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Ventilated Double Skin Façades

Classification & illustration of façade concepts

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(BBRI)

Contributed Report 03

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Acknowledgement

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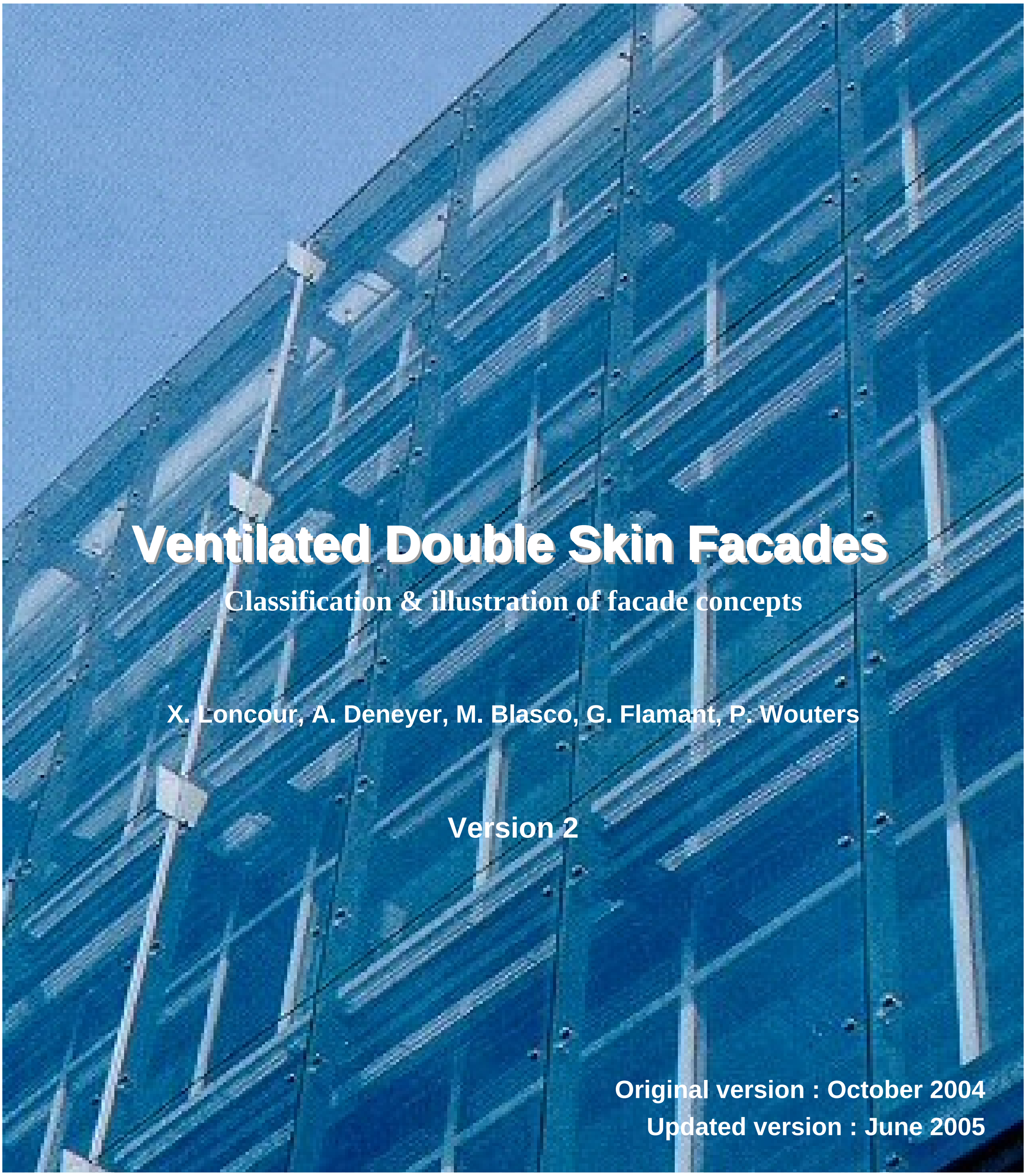

Ventilated Double Skin Facades

Classification & illustration of facade concepts

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Contents

Introduction

This document proposes a classification of the concepts of ventilated double facades, also referred to hereafter in this document as "VDF". The main classification adopted here (see Part 2) offers a coherent solution for unambiguously describing the various VDF concepts encountered in practice.

In order to integrate oneself into the international context, various classifications used in the literature were considered before developing this proposal.

A great deal of work was done in order to clarify the terminology associated with these facades. Numerous versions were discussed before arriving at this proposal, which forms the object of the broadest possible consensus among the many persons to whom it was submitted.

This document neither describes the performances of the facade concepts presented nor considers their technological aspects. These aspects are dealt with by other specific documents developed within the framework of the project mentioned below.

INTRODUCTORY COMMENT

This document was developed within the framework of the second biennial of the ´Ventilated Double Facades´ project financed by the Ministry of Economic Affairs in Belgium. Part 4 includes a portion of the document “Source book for a better understanding of conceptual and operational aspects of active facades” written within the framework of the first biennial of this project.

That source book has now been replaced by the present document. Indeed, as a result of the additional knowledge accumulated during the second biennial of this project, some parts of the above-mentioned document have become obsolete, and thus have not been included here. Only the relevant parts were integrated into the present document.

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Part 1 Definition of the Ventilated Double Facade concept

1.1 GENERAL DESCRIPTION OF THE VENTILATED DOUBLE FACADE CONCEPT

A ventilated double facade can be defined as a traditional single facade doubled inside or outside by a second, essentially glazed facade. Each of these two facades is commonly called a skin[1]. A ventilated cavity - having a width which can range from several centimetres at the narrowest to several metres for the widest accessible cavities - is located between these two skins.

There exist facade concepts where the ventilation of the cavity is controllable, by fans and/or openings, and other facade concepts where this ventilation is not controllable[2]. The indoor and outdoor skins are not necessarily airtight (see, for example, the « louver » type facades). Automated equipment, such as shading devices, motorised openings or fans, are most often integrated into the facade.

The main difference between a ventilated double facade and an airtight multiple glazing, whether or not integrating a shading device in the cavity separating the glazings (see Fig. 1), lies in the intentional and possibly controlled ventilation of the cavity of the VDF.

1.2 NORMATIVE REFERENCES

The European standard prEN 13119 :2004 ´Curtain walling – terminology´ defines the terms ´curtain walling´ and ´double-skin facade´ (see §2.2 on this subject).

The latter definition makes no mention of the ventilation of the cavity located between the two skins of the double-skin facade. Therefore the term ´double-skin facade´ cannot be used indiscriminately to designate all of the facades considered within the framework of this document.

For this reason, the terms ´Ventilated double facade´ or ´ventilated double-skin facade´ are proposed as a generic term designating all of the facades of this type.

1.3 AREA OF APPLICATION OF THIS DOCUMENT

Airtight multiple glazings like those described above are not regarded as ventilated double facades, and thus are not dealt with in this report.

In absolute terms, various facade concepts may be regarded as ventilated double facades, including:

- ventilated double facades whose two skins are parallel with one another

[1] Whence the widely-used name ´ventilated double-skin facade´

[2] The ventilation is produced in this case via fixed permanent ventilation openings.

- atrium-type spaces (see Fig. 2). According to the definition included in §1.1, an atrium could indeed be regarded as a VDF with a very large cavity.
- particular concepts of the « building in a building » type,

This report deals only with the first described case, i.e. ventilated double facades whose two skins are parallel with one another.

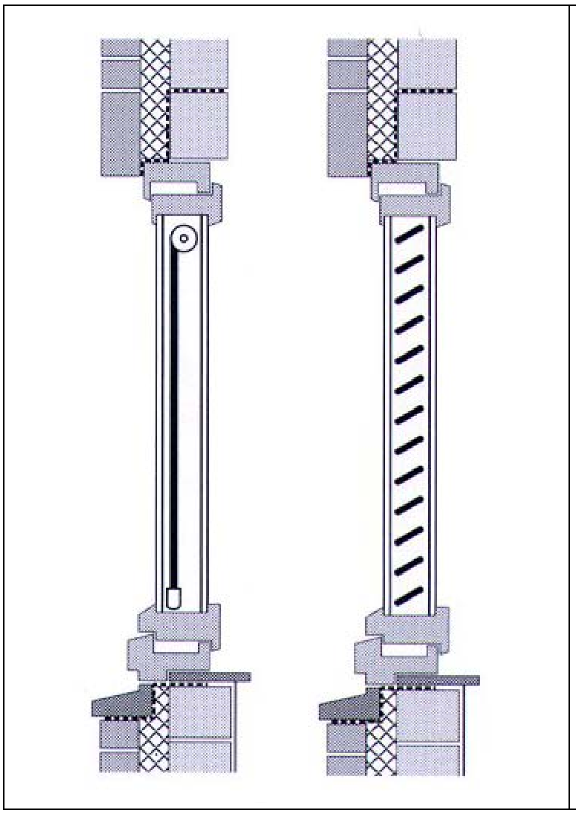


Fig. 1: Airtight double glazing integrating a shading device

Fig. 2: Example of an atrium

1.4 PRELIMINARY COMMENTS

1.4.1 DISTINCTION BETWEEN A FACADE AND A WINDOW

In practice one finds both ventilated double windows and ventilated double facades (see Fig. 3 and Fig. 4). A distinction must be made between these two types of components, essentially for structural reasons.

The European standards also clearly distinguish between these two types of components ; certain standards address themselves specifically to windows, while others address themselves only to facades.

Fig. 3: Example of a ventilated double window

Fig. 4: Mounting of a mechanically ventilated double facade - curtain facade element - active facade partitioned by storey with juxtaposed modules

The STS 52 (Technical Specification) [23] defines a **window** as: ´a component of the building intended to close a wall opening, permitting the passage of light and, possibly, ventilation.´

The document ISO/FDIS 6707-1 (2002) defines a **facade** as the exterior surface of a wall enclosing a building, usually nonloadbearing, which can include a curtain wall, cladding or other exterior finish.

This same document defines a **curtain facade** as a non-loadbearing wall positioned on the outside of a building and enclosing it.

1.4.2 CLARIFICATION ABOUT THE TERMINOLOGY USED

Unless explicitly mentioned, the term ´facade´ used in this report does not refer to the structural aspect.

In order to simplify the text, the terms ´ventilated double facades´ also cover the concepts of ventilated double windows, notwithstanding the observations made in §1.4.1. The distinction between these two terms (facade and window) is only made when a proper understanding of the text makes it imperative.

Unless explicitly mentioned, the term ´partitioning´ used in this document does not refer to the concept of partition as employed with regard to fire protection. The partitioning of the cavity instead refers to a physical delimitation of the dimensions of the cavity, without prejudging the ability of the walls delimiting this cavity to resist a fire.

Part 2 Classification of the Ventilated Double Facade concepts

There are many ventilated double facade concepts. However, a distinction must be made between all of the imaginable concepts (even if some offer little interest) and those facade concepts which are actually applied in practice.

Various terms are used to name these facades. Terms such as ´active facades´, ´passive facades´, ´double-skin facades´, ´climatic facades´ or ´multiple-skin facades´ are often used, while not always designating particularly well-defined concepts. They will be explained below. In addition, it should be noted that terms which might be regarded as generic are sometimes used in some countries to designate a quite specific facade concept. The facade manufacturers use their own terminology as well.

2.1 THE 3 MAIN CRITERIA FOR CLASSIFYING VDF´S

In the literature one finds many classifications of VDF´s. Most of these classifications are essentially based on the geometric characteristics of the facades. Their different modes of working are not always taken into account. The classification worked out here takes into account the modes of working of the facade and introduces three criteria which are independent of one another:

1. The type of ventilation ;
2. The partitioning of the facade ;
3. The modes of ventilation of the cavity.

2.1.1 FIRST CLASSIFICATORY CRITERION: THE TYPE OF VENTILATION

The type of ventilation refers to the driving forces at the origin of the ventilation of the cavity located between the two glazed facades. Each VDF concept is characterised by only a single type of ventilation. One must distinguish between the three following types of ventilation:

1. Natural ventilation ;
2. Mechanical ventilation ;
3. Hybrid ventilation.

The standard NBN EN 12792 defines **natural ventilation** as: « *ventilation (…) which relies on pressure differences without the aid of powered air movement components* ».

The two driving forces of natural ventilation are the differences in pressure created by the stack effect and by the effect of the wind.

Mechanical ventilation is defined in this same document as being the « ventilation with the aid of powered air movement components ».

> <u>Note: The stack effect</u>
>
> The stack effect (or chimney effect) is a phenomenon related to the rising of hot air which is lighter than cold air. Applied to a VDF, the concept of stack effect expresses the fact that the air of the cavity hotter than the outside air has a tendency to escape at the top of the cavity. An increase in the stack effect entails, all else remaining equal, an increase in the ventilation flow within the facade.

Hybrid ventilation lies in a controlled compromise between natural ventilation and mechanical ventilation. In general, in this type of ventilation, natural ventilation is used as far as possible. The mechanical ventilation is only triggered when the driving forces of natural ventilation become inadequate and no longer make it possible to achieve the desired performances. A control system permits the shift from one type of ventilation to the other in an automatic and controlled manner on the basis of a control algorithm. It should be noted that few ventilated double facades use this type of ventilation.

It is important to emphasise that the type of ventilation exerts, among other things, a considerable influence on the thermal performances of the facade and on its variability over time. Indeed, while it is possible to guarantee the performances of a mechanical ventilation system, this is not necessarily the case for natural ventilation because, essentially, the performances of natural ventilation vary over time as a function of meteorological conditions (wind and temperature difference).

2.1.2 SECOND CLASSIFICATORY CRITERION: THE PARTITIONING OF THE CAVITY

The partitioning[3] of the cavity tells us how the cavity situated between the two glazed facades is physically divided.

A first distinction must be made between windows and facades. On the one hand there are ventilated double windows (see Fig. 3), and on the other ventilated double facades (see Fig. 4).

Within the ventilated double facades, numerous possibilities of partitioning are imaginable and an additional classification can be created. One observes that the partitioning solutions implemented in practice can be classified as follows:

- Ventilated double window

[3] As explained earlier, this term "partitioning" does not refer to the concept of partition as defined with regard to fire prevention in the buildings, but instead refers to partitioning as used in ventilation.

- Ventilated double facade
  - partitioned by storey
    - with juxtaposed modules
    - corridor type,
  - ´shaft-box´ type
  - ´multi-storey´ type
  - multi-storey louver type

2.1.2.1 The ventilated double window

A facade equipped with a ventilated double window is characterised by a window doubled inside or outside by a single glazing or by a second window. From the partitioning perspective, it is thus a window which functions as a filling element in a wall (see Fig. 3 on page 7).

Some concepts of naturally ventilated double windows are also called ´Box-window´ in the literature.

2.1.2.2 The ventilated double facade partitioned by storey with juxtaposed modules

In this type of facade, the cavity is physically delimited (horizontally and vertically) by the module of the facade which imposes its dimensions on the cavity. The facade module has a height limited to one storey as illustrated in Fig. 5, which shows an inside view of a ventilated double facade.

Fig. 5: View of different juxtaposed modules

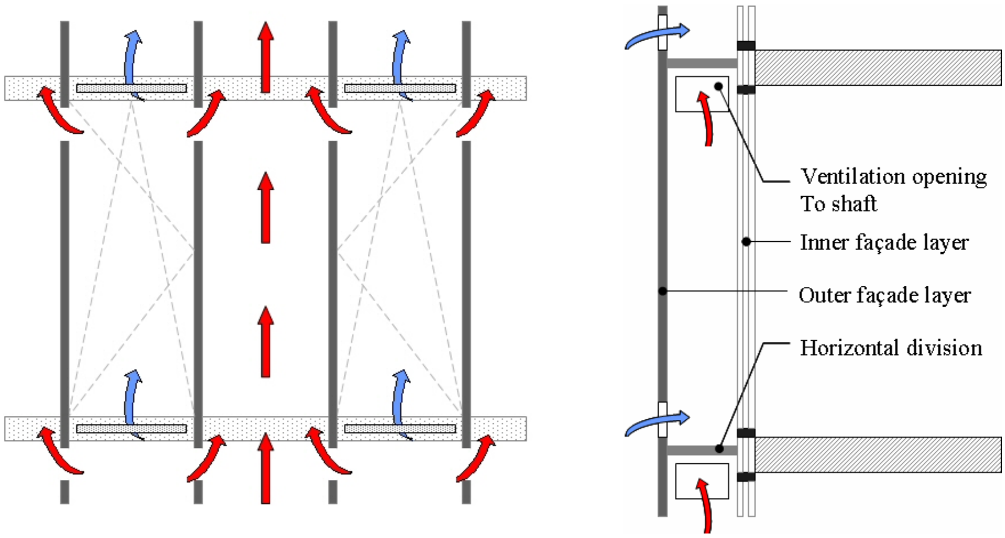
2.1.2.3 The corridor-type ventilated double facade partitioned by storey

´Corridor´ type ventilated double facades partitioned by storey are characterised by a large cavity in which it is generally possible to walk. While the cavity is physically partitioned at the level of each storey (the cavities of each storey are independent of one another), it is not limited vertically, and generally extends across several offices (Fig. 23a) or even an entire floor (Fig. 23b).

2.1.2.4 The ´Shaft-box´ ventilated double facade

The objective of this partitioning concept is to encourage natural ventilation by adapting the partitioning of the facade so as to create an increased stack effect (compared to the naturally ventilated facades which are partitioned by storey). Thus it is logical that this type of facade and partitioning is applied only in naturally ventilated double facades.

This type of facade is in fact composed of an alternation of juxtaposed facade modules partitioned by storey and vertical ventilation ducts set up in the cavity which extend over several floors. Each facade module is connected to one of these vertical ducts, which encourages the stack effect, thus supplying air via the facade modules. This air is naturally drawn into the ventilation duct and evacuated via the outlet located several floors above, as presented in Fig. 6, which represents a schematic view of the partitioning of this type of facade.



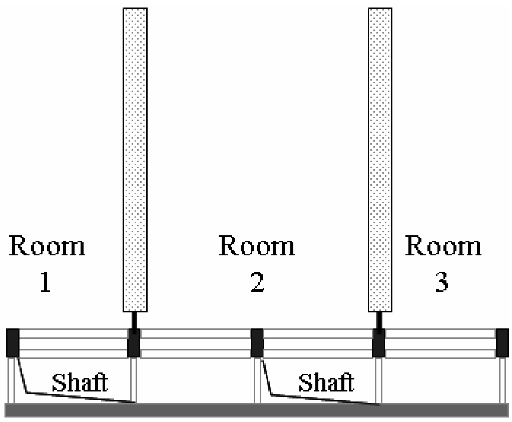


Fig. 6: Partitioning of a ´Shaft-Box´ VDF

Elevation view - Section view and plan view

2.1.2.5 The multi-storey ventilated double facade

Fig. 7: Multi-storey ventilated double facade

Multi-storey ventilated double facades are characterised by a cavity which is not partitioned either horizontally or vertically, the space between the two glazed facades therefore forming one large volume.

Generally, in this type of VDF, the cavity is wide enough to permit access to individuals (cleaning service, etc.) and floors which can be walked on are installed at the level of each storey in order to make it possible to access the cavity, primarily for reasons of cleaning and maintenance.

In some cases, the cavity can run all around the building without any partitioning. Generally, the facades with this type of partitioning are naturally ventilated ; however, there are examples of facades of this type which are mechanically ventilated.

It should be noted that the facades of this type generally have excellent acoustical performances with regard to outdoor noise. This characteristic can be the reason for applying this particular type of facade.

2.1.2.6 The multi-storey louver naturally ventilated double facade

The multi-storey louver naturally ventilated double facade is very similar to a multi-storey ventilated double facade. Indeed, its cavity is not partitioned either horizontally or vertically and therefore forms one large volume. Metal floors are installed at the level of each storey in order to allow access to it, essentially for reasons of cleaning and maintenance.

a. View of the louvers in horizontal position	b. View of the large cavity and the louvers in vertical position

Fig. 8: Ventilated double facade with louvers

The difference between this type of facade and the multi-storey facade lies in the fact that the outdoor facade is composed exclusively of pivoting louvers rather than a traditional monolithic facade equipped (or not) with openings. This outside facade is not airtight, even when the louvers have all been put in closed position, which justifies its separate classification. However, the problems encountered with these facades are generally comparable to those encountered in the other VDF´s.

2.1.3 THIRD CLASSIFICATORY CRITERION: THE VENTILATION MODES

2.1.3.1 The five ventilation modes

The ventilation mode refers to the origin and the destination of the air circulating in the ventilated cavity. The ventilation mode is independent of the type of ventilation applied (the first classificatory criterion presented).

Not all of the facades are capable of adopting all of the ventilation modes described here. At a given moment, a facade is characterised by only a single ventilation mode. However, a facade can adopt several ventilation modes at different moments, depending on whether or not certain components integrated into the facade permit it (for example, in the event of the presence of openings in the indoor and outdoor facades).

The different ventilation modes described here bear on the ventilation of the facades at the component level, not at the building level. One will consider for a facade module of which the air is extracted via the mechanical ventilation system of the building that the extracted air (at the component level) is transported towards the interior even if ultimately this air is rejected to the outside of the building rather than being circulated.

One must distinguish between the following 5 main ventilation modes (see Fig. 9):

1. Outdoor air curtain,

   In this ventilation mode, the air introduced into the cavity comes from the outside and is immediately rejected towards the outside. The ventilation of the cavity therefore forms an air curtain enveloping the outside facade.

2. 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. The ventilation of the cavity therefore forms an air curtain enveloping the indoor facade.

3. Air supply,

   The ventilation of the facade is created with outdoor air. This air is then brought to the inside of the room or into the ventilation system. The ventilation of the facade thus makes it possible to supply the building with air.

4. Air exhaust,

   The air comes from the inside of the room and is evacuated towards the outside. The ventilation of the facade thus makes it possible to evacuate the air from the building.

5. Buffer zone,

   This ventilation mode is distinctive inasmuch as each of the skins of the double facade is made airtight. The cavity thus forms a buffer zone between the inside and the outside, with no ventilation of the cavity being possible.

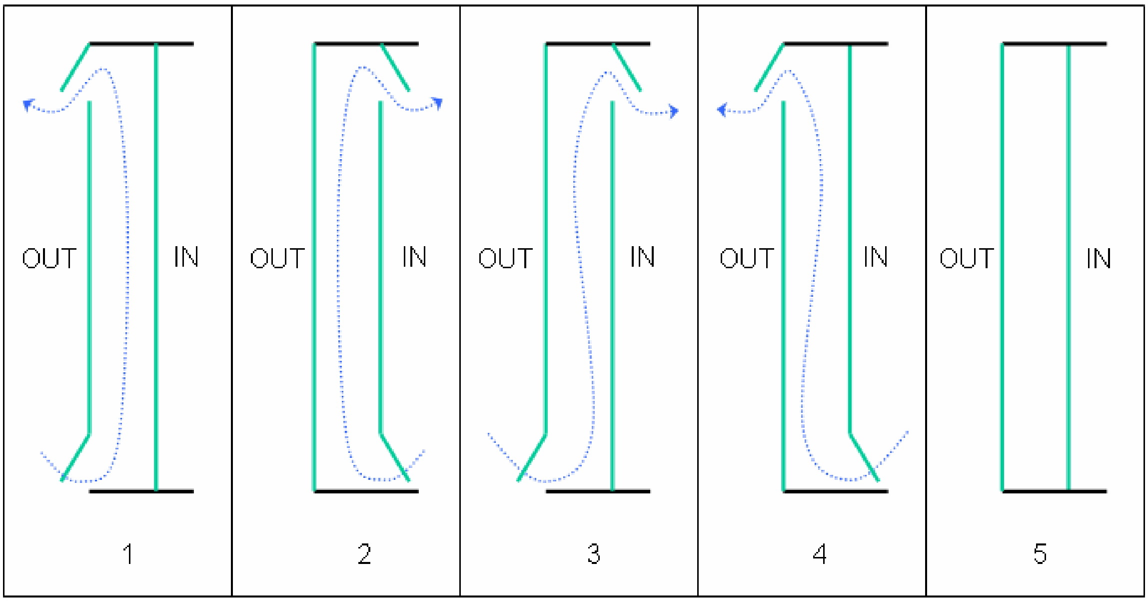


Fig. 9: The five main ventilation modes

Four variants are also possible by reversing the direction of the ventilation flow indicated above (see Fig. 10). The terminology associated with these variants is identical to that of the main modes described above.

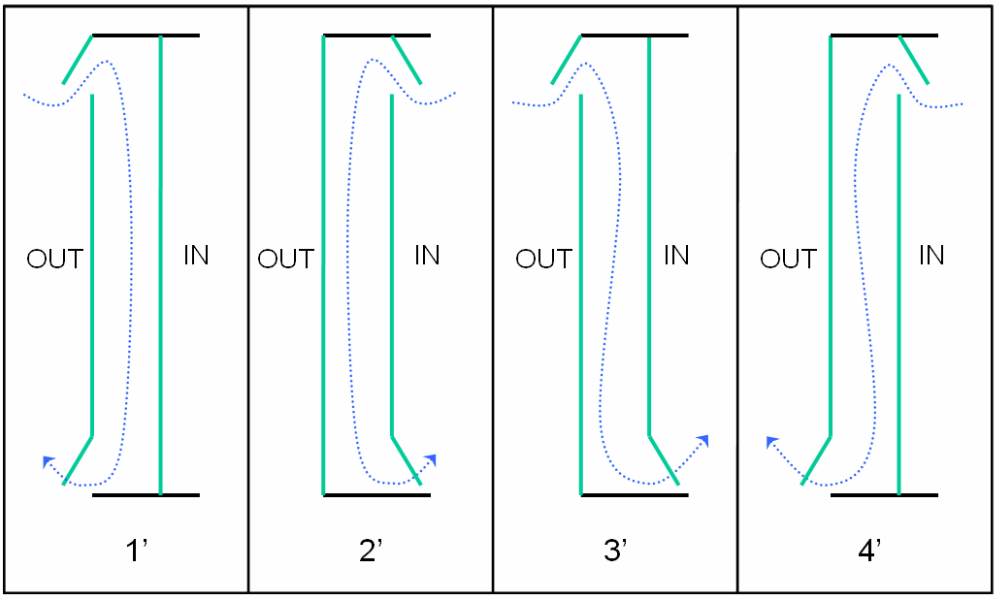


Fig. 10: Variants to the main ventilation modes

A last special ventilation mode only applicable to facade concepts integrating openings at the level of the indoor and outdoor skins at both the top and the base of the component is illustrated in Fig. 11.

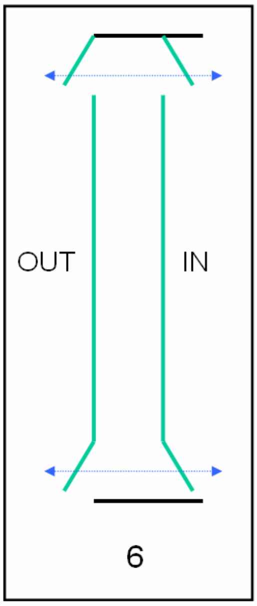


Fig. 11: Additional ventilation mode

2.1.3.2 Coexistence of several ventilation modes in a facade

Several ventilation modes can coexist within a single ventilated double facade. Generally, naturally ventilated double facades are those which present several ventilation modes, the shift from one ventilation mode to the other being done by motorised ventilation openings.

Fig. 12: example of motorised opening in a naturally ventilated double facade permitting the shift from one ventilation mode to another

The motorised openings as presented in Fig. 12 make it possible to shift from one ventilation mode to another as a function of their position (in this case, from a strategy of outdoor air curtain when the openings are open to a buffer zone strategy when they are in closed position).

In the case of naturally VDF´s, determining the precise mode of ventilation is not always self-evident. Indeed, when an opening is placed in open position, the ventilation phenomena which take place depend on the pressure conditions inside the cavity. The latter in turn depend on a multitude of factors, including the climatic conditions: speed and direction of the wind, temperature difference, sunshine, mode of working of the building´s mechanical ventilation system, opening of the inside doors, etc.

In general, mechanically ventilated double facades are not equipped with ventilation openings and most of the time are characterised by a single ventilation mode.

2.2 TERMINOLOGY

The standard prEN 13119 [22], specifying the terminology associated with curtain walls, gives a definition of curtain walling and of a ´double-skin facade´. These are defined as:

> *´Curtain walling: external building facade produced with framing made mainly of metal, timber or PVC-U, usually consisting of vertical and horizontal structural members, connected together and anchored to the supporting structure of the building, which provides, by itself or in conjunction with the building construction, all the normal functions of an external wall, but does not contribute to the load bearing characteristics of the building structure.´*
>
> *´Double-Skin Facade: 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.´*

This definition includes only references to the constructive and structural aspects of the facade. No reference is made to the ventilation of the cavity. Thus formally, the term "double-skin facade" does not designate a ventilated double facade. It is for this reason that the term ´Ventilated Double-Skin Facade´ is proposed as the generic term to designate these facades.

On the basis of the 3 criteria presented above, it is possible to characterise all VDF´s. However, some generic terms used to designate the VDF´s are based on only one of these criteria, the type of ventilation.

Thus, the term ´active´ facade can be interpreted as referring to the (active) mechanical strategy used to ventilate the VDF.

Type of ventilation	Name of the facade concept
Natural	Passive facade
Mechanical	Active facade
Hybrid	Interactive facade[4]

Table 1: Name of the VDF concepts according to the type of ventilation of the facade

Table 1 contains the commonly used names referring (only) to the type of ventilation and thus giving no indication about the partitioning of the facade or the ventilation modes.

In the literature, the VDF´s adopting the ´air supply´ ventilation mode are called ´airflow window´ or also ´ventilated window´.

The facades adopting the ´air exhaust´ ventilation mode are also called ´extract air´ or ´exhaust airflow´.

2.3 THE VARIOUS IMAGINABLE FACADE CONCEPTS

The classificatory criteria explained in section 2.1 can be combined amongst themselves so as to form all of the ventilated double facades concepts imaginable (on the basis of these criteria). These various combinations are illustrated in Fig. 13.

[4] Terminology coming from the company ‘Permasteelisa’

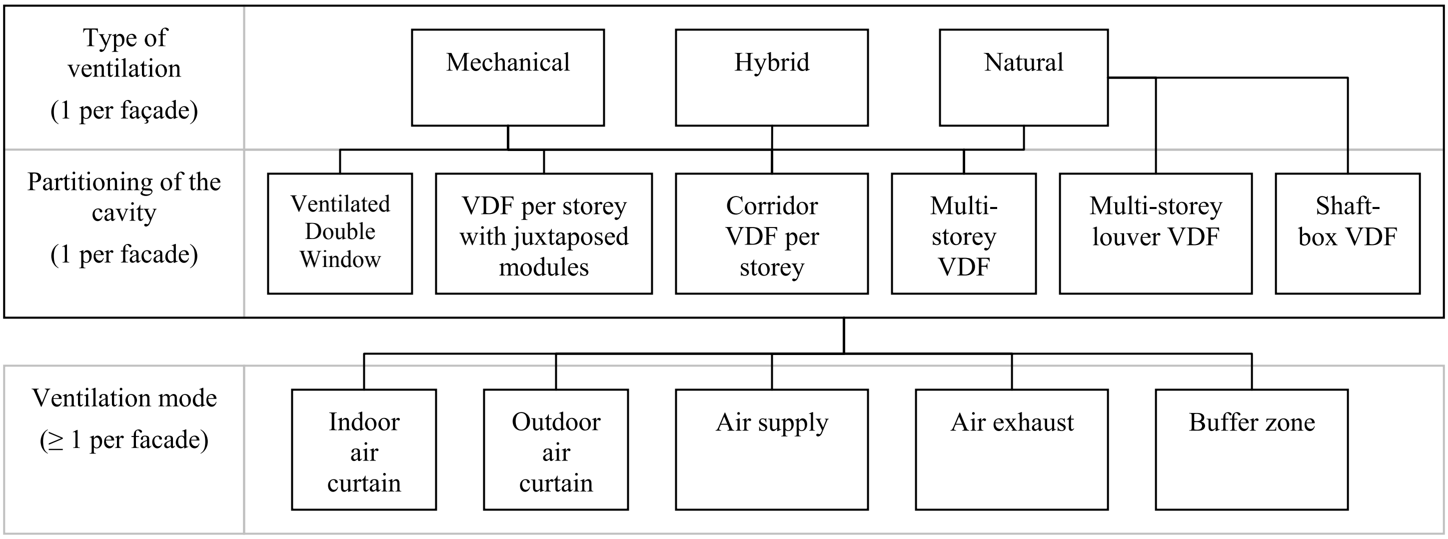


Fig. 13: Various concepts of ventilated double facades imaginable by combining the three classificatory criteria

Not all of these imaginable concepts are applied in practice. The concepts which are applied in practice are not applied in all climates. Indeed, most of the facade concepts are more specifically adapted to one particular type of climate.

Some partitionings of the cavity are applied only in naturally ventilated double facades. This is the case of shaft-box ventilated double facades or multi-storey louver facades.

Part 3 The main Ventilated Double Facade concepts implemented in practice

This chapter addresses the main VDF concepts which are applied in practice. It is important to bear in mind that, as explained earlier, not all of the facade concepts presented are adapted to all climates. It is also important to point out once again that the performances of the facade concepts presented are not described here, and that no judgement on the subject of their relevance is being formulated. Moreover, alongside the characteristics belonging to the VDF, the control strategies also play a determining role in the overall performances of the facade. This last aspect too is left out of consideration in this document.

Very often there exist numerous variants of facades around a given concept. Some of these variants are presented for illustration but, like the limited list of the concepts presented here, this presentation by no means aims to be exhaustive.

The examples of facades presented are classified in two major families:

- mechanically ventilated double facades ;
- naturally ventilated double facades.

3.1 MECHANICALLY VENTILATED DOUBLE FACADES

The mechanically ventilated facades, commonly called ´active facades´, are generally characterised by a single ventilation mode: the indoor air curtain. The facade is used to extract the air from the room with which it is in contact. The types of partitioning encountered in practice are essentially limited to double windows and to facades partitioned by storey with juxtaposed modules. Most of the mechanically ventilated double facades in Belgium are of this type.

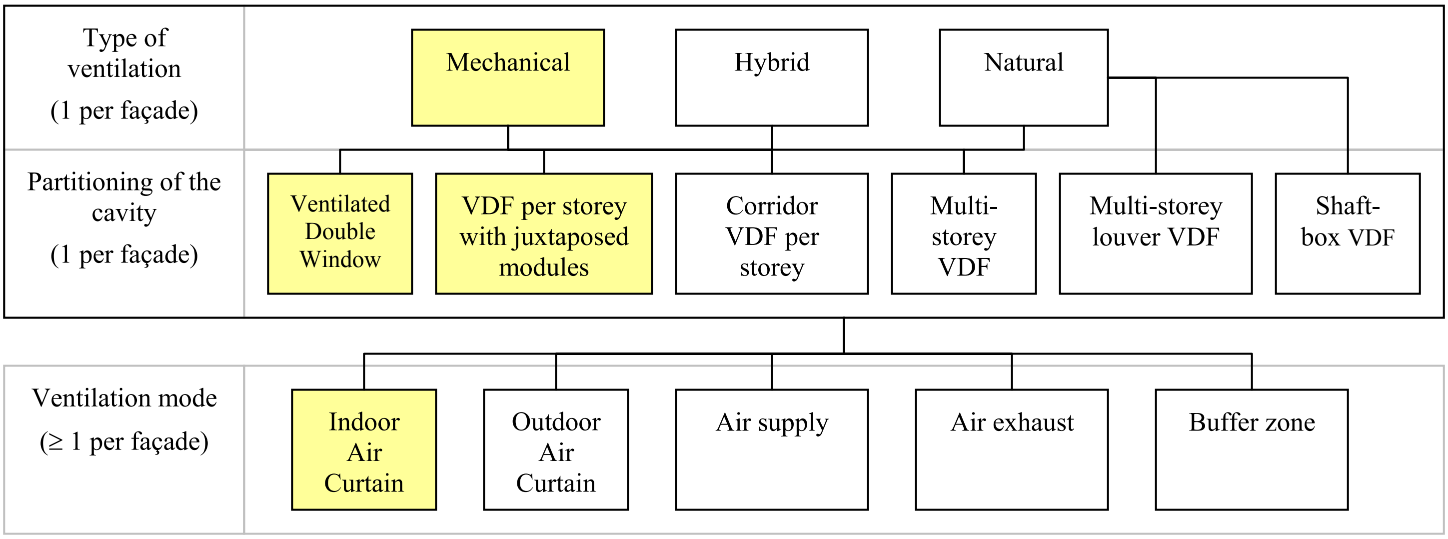


Fig. 14: Illustration of the main characterics of the mechanically ventilated double facades

3.1.1 CHARACTERISTICS OF THE VENTILATED DOUBLE WINDOW AND THE VENTILATED DOUBLE FACADE PARTITIONED BY STOREY WITH JUXTAPOSED MODULES

3.1.1.1 Common characteristics

If one studies the common characteristics of these VDF´s, it is important to look at the glazings, the cavity, the ventilation (its mode and its characteristics) as well as the working principle of this type of facade.

With respect to the **glazings**, a thermally-insulating double glazing is generally placed on the outside (it is important that this glazing has good thermal performances in order to prevent condensation phenomena inside the facade).

The indoor glazing is generally a reinforced single glazing which is closed most of the time and which is only opened for reasons of cleaning or maintenance.

The width of the **cavity** is typically on the order of 12 to 15 cm, i.e. the dimension necessary for integrating a shading device into it.

The two facade concepts are generally characterised by the same **ventilation mode** i.e. the indoor air curtain: the air inside of the room is extracted via the cavity of the ventilated double facade/window.

The cavity is generally ventilated from below to above. A slit of 12 to 15 mm is often created at the bottom of the indoor glazing in order to make it possible to feed air into the cavity. A flexible joint is generally located around the perimeter of the indoor glazing in order to extract the air by the facade only via the lower slit provided for this purpose. A ventilation plenum generally located at the top of the facade module makes it possible to uniformly extract the air from the cavity. This ventilation plenum is connected to the building´s ventilation system. The air flows extracted via the cavity are typically on the order of 30 to 50 m^3/h per running metre of facade. The air speeds within the facade amount to several cm per second.

Fig. 15: View of the ventilation plenum linking a facade module to the building´s ventilation system (to be connected)

The **working principle** of these 2 types of facades is identical: in case heat is needed in the room, the air (at room temperature) extracted via the facade makes it possible to maintain the temperature of the indoor glazing at a temperature close to the temperature of the room. This makes it possible to limit the problems linked to the radiation of the cold surfaces and to build facades which are fully glazed from floor to ceiling while limiting discomfort problems. These facade concepts do not require heating elements to be installed near the facade. The heating in buildings equipped with this type of facade is generally provided by the ventilation air of the rooms.

In case of high levels of direct sunshine, the shading device installed in the facade reduces the direct solar transmission. A large part of the incident energy is absorbed or reflected by the shading device. The ventilation air extracted by the cavity evacuates a part of the heat absorbed via the building´s ventilation system, the ventilation ducts being insulated in order to limit the re-emission of the extracted heat via the ventilation air elsewhere in the building.

All types of control of the motorised shading devices are applicable: manual control, automated control with possibility (or not) of derogation by the user, individual control of each shading device, control by group of shading devices, common control of all of the shading devices of a given orientation, by storey, by facade, etc.

As long as a heat recovery system has been installed, in the event that heat is needed, the new air can be (pre-)heated by the air extracted from the facade.

Fig. 16: View of installations combined with a mechanically ventilated double facade partitioned by storey with juxtaposed modules - View of the insulated supply ducts (in the upper right) - View of the insulated extraction ducts to be connected to the facade modules via the ventilation plenums located at the top of the facade elements - View of the cold beams

From the perspective of solar transmission, the performances of this type of facade are generally sufficient to make it possible for buildings equipped with facades of this type to use systems of cold ceilings or cold beams presenting limited cooling powers.

Compared to a traditional facade, it should be noted that this facade concept generally entails a limitation of heat losses through the outdoor insulating glazing. When meteorological conditions lend themselves to it, this can give rise to condensation phenomena of the outside air on the outside face of the facade, which can cause visual discomfort [16].

The indirect solar gains (relating to the heating of the indoor glazing) as well as the reduction of the heat losses through the facade can entail an increase in the energy consumption for cooling of the room in addition to the reduction of heating consumption. That is why it is not always wise to implement this concept on exclusively thermal bases.

3.1.1.2 Specific characteristics of the mechanically ventilated double window

This type of component is sometimes called a ´climatic window´, referring to its functioning similar to that of the ´climatic facade´ mentioned below (*see point 3.1.1.3*). It is characterised by a sizeable frame, thus limiting the surface area of the glazing (in comparison to the climatic facade). Although this limitation of the glazing surface area entails a reduction in the availability of daylight, the ventilated double window generally offers acoustical performances which are greater than those of fully glazed facades ([17]).

In addition, the limited height of the facade element makes it possible, in the event of significant sunshine, to limit the temperature within the cavity, which generally does not attain excessively high values.

Fig. 17: Interior view of a mechanically ventilated double window – indoor air curtain ventilation mode

3.1.1.3 Specific characteristics of ventilated double facades partitioned by storey with juxtaposed modules

This type of facade is sometimes called a ´climatic facade´. However, this term produces confusion because it does not explicitly designate the facade concept that it covers. That is why we are trying to limit its use.

With regard to its structure and principle, the ventilated double facade is explained in point 3.1.1.1. However one should add that facades of this type are very largely or even totally glazed, which has a major impact on the availability of daylighting in the building.

The glazed surface areas installed being greater, it is important to devote particular attention to the fixation of the indoor glazing and to its opening (fixation of the hinges, space taken up, etc.)

Fig. 18: Mechanically ventilated double facade (active facade) partitioned by storey with juxtaposed module - indoor air curtain ventilation mode

3.1.1.4 Other examples of mechanically ventilated double facades partitioned by storey

The examples of ventilated double facade presented in the preceding sections can have numerous variants.

In practice one can find very similar facade concepts where the cavity is ventilated from above to below (ventilation mode 2´ of Fig. 10 on page 14). Other variants can play on the width of the cavity, which can also be greater than the several centimetres mentioned in the preceding examples (see Fig. 19).

Fig. 19: View of a large cavity of a mechanically ventilated double facade partitioned by storey

Other facade concepts function according to a similar principle: these are the traditional single facades equipped with interior shading devices permeable to the air. In this type of facade, the heat absorbed by the shading device is theoretically evacuated via the ventilation air crossing the shading device. This air is, following the example of the other concepts of this type, evacuated at the top of the facade element via the building´s ventilation system. It should be noted that this type of facade is in fact rarely applied in practice.

3.2 NATURALLY VENTILATED DOUBLE FACADES

The naturally ventilated facades, commonly called ´passive facades´, are also often designated by the general term ´double-skin facade´. As for the so-called ´active´ facades, this term is a source of confusion because in principle it can apply to all VDF´s, naturally ventilated or not, all of which are, in one way or another, characterised by two skins. We will thus avoid the use of this term within the framework of this report.

The various existing naturally VDF concepts are quite numerous, and each presents its own particularities. The large number of existing concepts is explained, inter alia, by the fact that the facades of this type can frequently adopt several ventilation modes, thus sharply increasing the combination possibilities.

The naturally VDF´s can be classified in two major categories:

- the facades whose ventilation of the cavity is not controllable (see example in Fig. 23a on page 28)
- the facades whose ventilation is controllable (see Fig. 23b).

The facades whose ventilation is controllable are characterised by the presence of openings, boxes or similar systems permitting controlled ventilation. In general, it is the activation of these openings which entails the shift from one ventilation mode to another.

While the number of facades of this type implemented in Belgium is relatively low, that is not true in Germany, Scandinavia or Switzerland, where this type of facade is more widespread.

One of the characteristics of naturally ventilated facades is that they generally make it possible to naturally ventilate offices. This particular characteristic is a large part of the reason why this type of facade is so successful in these countries.

Because the indoor air can be transported to the outside via the facade, intentionally or as a result of air leaks, particular attention must be devoted to the potential problems of condensation of this indoor air within the facade [16].

One way or another, naturally ventilated double facades are in contact with the outside and one does not find the « indoor air curtain » ventilation mode.

In contrast to mechanically ventilated facades, the natural ventilation of the cavity is intrinsically characterised by variable performances linked to the meteorological conditions (wind and temperature difference). These variable performances significantly complicate the design of the facade as well as the estimation of the thermal or ventilation performances of facades of this type.

These facades are characterised by a natural cavity temperature self-regulation mechanism. Thus, an increase in the air temperature of the cavity located between the two glazed facades, as a result (for example) of strong sunshine, will entail an increase in the stack effect within the facade. This greater stack effect in turn entails greater air flows which thus limit the temperature attained within the facade. The temperatures which can be attained within the cavities, in particular in the case of facades whose cavity extends over several floors, sometimes being quite high, one must take this into account when choosing the glazings and the dimensioning of the building´s cooling systems.

Specific attention must also be devoted to the phenomena of soiling and maintenance with respect to facades ventilated with outside air. These problems are also posed, but generally in a more limited way, when the ventilation is done with indoor air [16], [18].

Because the inside of the building can be in indirect contact with the outside via the facade, a problem specific to the facades of this type is posed ; i.e. control of the pressure conditions inside the building and in the facade. Some naturally VDF are installed on tall buildings and, because the wind speeds can be significant at certain heights, one must correctly design this type of facade so as to control the pressure conditions inside the building (among other things, it is important to avoid that it becomes difficult to open the interior doors of the building due to inadequately controlled pressure differences, etc.) [16].

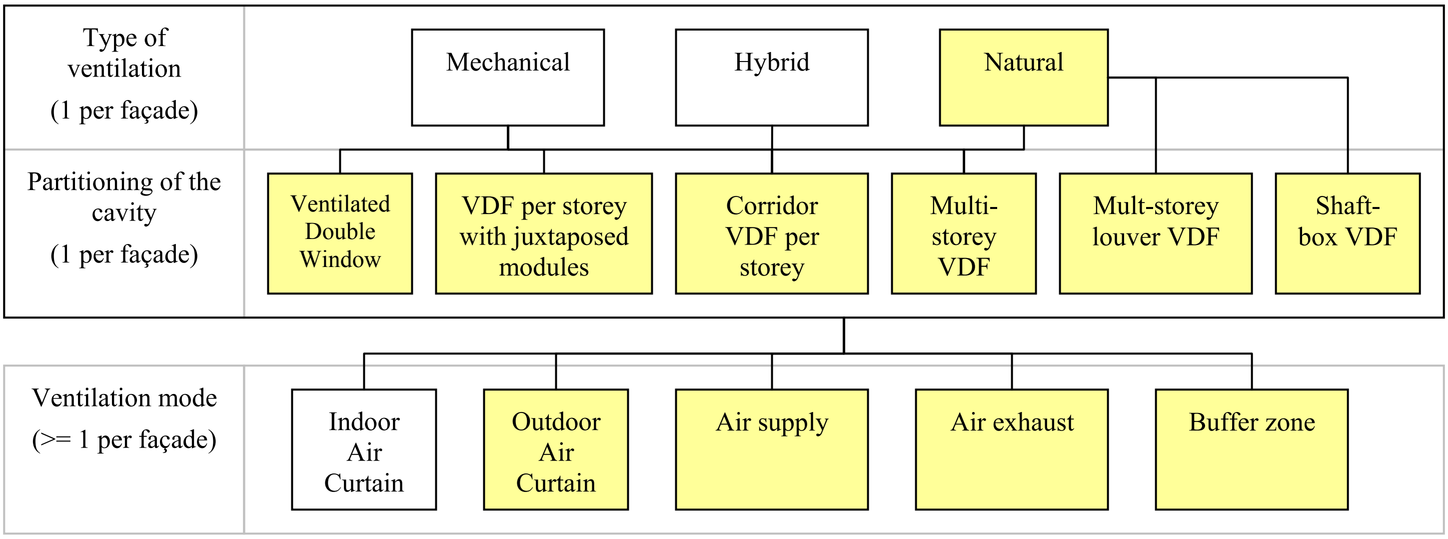


Fig. 20: Illustration of the main characteristics of naturally ventilated double facades

Although the dimensioning can take into account the specific climatic conditions of the place where the naturally VDF is installed, one should emphasise that they are particularly well-suited to climates where a substantial stack effect can be expected, i.e. in cold or temperate climates. Facades whose performances depend primarily on stack effect are generally not well suited to hot climates, due to the fact that this stack effect is logically more limited than in colder climates.

Often, these facades also make it possible to adopt the so-called ´buffer zone´ ventilation mode where no ventilation is possible any longer. However, from the thermal point of view, this ventilation mode is essentially interesting when the outdoor climatic conditions are harsh.

As for mechanical ventilation, we will distinguish in the case of natural ventilation between double windows and double facades.

3.2.1 NATURALLY VENTILATED DOUBLE WINDOWS

This type of facade, in the literature called ´Box window´, is generally installed in tall buildings in order to permit the use of outdoor shading devices (see below).

Naturally ventilated double windows are composed of a traditional window doubled on the outside with a second window. The indoor glazing is a double insulating glazing while the outdoor glazing is generally composed of a reinforced single glazing. A motorised shading device is integrated into the cavity whose width is limited to the space necessary for its proper integration. The inside window can generally be opened, which allows the offices to be naturally ventilated.

In the example presented in Fig. 21, the ventilation of the cavity is not controllable. Permanent non-closable slits are created below and above the outdoor glazing, the ventilation mode by default therefore being the outdoor air curtain. When the inside window is open, the air flows between the outside and the room are either of the air supply or the air exhaust ventilation mode, depending on the pressure conditions.

Fig. 21: View of a naturally ventilated double window presenting the outdoor air curtain, air supply and air exhaust ventilation modes

Because the height of the cavity is limited, the heating as well as the stack effect within the cavity are also limited, which can have an impact on the proper ventilation of the cavity. This finding is at the origin of the development of alternative facade concepts.

Like traditional windows, one finds heating elements near the facade because the ventilation of the cavity being done with potentially cold outdoor air, the inside temperature of the indoor glazing is likely to entail problems relating to the cold surfaces (radiation / condensation / etc.).

One finds naturally ventilated double facades partitioned by storey with juxtaposed modules based on the same concept as that presented here. However, this particular type of facade is not described in detail here.

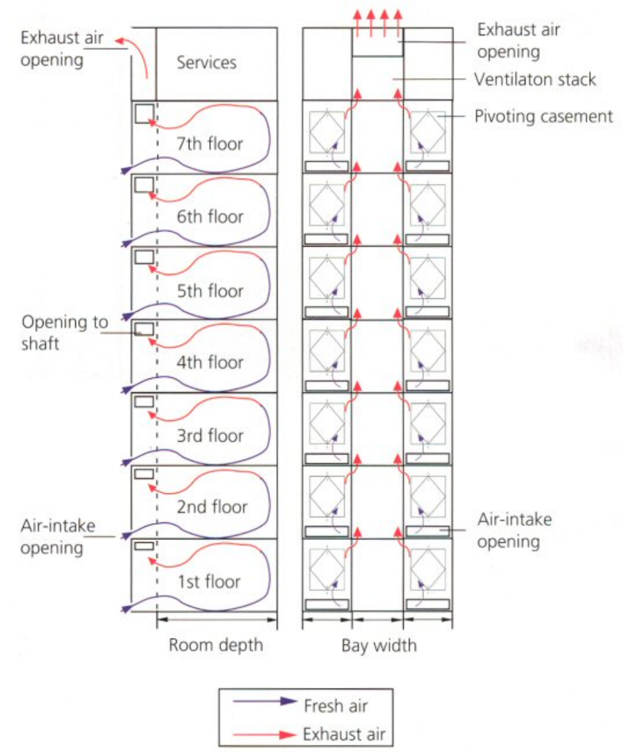
3.2.2 NATURALLY VENTILATED DOUBLE FACADES

There are several types of naturally Ventilated Double Facades. Here we will examine:

- The shaft-box naturally VDF´s;
- the corridor-type naturally VDF´s partitioned by storey ;
- the multi-storey naturally VDF´s ;
- the multi-storey louver naturally VDF´s.

3.2.2.1 Shaft-box naturally ventilated double facades

This concept as well as its mode of working were largely presented in §2.1.2.4. Fig. 22 below includes an example of this type of facade.



a. Ventilation concept at the level of the facade

b. View of the facade and the vertical ventilation ducts - alternation of the facade elements partitioned by storey with juxtaposed module and vertical ventilation ducts

Fig. 22: ´Shaft-box´ ventilated double facade

3.2.2.2 Corridor-type naturally ventilated double facades partitioned by storey

The partitioning of facades of this type was described in §2.1.2.3 on page 10. The cavity forming a corridor can extend across several rooms (Fig. 23a) or even sometimes over an entire storey without any vertical partitioning (Fig. 23b). In this type of facade, one also distinguishes between facades where there is an uncontrollable ventilation and facades where the ventilation of the cavity is controllable.

In the case of Fig. 23b where control of the ventilation is possible via ventilation boxes placed above and/or below, several ventilation modes are possible. These include:

- the outdoor air curtain when the ventilation boxes are open and the indoor glazings are closed;
- air supply and exhaust when the boxes and the indoor glazings are simultaneously open;
- buffer zone when the boxes and the indoor glazings are simultaneously closed.

	
a. cavity extending across several rooms - ventilation not controllable via permanent ventilation openings	**b. cavity extending over a whole storey – ventilation controllable by means of ventilation boxes**

Fig. 23: Corridor-type ventilated double facade partitioned by storey

3.2.2.3 Multi-storey naturally ventilated double facades

These facades are generally characterised by at least two ventilation modes, i.e. the outdoor air curtain and buffer zone.

In this type of facade, it is generally not possible to open the indoor glazings. The cavity located between the two glazings is accessed via sites specifically provided for this purpose, essentially "access doors" to the cavity.

The working mode in ‘buffer zone’ is particularly indicated for thermal reasons when an increased thermal insulation of the double facade is required. This case is present inter alia in winter in countries with cold or harsh climates.

The very good acoustical performances of these facades can also justify their application [17].

The appearance of the facade, fully glazed from top to bottom, is also sometimes one of the reasons for choosing to implement this type of facade. Generally, the facades of this type require a double structure and pose questions and problems from the perspective of fire protection.

Fig. 24: Multi-storey naturally ventilated double facade

3.2.2.4 Multi-storey louver naturally ventilated double facades

As explained in point 2.1.2.6, the multi-storey louver naturally VDF´s can be, for many aspects, assimilated to a multi-storey facade whose outdoor skin is not airtight.

However, questions very specific to these facades, relating to the rotation of the louvers, notably with regard to the availability of daylight, are posed [19]. The aspects of stability [20] and fire protection [21] must also be carefully controlled in facades of this type.

a. View of the louvers in horizontal position

b. View of the outdoor facade with some louvers tilted

Fig. 25: Ventilated double facade with louvers

Part 4 Additional classificatory criteria for Ventilated Double Facades

This part consists of the document "Source book for a better understanding of conceptual and operational aspects of ventilated double facades" drafted during the first biennial of the ´Ventilated Double Facades´ project.

This text was updated when the present document was drafted (inter alia with respect to the terminology employed).

The earlier versions of the source book are replaced by this document.

4.1 INTRODUCTION

A complementary classification system with three different levels has been developed. It can help to highlight some choices that have to be made when selecting a given façade concept:

1. General and technical information about the façades and the building;
2. Invariable characteristics of the façade and the building;
3. Variable characteristics of the façade and the building.

The **Invariable characteristics** are descriptive elements that stay invariable whatever the season or the building uses. These concepts can be deduced from the plans of the façade i.e. no knowledge of the use of the building is necessary to classify the façade. Each façade gets only one classification for each concept.

The **Variable characteristics** make a distinction depending on the external/internal environmental conditions and the use of the building during different periods of time. Also knowledge of the systems scheme and performance is here necessary to classify the façade. A façade can have a time dependent classification system.

4.1.1 GENERAL AND TECHNICAL INFORMATION ABOUT THE FAÇADES AND THE BUILDING

We summarise first some information about the façade and the building. This information does not form directly part of classification system but it is needed to understand the interaction between façade, HVAC-systems and building better.

4.1.2 INVARIABLE CHARACTERISTICS

The following supplementary characteristics can be considered as independent of the external/internal conditions:

I1. Criteria n°1 - New Building or Retrofitting

I2. Criteria n°2 - Level of industrialisation

I3. Criteria n°3 - Air tightness of the two-layered façades

I4. Criteria n°4 - Physical connection between cavity and HVAC system

I5. Criteria n°5 - Width of the air cavity

I6. Criteria n°6 - Layer characteristics

I7. Criteria n°7 - Solar and visual shading device

I8. Criteria n°8 - Presence of active cooling system

I9. Criteria n°9 - Presence of heating elements near façade

4.1.3 VARIABLE CHARACTERISTICS

The next elements are described in order to characterize the way the façade is working in function of different operating conditions:

V1. Type of Ventilation of the air cavity

V2. Opening of the openable parts of the two-layered façade

V3. Applied Ventilation mode

The next operating conditions can be considered:

Outside	Inside
▪ Winter / Summer ▪ Day / Night ▪ Wind / No wind ▪ Sun/No sun ▪ etc...	▪ Low/High temperature, ▪ Low/High relative humidity, ▪ Light requirements (tasks, daylight-electric, glare,…) ▪ etc…

table 1 : possible parameters for classification of variable characteristics

All these elements may influence the working conditions (opening of window, position of the solar shading, increased airflow, etc…) of the façade.

4.2 GENERAL AND TECHNICAL INFORMATION ABOUT THE FAÇADE – MOTIVATIONS FOR CHOOSING THIS FAÇADE

If the classification is applied on a specific façade and building and if the information has to be used by other persons, it may be appropriate to include additional general information about both façade and building.

4.2.1 GENERAL AND TECHNICAL INFORMATION ABOUT FAÇADE AND BUILDING

An overview of important information about the building is given in this section. At this stage, this information is not used to classify the façade concepts.

The following information about the building can be considered:

1. Organisations involved in the design and construction phases

   Different construction partners can be involved at the design and construction phases of the building and façades: owner, tenants, architects, consultant, major suppliers, main contractor, façade contractor, installers, maintenance companies…

2. Function of the building during the occupation phase

   Who will be occupying the building? 1 user, several users, multiple functions, rented building or used by owner, etc…

3. Construction year

   The construction year and/or year of the main retrofitting works.

4. Overall building geometry

   Information about the building geometry can be given height, major sizes, volume, number of floors, compactness…

   For example, the height of the building can have an important impact on the choice of the ventilation strategy and the air space of the façade.

5. Local environment of the building

   The environment of the building can also impose some conceptual choices. A building situated in the city centre will not have the same requirements in terms of acoustical performances compared with a building situated in the country side. The environmental conditions also influence the possibility of natural ventilation. Natural ventilation is not obvious in a dirty and noisy environment.

Class	*Description*
1	Calm environment – residential area – country side
2	Urban residential area
3	Light industries – commercial and residential area
4	City centre – area with heavy industries

The categories presented in the table correspond to the four choices existing in the Belgian standard NBN S01-401 (1987).

The outdoor climate plays an important role in the choice of a ventilated double façade and can explain why some concepts are not applied.

The following information can be useful: temperature, solar radiation, wind, ...

6. Façade concept

   In this section, the façade concept is briefly described with some pictures, cross sections,…

7. HVAC concept

   Some explanations on the HVAC concept are given (type of system, heat recover, …) with some pictures and drawings, …

8. Other relevant information

4.2.2 MOTIVATIONS FOR CHOOSING THE VENTILATED DOUBLE FACADE AND ATTENTION POINTS – CHECK-LIST

The next table summarizes the order of priority of the different elements taken into account at the design level of the façade. This table can be completed for each project. The designers (architect – study bureau – others) may have different priorities. Different actors of the design process could complete such a table.

	Criteria	High priority	Medium priority	Low priority	Not relevant
Architecture	Highly glazed façade	☐	☐	☐	☐
	High-tech image	☐	☐	☐	☐
	Increase of the space use	☐	☐	☐	☐
Thermal Comfort	During heating season	☐	☐	☐	☐
	During cooling season	☐	☐	☐	☐
Acoustics	High acoustic performance relatively to the outdoor noise	☐	☐	☐	☐
	Attention paid to the potential flanking problems	☐	☐	☐	☐
Visual comfort	Glare control	☐	☐	☐	☐
	Privacy reasons	☐	☐	☐	☐
Energy consumption	Limiting heating consumption	☐	☐	☐	☐
	Limiting cooling consumption	☐	☐	☐	☐
Ventilation	Realizing natural ventilation of the offices	☐	☐	☐	☐
	Realizing night cooling of the offices	☐	☐	☐	☐
Systems	Avoiding a full air-conditioning system	☐	☐	☐	☐
	Avoiding heating element in offices	☐	☐	☐	☐
	Possibility to use the solar shading in nearly all meteorological conditions	☐	☐	☐	☐
Maintenance	Limiting maintenance of the solar shading	☐	☐	☐	☐
	Limiting maintenance of the cooling system	☐	☐	☐	☐
Users	Need to give the user control on the system (solar shading, etc…)	☐	☐	☐	☐
	Possibility to open the windows – contact with the exterior	☐	☐	☐	☐
Other	Green image – low consumption building	☐	☐	☐	☐

4.3 INVARIABLE CHARACTERISTICS

4.3.1 CRITERIA N°1 - NEW BUILDING OR RETROFITTING

- ***Purpose of this concept***

  In case of a new building, one has in principle an "unlimited" freedom in the concept of the façade and the level of integration with the building and the HVAC system. In the case of retrofitting of existing facades, there might be restrictions for optimising the integration between the ventilated double façade, the building and the HVAC systems.

- ***Classes***

Class	*Description*	*Comments/Examples*
1	New building	ING House
2	Complete retrofitting of building and installations	Berlaymont
3	Total new facade, original installations maintained	
4	Upgrading of existing façade	

- ***Examples***

Fig. 26: New building : ING house (Zuidas)

Fig. 27: Complete retrofitting of an existing building : Berlaymont (Brussels)

4.3.2 CRITERIA N°2 - LEVEL OF INDUSTRIALISATION

- ***Purpose of this concept***

  Some fully industrialised systems of ventilated double façade exist. All the components of the façade are assembled in the factory and the whole panellised unit is attached to the building. Such elements can be used in new projects without major modifications and without a lot of on-site assembly.

  On the other hand, bespoke solutions are sometimes developed for specific projects with complicated geometrical shapes or for other reasons.

- ***Classes***

Class	*Description*	*Comments/Examples*
1	Project specific, bespoke façade element assembled on site	Aula Magna
2	Application of industrial integrated concept (slightly adapted to the specific project)	Victoria

- ***Examples***

Fig. 28: Project specific façade elements

Aula Magna (Louvain-la-neuve)

Fig. 29: Industrial integrated concept

Victoria building (Düsseldorf)

4.3.3 CRITERIA N°3 - AIR TIGHTNESS OF THE TWO-LAYERED FAÇADES

- ***Purpose of the concept***

  In this section the façades are classified according to the air tightness of both the inside and outside skin of the façade. This air tightness influences the possibilities for natural ventilation.

- ***Classes***

  The next table gives the different categories with an example and explanation of each combination.

	Classes	*Indoor façade*	*Outdoor façade*
1.	**Airtight** cannot be opened even not for maintenance reasons	Some multi-storeys façades Ex : AULA MAGNA	Climate façade / Climate window systems Ex : UCB headquarters , Greensquare, Galilee, etc…
2a.	**Possibility to be airtighted** can be opened by the user and for maintenance reasons	• Naturally ventilated double-skin façades (box-window – corridor façades – shaft box – multi-storey) Ex : Düsseldorf City Gate • Louver facade	Naturally ventilated double-skin façade (Corridor façade – multi-storey façades) Ex : CNP
2b.	**Possibility to be airtighted** can be opened only for maintenance reasons	Some climate façades Ex : DVV building	Ex : Brussimo
3.	**Not airtight** (cannot be tightened)	• Classic Climate façades • Indoor façade constituted by permeable solar control Ex : Mercator	• Naturally ventilated double-skin façade (some building equipped with 'box window' façades) Ex : Commerzbank • Louver façade Ex : Debis building

Some façade systems allow to simultaneously open the two façade layers. The whole façade element is moved in order to provide natural ventilation; this kind of system is mainly encountered with climate façade systems. For each facade, only one check box can be selected for each column.

	Classes	Indoor façade	Outdoor façade
1.	**Airtight** cannot be opened even for maintenance reasons	☐	☐
2a.	**Possibility to be air tightened** can be opened by the user and for maintenance reasons	☐	☐
2b.	**Possibility to be air tightened** can be opened only for maintenance reasons	☐	☐
3.	**Not airtight** (cannot be tightened)	☐	☐

▪ ***Examples***

Fig. 30: Airtight indoor façade (cannot be opened even for maintenance reasons)
Aula Magna (Louvain-la-neuve)

Fig. 31: Airtight indoor façade (can be opened by the user and for maintenance reasons)
Düsseldorf city gate (Düsseldorf)

Fig. 32: Airtight indoor façade (can only be opened for maintenance reasons)
DVV – Brussels

Fig. 33: Indoor façade not airtight (cannot be tightened) – in this case of a solar control serves as inner layer
Mercator building - Nijmegem

Fig. 34: Airtight outdoor façade (cannot be opened even not for maintenance reasons)
UCB Center (Brussels)

Fig. 35: Airtight outdoor façade (can partly be opened for maintenance reasons)
Brussimo Building (Brussels)

Fig. 36: Airtight outdoor façade (can be opened by the user and for maintenance reason)
CNP building (Gerpinnes)

Fig. 37: Outdoor façade not airtight (cannot be tightened)
Debis building (Berlin)

4.3.4 CRITERIA N°4 - PHYSICAL CONNECTION BETWEEN CAVITY AND HVAC SYSTEM

- ***Purpose of the concept***

  This criterion indicates if a physical connection between the air cavity and the ventilation system exist. It does not say anything about the way the system is working.

  Only a direct connection between the air cavity and the ventilation system is described. It means that systems where the air is passing through an office before accessing the air cavity are considered as no physical connection between the air cavity and the considered systems.

- ***Checkboxes***

	Air supply	Air exhaust
Connection with Ventilation system	☐	☐

4.3.5 CRITERIA N°5 - WIDTH OF THE AIR CAVITY

- ***Purpose of the concept***

  Classification with respect to the dimension of the ventilated air cavity.

- ***Classes***

Class	*Description*	*Comments/Examples*
1	< 50mm	Such widths are rarely encountered in practice
2	50…200 mm	Ventilated double façade applying the indoor air curtain strategy are generally situated in this category Ex : UCB Research facilities
3	200 … 500 mm	
4	500 … 2000 mm	Accessible for people Ex: Brussimo
5	> 2000mm	Mainly atria Ex : Commerzbank

The classification specifies classes. This can be completed with an indication of the exact width of the air cavity.

- ***Examples***

Fig. 38: Cavity width : 50…200mm (in this case Climate façade)

UCB Building (Brussels)

Fig. 39: Cavity accessible for people (500mm …2000mm)

Brussimo (Brussels)

Fig. 40: Cavity with a width > 2000mm (atrium)

Commerzbank (Frankfurt)

4.3.6 CRITERIA N°6 - LAYER CHARACTERISTICS

- Purpose of the concept

This category will give information about the two external glass layers of the façade. Some information is given for each layer (type of glazing, % glass, window that can be opened, control strategy)

- Characteristics

	Glazing layer 1 (outside)	*Glazing layer 2 (inside)*
Type of layer		
Type of glazing		
Glazing characteristics (U-value, τ_v, g-value)		
% glass		
Possibility to open window		
Control strategy opening		
Material of window profile		

Definition of the sub-classes

- Sub-Class 0 : Type of layer

Class	*Description*	*Comments / Examples*
1	Glazing	
2	Solar shading	Some concepts of VDF use solar shading as second layer

- Sub-Class 1 : Type of glazing

Class	*Description*	*Comments / Examples*
1	Single glass	
2	Ordinary double glass	
3	High-efficiency double glass	
4	Selective glazing	

- Sub-Class 2 : possibility to open window?

Class	Description	Comments / Examples
1	No	No possibility to open the window
2	Yes	A description of the way the window can be opened (sliding, towards inside, towards outside, etc…) can be given

- Sub-Class 3 : Description of window frame

Class	Description	Comments / Examples
1	Wood	
2	Aluminium	
3	Steel	
4	PVC	

4.3.7 CRITERIA N°7 - SOLAR AND VISUAL SHADING DEVICE

- Purpose of the concept

This criterion describes the solar and visual control of the façade. Some sub-classes are defined. The classification of the solar and visual controls is made by collecting the relevant information from the different sub-classes.

The classification gives an indication of the existing solar and visual control systems. How many solar and visual control systems are installed? Where? Which type of system?

- Characteristics

Number of solar control (see Sub-class 1)		
Characteristics	*Solar control n°1 (if existing)*	*Solar control n°2 (if existing)*
Position (see Sub-class 2)		
Type (see Sub-class 3)		
Control strategy		

- Definition of the sub-classes :

➢ Sub-class 1: Number of solar and visual control systems

Class	*Description*	*Comments / Examples*
0	No solar and no visual control system	
1	One	
2	Two	

➢ Sub-class 2 : Position of the control

Class	*Description*	*Comments / Examples*
1	External	
2	Between in the middle of the air space	In the air cavity between the 2 façades
3	Between near outside glass layer	In the air cavity between the 2 façades
4	Between near inside glass layer	In the air cavity between the 2 façades
5	Internal	

➢ Sub-Class 3 : Type of solar control

Class	*Description*	*Comments / Examples*
1	Screen	
2	Venetian blind	
3	...	

4.3.8 CRITERIA N°8 - PRESENCE OF ACTIVE COOLING SYSTEM

- Purpose of the concept

Avoiding active cooling systems determines the design of the entire building (type of façade, solar control system, glazing area, type of glazing,. etc…). Hence, this information permits to estimate the importance of the façade in the complete strategy of comfortable indoor climate.

- Classes

Class	*Description*	*Comments / Examples*
1	Yes, full capacity	Active cooling – full capacity
2	Yes, limited cooling capacity	Active cooling – limited cooling capacity
3	No	No active cooling system

4.3.9 CRITERIA N°9 - PRESENCE OF HEATING ELEMENTS NEAR FAÇADE

- Purpose of the concept

According to the façade concept applied, heating elements near the façade can be avoided or not. This point is specified here.

- Classes

Presence of heating elements near façade	Yes	No

- Examples

Fig. 41: No heating element near façade

(in this case a one storey-height mechanically ventilated double façade with adjacent façade modules applying an indoor air curtain strategy)

Greensquare Building (Diegem)

Fig. 42: Presence of a heating element near the façade

Commerzbank (Frankfurt)

4.4 VARIABLE CHARACTERISTICS

The variable characteristics have to be described by considering possible variation within the time (for instance which ventilation strategy is applied in the winter/summer time).

At the level of this document, the next conditions will be considered:

1. Manual control : the next symbol will be used ⓿
2. If the control of the considered system is automated, then the next operating conditions will be considered:

	Heat demand		Cool demand	
	Tout > Tin	Tout < Tin	Tout > Tin	Tout < Tin
Occupied	-	❶	❸	❺
Unoccupied	-	❷	❹	❻

Supplementary relevant conditions could be considered in function of the considered building (for instance windy or not windy if natural ventilation is a possible type of ventilation).

Remarks: In the next paragraphs an example of a mechanically ventilated double façade applying an indoor air curtain ventilation strategy (climate façade) is taken to illustrate the different variable characteristics.

4.4.1 TYPE OF VENTILATION OF THE AIR CAVITY

In principle, a ventilated double façade is characterized by only one type of ventilation (see §2.1.1). However, some complementary information can be given here for hybrid ventilated double façade. This table allows indicating which ventilation type is applied for an hybrid ventilated double façade in function of the operating conditions

Class	*Operating conditions*
Natural ventilation - Applying for naturally ventilated façade - Applying for hybrid ventilated façade when the natural type of ventilation apply	
Forced ventilation (mech. Driven) - Applying for mechanically ventilated façade - Applying for hybrid ventilated façade when the mechanical type of ventilation (fan-assisted) apply	❶❷❸❹❺❻

4.4.2 OPENING OF THE OPENABLE PARTS OF THE TWO-LAYERED FAÇADE

This table indicates when the operable parts of the façade are used.

	Inner layer	Outdoor layer
Airtight façade – not possible to open		❶❷❸❹❺❻
Open façade not possible to tighten		
Openable parts placed in open position		
Openable parts placed in closed position	❶❷❸❹❺❻	

4.4.3 APPLIED VENTILATION MODE

Description of the applied ventilation mode (see §2.1.3) in function of the time.

Applied ventilation mode	Operating condition
Outdoor air curtain	
Indoor air curtain	❶❷❸❹❺❻
Air supply	
Air exhaust	
Buffer mode	

Credits

Aula Magna
Architect : Samyn & Partners
Fig.24 p28, Fig. 28 p. 36 (photo Ronsmans), Fig. 30 p. 38

Berlaymont
Architect : Berlaymont 2000 s.a., P. Lallemand, S. Beckers
Fig. 8 p. 12, Fig. 25 p. 29, Fig. 27 p. 35 (photo : Berlaymont 2000)

Brussimo
Architect : Samyn & Partners
Fig. 35 p.38, Fig. 39 p. 40

CNP
Architect : Samyn & Partners
Fig. 36 p. 39

Commerzbank
Architect : Foster & Partners
Fig. 40 p. 40 (photo Ref [13]), Fig. 42 p.43 (photo Ref [13])

Debis
Architect : R. Piano
Fig. 37 p. 39 (photo R. Piano BW)

Düsseldorf City Gate
Architect : Petzinka & partners
Fig. 31 p. 38

DVV
Architect : Groep Planning
Fig. 32 p.38

Greensquare
Architect : Archi+I, Atelier de Genval
Fig. 5 p. 10, Fig. 41 p. 43

ING House
Architect : Meyer en Van Schooten Architecten
Fig. 26 p.35

Mercator
Architect : P. de Ruiter
Fig. 33 p. 38 (Photo : Architectenbureau P. de Ruiter)

UCB headquarters
Architect : Assar
Fig. 34 p. 38

UCB Reseach facilities
Architect : Bureau d'architecture Emile Verhaegen s.a
Fig. 38 p. 40

Victoria
Architect : HPP Hentrich – Petschnigg & Partners
Fig. 29 p. 36

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