

Ventilated Facades



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Ventilated Facades

Climate Facade versus
Double-Skin Facade

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This report is the eight in a series of technical papers by top E

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Preface



The ventilated facades demonstrate a blend of lightness and elegance due to its transparent appearance. The functional condition of the building together with the environmental detail is visible due to the multi layers. The use of steel and glass material gives the impression of futuristic technical orientation. In order to live up to this expectation, careful consideration must be given to all preconditions and necessary planning.



1. Introduction

What is a Ventilated Facade?

The construction of sustainable and energy saving buildings has an increasingly strong influence on the facade design, especially in non-domestic buildings. The construction design and the design of the installations have to be integrated as far as possible in order for this to happen. It is no longer

acceptable for any shortcomings in the construction design to be compensated at the expense of the installation design. The concept of ventilated facades is responding to this development with two facade types:

*Climate facades and
Double-skin facades*

Climate facade

The climate facade is a clear example of a synthesis of the architecture and the design of the installations; the facade and the installations become components of each other, as the facade is ventilated with inside air.



Fig 1 *Dexia Bank in Brussels.
The Climate Facade technology utilised for this refurbishment of 34.000 m² of office accommodation comprised a factory prefabricated curtain wall type facade, consisting of a double outer and single inner glazing with solar protection in between. The overall thickness of the facade was about 180 mm with easy access to the inner glazing for cleaning purposes.*

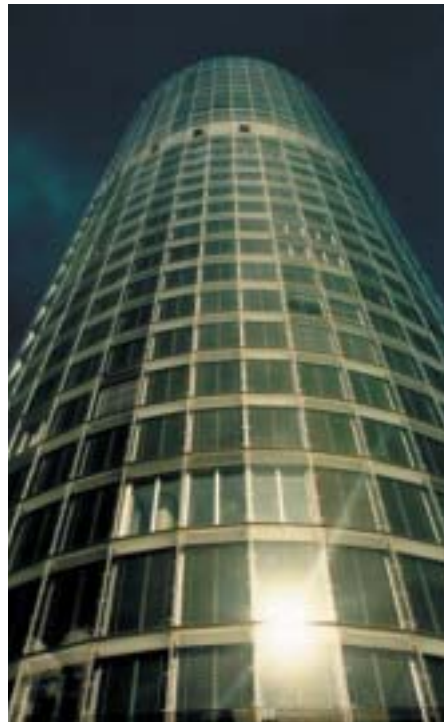
The cavity, including the solar protection between the two glazing is aerated with extracted ventilated air from the building.

Photo: Macq & Roba



Double-skin facade

The double-skin facade is ventilated with outside air and allows the ventilation of outside air through openable windows - even in high rise buildings without causing any nuisance.



*Fig 2 A speech-making double-skin facade, the first one in Germany, is the 127 m high RWE tower in Essen. The architects provided this cylindrical high rise building, diameter 32 m, with 7000 m² of double-skin facade. The total facade surface area comes to 17.000 m².
Photo: Gartner*





When and where are they used?

Modern climate facades were introduced at the beginning of the 1970s. Recently however, there has been an increased interest in the concept of the double-skin facade in Northwest Europe. The utilisation of double-skin facades has been particularly apparent in Germany over the last few years.

Both types of facades are being selected more and more by building owners and building users situated in attractive locations.

The aforementioned facades have their own specific advantages, which will be outlined in this brochure and illustrated by photos and drawings. All the pictorial buildings depicted herein are project or proposals in which top E Members have been partner.



*Fig 2 Double-skin facade.
Photo: Gartner*



*Fig 2 Climate facade at the ICT Business
Centre Groningen
Photo: BV Technical Management (TM).*

2. Where do they fit in the Survey of Facades?



Facades

Facades may be designated in various ways. Arranging facades according to their specific structure allows for grouping in principally two groups as shown in Figure 3

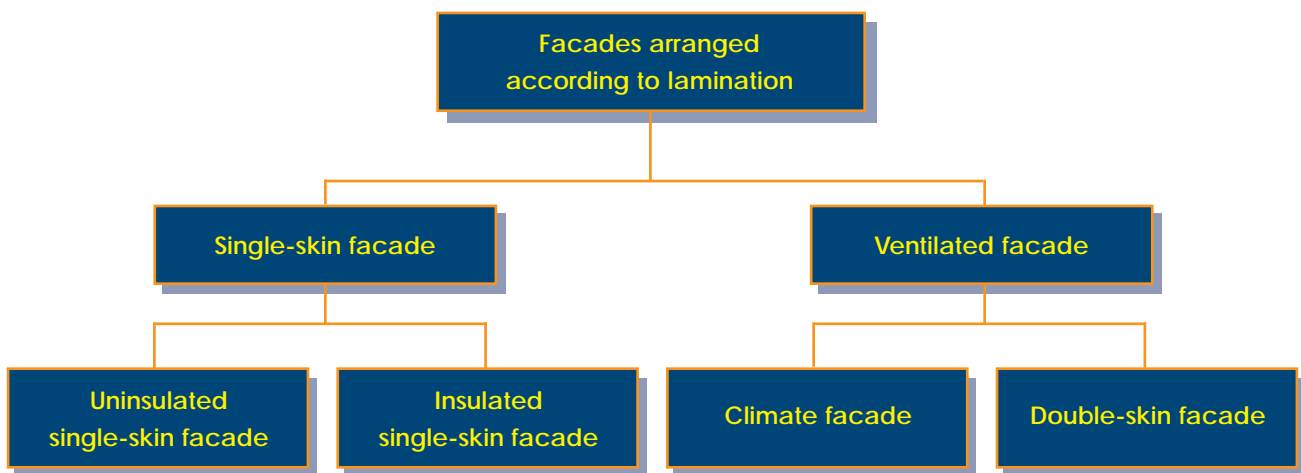


Fig 3 Facades

Drawing: BV Technical Management (TM)



Single skin facades

Not-insulated and insulated facades of one layer or more layers and without ventilated cavity belongs to the group of single skin facades. Today, these facade types are often supplemented by shading devices outside or inside of the facade. Also integrated shading devices are in use. The devices are manually opened and closed or are controlled by a sun and daylight management system.

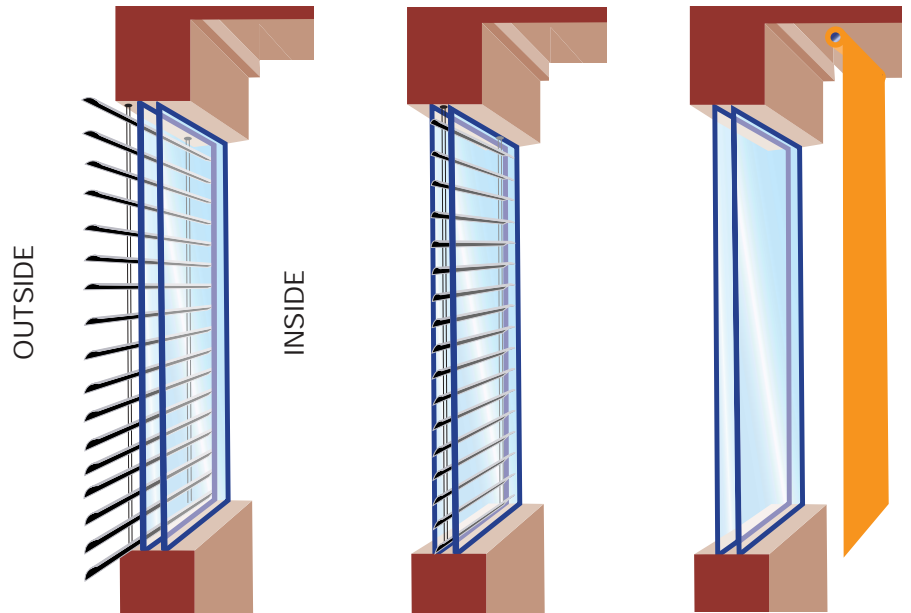


Fig 4 Single skin facades with different position of the shading devise
Illustration: top E

Ventilated facades

Ventilated facades are categorised by their structure. The position of the insulated double glazing layer and the depth of the air cavity are important. Practically ventilated facades are sub-categorised into climate facades and double-skin facades Figure 5.

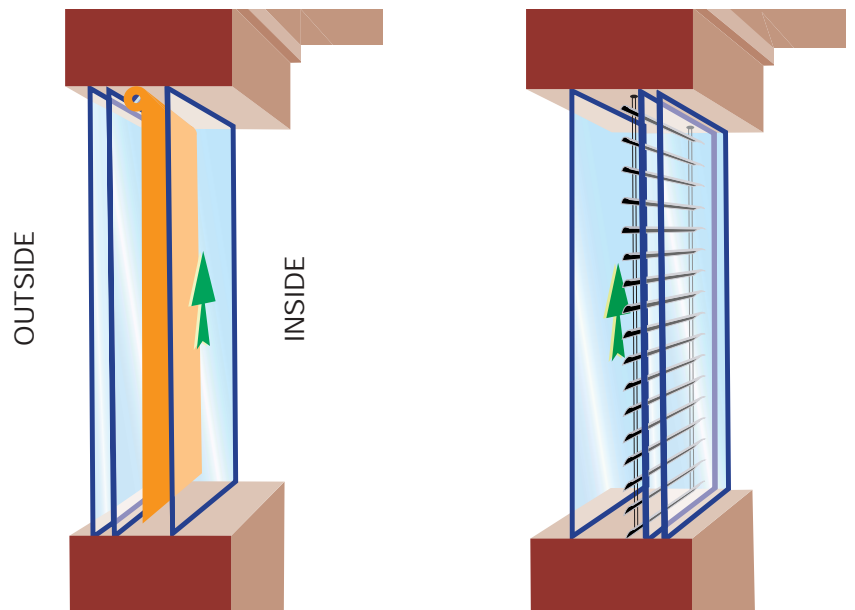
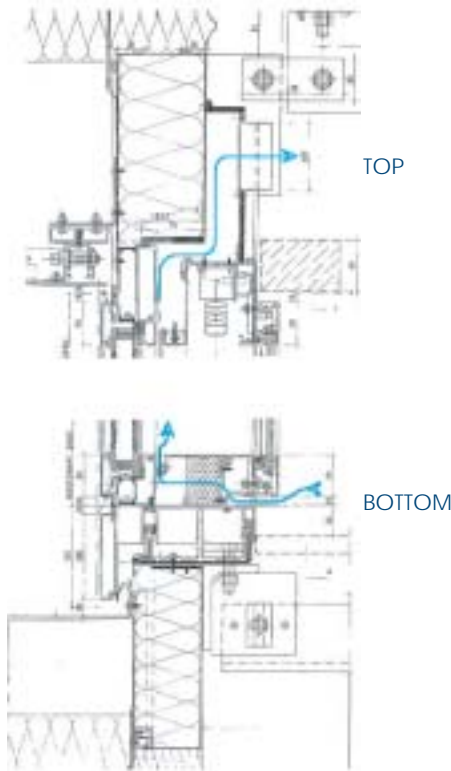


Fig 5 Ventilated facades
The shading device is places in the ventilated cavity
Illustration: top E

3. What are the Characteristics of the Ventilated Facades?



Climate facade

Climate facades are characterised by a closed double glass layer in the outer structure an openable single glass layer in the inner structure, with a cavity space varying from 60 to 200 mm. The cavity space between

the glass structures is ventilated by means of exhausting air through the space with air drawn from the room on the inner side. Solar and daylight control facilities are located in the cavity space.

The climate facade with stands maximum outdoor climate influences and offers a solution to reduce the problem of heat loss in winter and heat load in the summer, particularly in high rise buildings, which have a relatively large and preferably clear glass facade area.

Fig 6 ABN-AMRO head office in Amsterdam. Vertical cross-section of a climate facade element. Drawing: Scheldebouw



Fig 7 The head office of ABN-AMRO in Amsterdam is provided with 24200 m² of climate facade. Photo: Capital Press



Fig 8 The interior at the east climate facade of the new Municipal Palace of Congresses & Exhibition in Madrid. The climate facade serves as an air duct for air pre-heat in winter for the auditoriums, or air discharge to insulate the building, creating an atrium without mechanical heating or cooling requirements. Photo: Aguilera Ingenieros S.A.



Double-skin facade

The double-skin facade is conversely characterised by an openable *double glazed inner windowpane* and a closed *single windowpane on the outside*. The cavity space between the glass structures is connected to the outdoor air to induce natural ventilation. The solar- and daylight control is also situated in the air cavity. The double-skin facade is of a bigger size than the climate facade. In practice the depth of the air cavity varies between 200 and 1000 mm. An air cavity depth smaller than 200 mm significantly reduces the air change rate in the room behind a double-skin facade.

The double-skin facade (figure 9) is particularly advantageous during the mid-season when, for the majority of the time, it utilises the outdoor climate. One of the most significant advantages it offers is the ability to use natural ventilation, even in high rise buildings.



Fig 9 *Banque Générale, Limpertsberg in Luxembourg; Double-skin facade of the 6-storey office building. Photo: Goblet & Lavandier*

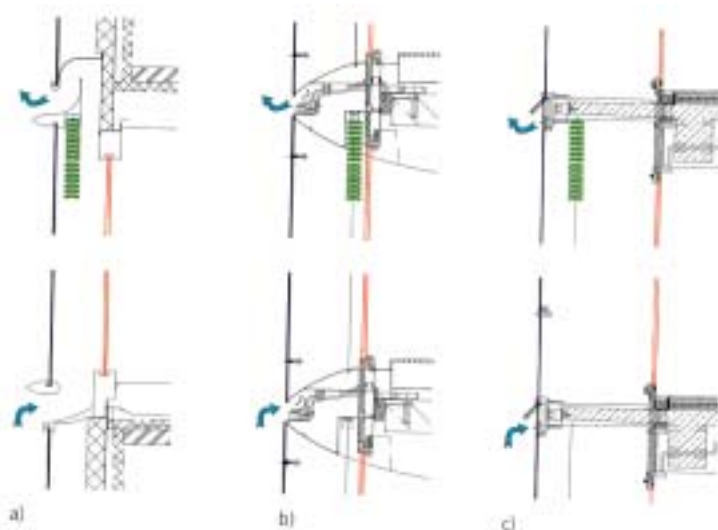


Fig 10 *Vertical cross-section of different versions double skin facade. Drawing: Gartner*

4. How do they Differ in Functioning?



Fig 11 National Nature-Historical Museum 'Naturalis', Leiden
An exceptional design of a climate facade is used in the depository tower. In order to reduce the influence of the outdoor climate to an absolute minimum there is no glass opening whatsoever in the facade and the air cavity is ventilated by an air-conditioned system.
Photo: VROM

The **climate facade** can best be described as a defensive separation between the outdoor and indoor environments – keeping out the influence of the outdoor climate. Only sun - and daylight can be passed through. The climate facade has a passive energy function, as the heating and cooling are mainly delivered and controlled by the installation. The air cavity is connected to the installation that controls the necessary ventilation, heating and cooling. The climate facade is reactive to the *indoor* climate.

The **double-skin facade** acts in a totally opposite manner, as it is an active separation between the outside- and inside environments, that endeavours to utilise the outdoor conditions as much as possible. The double-skin facade is reactive to the *outdoor* climate.

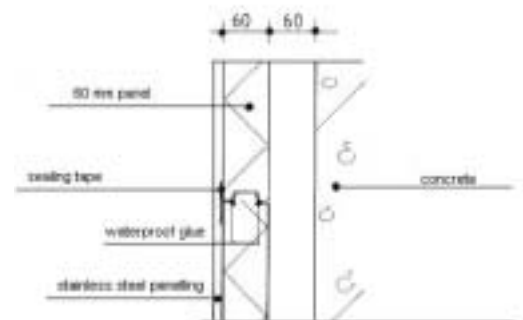


Fig 12 Vertical cross-section of climate facade for the depository tower of Naturalis.
Drawing: Metaflex.



5. What are the Advantages?

Ventilated facade compared with single skin facade

- Better thermal insulation
 - Better sound insulation
 - More comfort possibilities
 - Protection of the sunblinds
- Convective solar energy can be used
 - Less dust and air pollution resulting in lower and less frequent maintenance cost for cleaning sunblinds and windows

Climate facade compared with double skin facades

The advantages of a climate facade compared to a double-skin facade are as follows:

- The internal climate is less subject to disturbing influences of the external climate
- Convective heating is not required internally. In other words a less extensive heating system
- More usable space
- A more compact facade
- A more sound insulated facade
- Less possibilities of sound flashing trough the facade



Fig 13 The 1991 prize-winning design for the Commerzbank in Frankfurt am Main in Germany reflects the client's concern to produce an ecological, low-energy building
Photo : Gartner



Double-skin facade compared with climate facade

The advantages of a double-skin facade compared to a climate facade are as follows:

- openable windows in rooms at great height in the building
- less energy consumption for the cooling and ventilation system
- inner windowpane does not shield inside heat capacity of the building
- in buildings requiring renovation, thermal bridges are warmly wrapped up and the total insulation value of the facade is increased.

Fig 14 For this project two variations on the principle of the "buffer zone" for natural ventilation of the offices were used : as a double skin facade and as a winter garden
Photo : Gartner



6. Options for Ventilated Facades

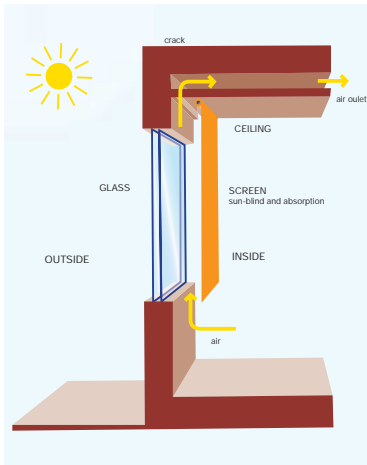


Fig 15 Cross-section of a climate facade The inner glazed windowpane is replaced with a sun-blinded screen
Drawing: Bouwjaar 98, Technische Universiteit Eindhoven, Faculteit Bouwkunde

Climate facade

Alternatively, the inner single glazed windowpane can be replaced with a sun-blinded screen which takes over the dual function of the window and the cavity mounted sun-blind, Figure 15

The efficiency of the climate facade can be improved by leading the exhaust air through a so called energy roof for pre-heating the air before passing through a heat recovery unit. Figure 16.

Double-skin facade

Manual control of the double-skin facade can result in less comfortable conditions in the working environment as well as the use of more energy. These conditions and the levels of energy consumption can be improved by the utilisation of a Building Management System for the control function of the double-skin facade.

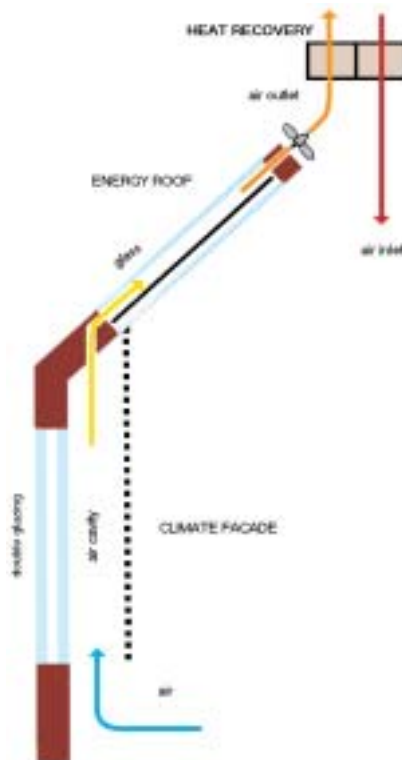


Fig 16 Integration of a climate facade and an energy roof. Drawing: Bouwjaar 98, Technische Universiteit Eindhoven, Faculteit Bouwkunde

The use of a Building Management System will optimise the use of the outdoor climate and the facade will become a more significant component of the energy management system, justifying the investment in this type of facade.

Alternatives, triple-skin facade

The ideal solution is to find a compromise, which combines the most effective elements of both ventilated facades, and this is achieved through the triple skin facade. Figure 17

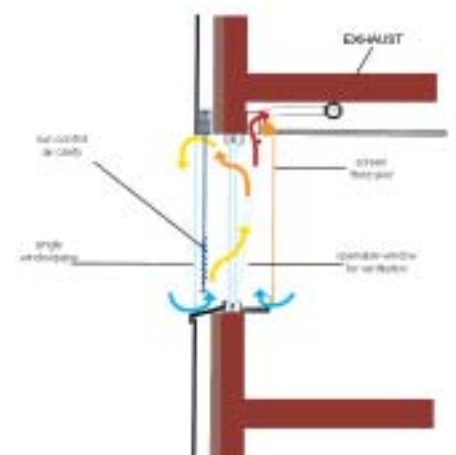


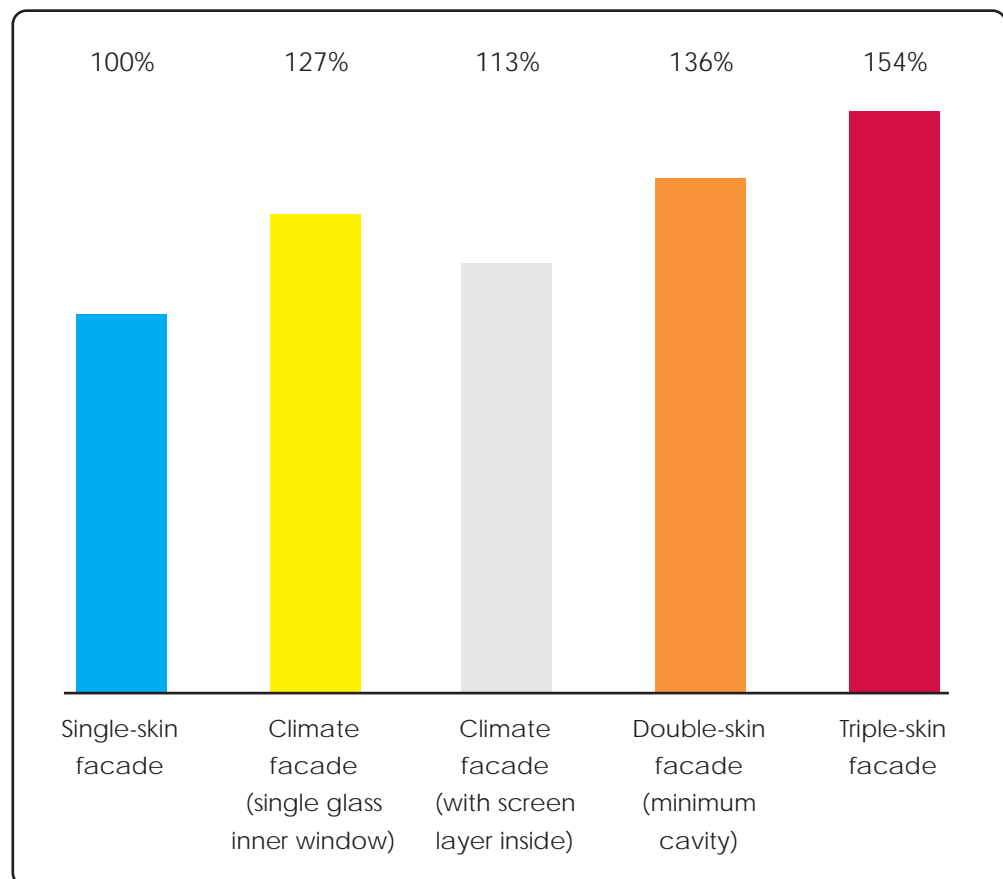
Fig 17 Cross-section of a triple skin facade.
Drawing: Facade en klimaat, dr. ing. J.L.M. Renckens

7. Cost Comparison



An estimate of the approximate cost comparisons for the different ventilated facades treated ahead compared with a single skin facade is detailed hereunder.

Cost recovery/benefit analyses already performed indicates that the costs for the application of a double-skin facade as opposed to a single skin facade can be recovered in less than 9 years.



Note: all facades with opening windows



8. Application Principles of Double-skin Facades

Comfort level

The application of a double-skin facade is primarily dependent upon the desired indoor working environmental conditions. Since the facade mainly utilises the outside air conditions, a certain fluctuation in indoor temperature must be accepted.

Situation

Double-skin facades are particularly effective when the following conditions exist:

- High rise buildings with natural ventilation,
- High traffic noise levels surrounding the building
- Re-developments.

Re-developments

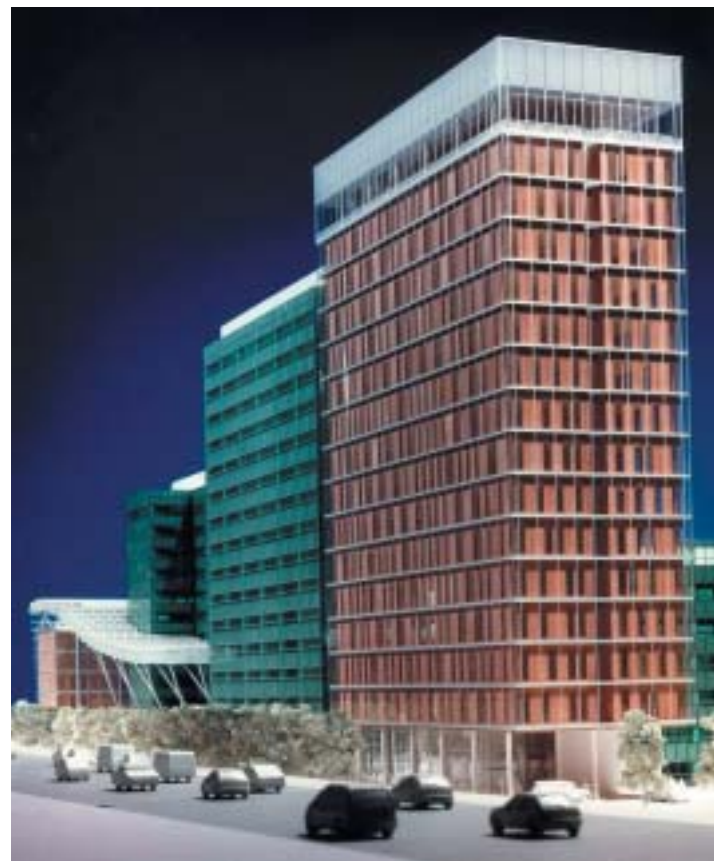
A positive benefit with regard to re-developments is that the original facade of the building is retained and this will increase the energy savings attainable. The use of double glazed instead of single glazed outer window may also be a preferred consideration under these circumstances.

Protection

A double-skin facade provides the following elements of building protection:

- Sound proofing/dampening of external traffic and other noises.
- Heat protection and shade.
- Weather proofing.
- Security protection against break-in and burglary, if windows are open.

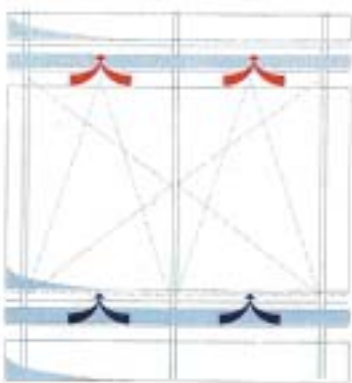
Fig 18 World Trade Center in Amsterdam. The choice of a double-skin facade is made because of the high traffic noise level coming from the nearby freeway, the demands of natural ventilation and no external blinds. Photo: BV Technical Management (TM)



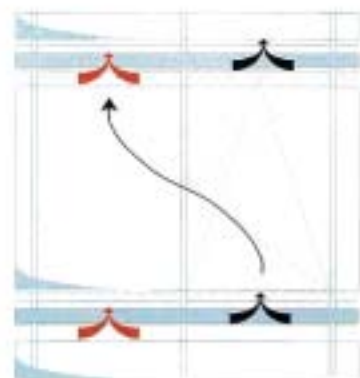
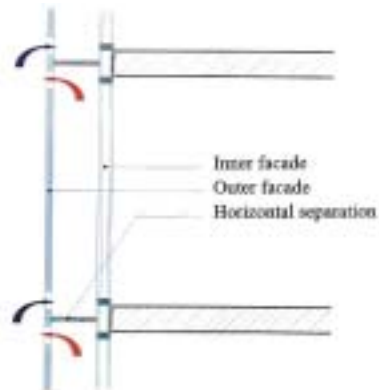


Ventilation of the cavity

Horizontal and/or vertical separations in the air cavity of the whole facade may also be necessary or desirable to prevent fire, noise and odour transmissions.



Box window



Corridor

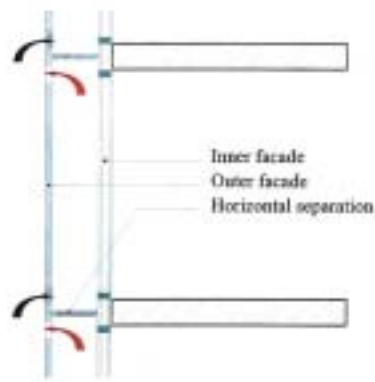


Fig 19 Ventilation methods
(Views and cross sections).
Drawing: Doppelschalige
Fassaden, Oesterle,
Lieb, Lutz, Heusler.



Various ventilation methods are illustrated in figures 19 and 20. Recirculation of air between the outlet and inlet openings must be avoided to prevent transfer and air quality reduction.

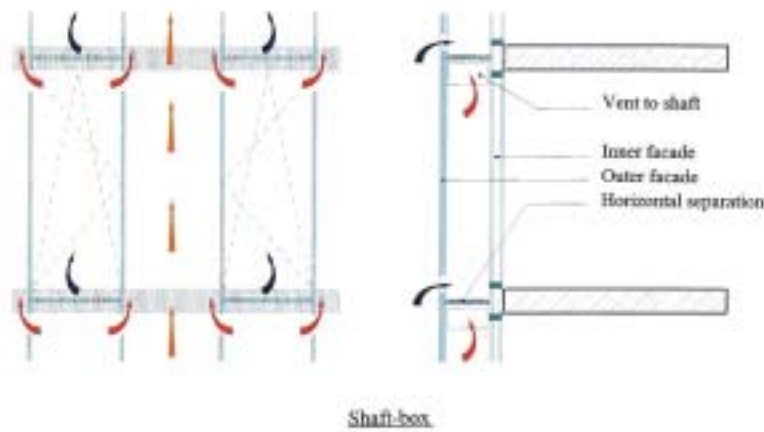
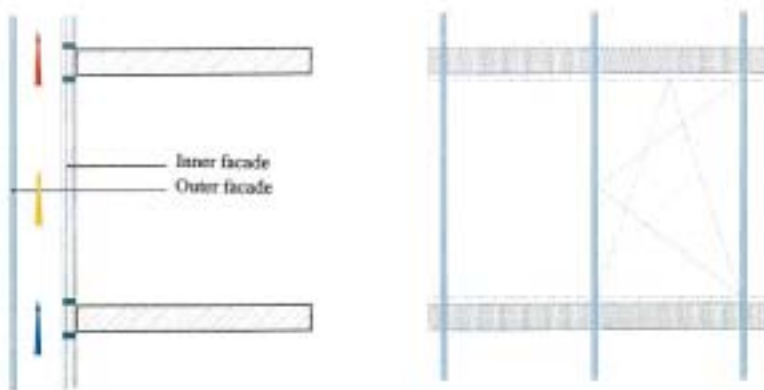


Fig 20 Ventilation methods (Views and cross sections). Drawing: Doppelschalige Fassaden, Oesterle, Lieb, Lutz, Heusler.



Multistory

9. Natural Ventilation with Double-skin Facades



Stack effect

It is possible to estimate the natural air change rate in rooms having a double-skin facade in moderated climatic conditions (low wind and no direct solar radiation) due to indoor/outdoor air temperature differences.

Sun influence

The air change rate in rooms having a double-skin facade is reduced when the facade together with the cavity are heated by the sun. To date, no definitive relationship has been established between the air change rate reduction and number of ventilation openings in the facade.

Windvelocity

The influence of wind velocity on the air change rate in a room with a double-skin facade has not yet been established. In order to do so, consideration must be given to the pressure differences surrounding the building, the floor height, the position of the room in the building as well as the airflow resistance of the building. One of the major influences to the air change rate in a room with a double-skin facade is caused by the position of the entrance, whether it is open or shut and the space beneath and around the door.

Modelling

Due to the lack of definitive, validated, mathematical models of air-change in a building, it is recommended that a full sized mock-up of the double-skin facade be constructed for each new project, in order to test its performance under real climatic conditions.



10. Door-opening Forces

Individual room door opening forces are another important factor to consider in the case of double-skin facades. Under normal circumstances, door-opening forces should not exceed 25 N (or 2,5 kg). Door-opening forces up to 40 N are only acceptable during a few

hours or for a few days per year. The door-opening force must never exceed 100 N (figure 21). Pressure compensation methods can lead to vulnerability in other areas, that is with regard to the spread of fire and noise transmission.

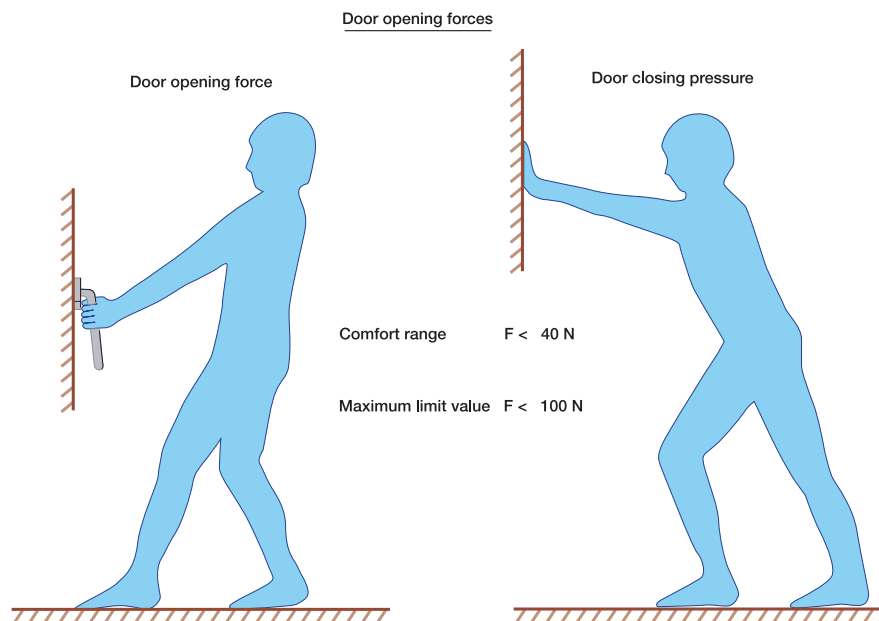


Fig 21 Door opening forces.
Drawing: HL-Technik

11. Sun-blinds and Daylight Control



In order to maintain efficient energy levels, sun-blinds and daylight facilities located in the air cavity require automatic controlling. Generally, occupants are able to manually over-rule these settings; although an automatic time dependent control is required to re-set the blinds if necessary.

The optimum position of the sunblinds in the air cavity of a double skin facade is at one third of the distance between the windows from the outer glasslayer.

The sunblinds in ventilated glass facades should be installed for the full width of the outer windowpane.

















Fig 24 Climate facade with sun-blinds installed in the cavity.

Photo: BV Technical Management (TM).



12. Conclusion

“Ventilated facades open up new possibilities for clients and planners seeking creative new designs that are intelligently adapted to environmental conditions. Up to now ventilated facades have been used mainly for large buildings. However, they can be used with equal success for smaller buildings as means of reducing the ingress of external noise and improving ventilation. This requires however the close synchronization of building type, physics and aerophysics”

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