer side of the internal façade. For the two middle levels most of the time accessible grids are part of the façade gap. This facilitates the work and leaves only the same levels as with conventional façades. However additional cleaning cost has to be taken into account with DSF. Also for repair two shells might now have defects. On the other hand a DSF offers some advantages like a protected shading system in the gap, which will less often have defects. So all in all it depends on the amount of façade fixtures whether the need for maintenance is higher or not compared to CGFs.

CONCLUSIONS

Most of the buildings are office buildings followed by schools and service buildings. Nearly all of the buildings have mechanical ventilation systems and both heating and cooling are performed mostly by air heating/cooling systems. The types of façades are mainly multi-storey and corridor types, in Belgium juxtaposed modules are frequently used. The façade gaps are mostly naturally ventilated (except for Belgium, where the indoor air is led by mechanical ventilation via the gap to the centralized air handling unit). The shading is performed mainly with Venetian blinds located in the gap. The cleaning of the outer shell is done via a cradle or a lifting platform, the glazing of the gap is mainly cleaned from the gap or from the interior.

The cost of DSF are about 20 – 80 % higher compared to single glazed facades and about 100 to 150 % higher compared to opaque façades with windows. Therefore there have to be significant benefits in the HVAC system cost or the operating cost of DSF to make them more attractive compared to conventional façades.

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