Bulletin of the *Transilvania* University of Braşov • Vol. 5 (54) - 2012
Series 1: Special Issue No. 1

OFFICE BUILDINGS WITH DOUBLE-SKIN FAÇADE IN EUROPE

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Abstract: *Occupants and investors in office buildings ask increasingly these days building designer professionals, be they architects, structural engineers or building services engineers about confortable, healthy, energy efficient buildings that use at maximum free resources, renewable energy sources, performant materials or systems. The multitude of office buildings built with double-skin façade across Europe is a good example in respect these goals, even if is still too little experience of their behavior globally and more so in Romania. This paper aims to provide some examples of double-skin façade from Europe, with the ultimate goal to take into account all its benefits and apply them into our country.*

Key words: *office buildings, glass envelope, double skin façade, energy.*

1. Introduction

Double-skin façades have been developed as a response to provision of fully glazed curtain walls and as an effective way to control light, heat, cold air and noise through the building envelope and also to contribute on reducing energy consumption.

In Europe this system has been installed on several corporate office buildings, innovative, as an appropriate method to save energy and to receive as much sunlight during the day. Installation of these façades is a complex process which requires combining several fields of engineering area and therefore according to the goal of the system is required very close cooperation between those involved in the project, architects, builders, building services engineers, energy auditors etc.

2. Double skin façades in Europe

As a basis for further research in this paper was made use of all available literature in our country, on the internet and over time were made visits to several European Union countries, such as Spain, Belgium, The Nederlands, Austria, Germany and of course in our country, in Iaşi, where have been realized to experimental models.

2.1. Spain

In Spain were visited in November 2011 two buildings in the city of Barcelona, *Torre Agbar* and *Interface building* both located in the Glories part of town.

Torre Agbar building was designed by French architect Jean Nouvel in association with the firm B720

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Arquitectos, headed by Fermin Vásquez, is the headquarter of **Ag**ua de **Bar**ceona, has 35 floors and an overall height of 142 meters. The building is located in Barcelona, next to Plaça de les Glòries, between Avingua Diagonal and Carrer Badajos. This building's double skin façade consist of an inner concrete façade, upon were mounted boards painted in red, blue, green and grey, with integrated windows in the wall's structure and an exterior façade made of laminated glass modules, anchored by a steel structure on the interior concrete façade.

Fig.1. *Exterior façade, the inner cavity and overview of Torre Agbar, Barceloan, Spain*

The tower has 4500 windows to maximize natural ventilation and reduce energy costs by optimizing the use of sunlight. Energy consumption for air conditioning is reduced by using external temperature sensors, which controls the opening and closing tabs on the outer façade, adjusting the flow of fresh air in cavity, which enters then in the building, thus making natural ventilation.

Interface Building was designed by the design studio Battle i Roig Arquitectes, led by architects Enriq Battle and Joan Roig, and is the headquarter of several companies in the field of Information Technology and Telecommunications, has 14 floors and an overall height of 52 meters. At this building, the double-skin façade is more like a curtain wall with a fixed glass exterior façade opened on all sides.

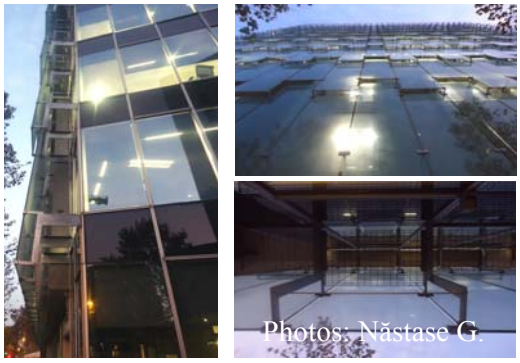

Fig. 2. *Side view, front view and under the cavity, Interface Building, Barcelona, Spain*

The outside glasses on this façade are disposed upward, as can be seen in Figure 2, to create a beautiful architectural effect, and at every level in the cavity is a metallic platform to pass by.

2.2. Belgium

In Belgium were visited in March 2012 four buildings in the city of Brussels, *Berlaymont* (Building of European Commission), *Brussimo* building, *DVV office building* on the street Joseph II no. 96 and *North Galaxy* building.

Berlaymont hosted since its construction (1963-1969) European Commission and has become a symbol for the Commission and for the Europeans by its presence in Brussels. The Commission itself is divided into about 60 "strange" buildings but Berlaymont is the headquarter of the institution, the seat of the European Commission President and its Board of Commissioners.

The building has a cruciform design, with four wings and different sizes that start from a central core, and this design is intended to convey a sense of light and transparency. The design includes and other decorative design details such as

carvings and frescoes, to prevent it from becoming monotonous.

The building now has 240,000 m^2 of floor, 18 floors, connected by 42 lifts and 12 escalators. Offices for the 3000 officials and meeting rooms are in the tower. And restaurant services, cafeteria with 900 seats, TV studio, conference rooms, storage rooms, sauna, parking for over 1,100 cars occupy the basement and other various services.

The architects Pierre Lallemand, Steven Beckers and Wilfried Van Campenhout conducted renovation during 1991-2004.

Fig. 3. *Front view, side view and overall view, Berlaymont Building, Brussels, Belgium*

The façade was replaced with a double-skin façade with movable screens that adapt to weather conditions and reduces glare, while still allowing light to penetrate inside. It also acts as a sound barrier, reducing noise came from the Rue de la Loi. Windows cancels air conditioning, when open, to prevent energy waste. Offices, which are currently bigger, have a heating system that can adjust automatically or manually, and automatically turns off when they are unoccupied.

The exterior façade on *Berlaymont* building is a blinds type, as in *Torre Agbar* building, in Barcelona, Spain. Inner envelope is composed of double glazed windows. The outer envelope is made of a series of suspended frames, which are glass plates (200 cm by 50 cm), not all with the same thickness (8 mm at the bottom and 12 mm at the top of the facade) because of their sizing against the wind.

Glass slides that form outer envelope are composed of two layers of glass separated by a perforated multilayer film showing a white face to the outside for better light reflection. On the inside blinds have a dark side, to allow visibility through them. The lighting contrast being positive, visibility is possible from the inside out, but it is impossible to reverse.

Brussimmo office building, the headquarter of the European Commission for Freedom of Movement. The site reveals a notable building, placed in the heart of Leopold district, the centre of business activities in Brussels and close to the main European institutions. Because of its location, the site is exposed to noise, dust and other pollution. The building had to be suitable for any kind of organization offices, from individual offices to a fully open plan arrangement, including concepts such as the Scandinavian "combi offices," which proved so effective and easy to use. Particular attention was paid to the architectural quality of underground parking area, as it is often the first contact of visitors with the building.

The concept was so designed to:

- Easy installation electrical of mechanical equipment, independent of partitioning;

- Simple change partitions without damaging the ceiling and soundproofing enough in enclosed spaces;
- Installation of equipment compatible with the current needs of large international companies;
- A quiet and pleasant working environment;
- Competitive performance of the project from a financial standpoint.

The building comprises a ground floor with reception area, a first floor with meeting offices and waiting areas, five floors with standard offices and level seven, which is half semi-cylindrical shape, which serves as a technical space.

Fig. 4. *Double-skin façade on Brussimo building, Brussels, Belgium*

The building is equipped with double glass façade, with the following advantages:

- Sound insulation is very good;
- A glass exterior facade, easy to maintain;
- Using transparent windows, which practically do not affect the comfort or the temperature inside the building;
- A large influx of natural light, through facades that are completely build with glass, from bottom to top;
- Easy distribution of mechanical and electrical parts.

Ex-*DVV* office building, placed on Joseph II building on the street, at no. 96 is a double-skin façade building, type "box" with mechanical ventilation and inside curtain airflow.

The building was started in 1993 and was completed in 1995, in april, and is a five-storey extension office of DVV insurance company, which since 1990 has increased the number of operations and thus the necessity of an extension appeared due to overcrowding the headquarter. Choosing "box" type windows was motivated by considerations of energy conservation, and good thermal and acoustic insulation. Windows are an integral part of the HVAC system with forced air circulation. In this building air conditioning is discharged into the room at floor level through discharge holes with variable flow control, which incorporate also an electric resistance for heating shortfall. In Figure 5 can be seen the box type double façade system box coupled with the building's HVAC system.

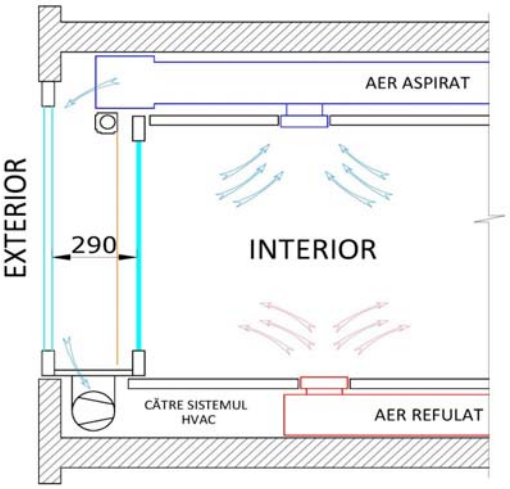

Fig. 5. *Air flow through DVV building's façade, Brussels, Belgium. Drawing not at scale.*

Warm air is taken from the top, through a system of pipes and sent to the window

cavity, which runs through and returns to the bottom of the HVAC system. Air can be recirculated or can be exhausted.

Fig. 6. *Double-skin façade, "box" type (southwest cardinal direction), DVV extension building, Brussels, Belgium*

Design airflow to be circulated through the cavity varies between 100 and 140 m^3/h m window width.

Exterior glass is a double glass type window with thermal break aluminium joinery and the interior glass is a single safety glass panel simple. In the cavity, the shading device like roll is placed about 8 cm from the inside window.

North Galaxy complex was designed by the architectural offices group M. & JM Jaspers - Eyers & Partners, Art & Build and Montois & Partners, the buildings were built mostly of prefabricated and currently, Galaxy North offices complex is one of the largest real estate projects in Brussels.

North Galaxy Towers, located on the Boulevard Roi Albert II, Brussels, Belgium have 28 levels each with two technical levels on top of each. The building is accessible through a majestic entrance, which is elliptical, with a double glass façade as a key feature. The windows are 13 m in height and hangs by tensioned cables using a steel structure from the roof to below ground floor.

Fig. 8. *Detail and overall double-skin façade from North Galaxy Towers entrance, Brussels, Belgium*

2.3. The Nederlands

In the Netherlands, at Amsterdam has been viewed *ABN-AMRO Bank Headquarters* building located in the south of the city.

The building is one of the top 10 tallest buildings in Amsterdam, with a height of 105 m and 24 floors.

Fig. 9. *Views of double-skin façade, headquarters of ABN AMRO Bank, Amsterdam, Netherlands*

The façade of this building includes cavity ventilation, automatic blinds, heat recovery system in the building and

lighting adjusts automatically depending on the occupancy and the level of brightness, thereby reducing energy consumption.

2.4. Austria

In Austria, Vienna has been viewed *IBM building*, located at Obere Donnaustraße 95, near the Danube Canal, which was built in 1969 and restored by architect Rudolf Prohazka in 1999-2001. Renovation of existing front consisted of mounting of a double glass façade, covering an area of 1000 m^2, to reduce energy consumption for cooling and heating. Outer envelope is slightly curved outward, as can be seen in the picture below.

Fig. 10. *Front view of IBM building's double skin façade, Vienna, Austria*

In the same area, just near IBM is building a *Raiffeisen Bank* with double glass façade that allows good natural ventilation of the building. Construction is almost complete and is intended to be a reference building in resource conservation, energy efficiency and environmental protection. Flagship office building was designed by architects Dieter Hayde, Ernst Maurer and Radovan Tajder and is modeled after the concept of "Raiffeisen Klimaschutz-Initiative" (Raiffeisen climate protection initiative).

Fig. 11. *Double-skin façade of Raiffeisen Bank in Viena, Austria*

Also, has been viewed the *UNIQA Tower*, headquarters of insurance company UNIQA Group Austria, completed in 2004 and designed by the Austrian architect Heinz Neumann.

Fig. 12. *UNIQA tower's double skin façade, Vienna, Austria*

This building is the first building in Austria, which has been awarded with a "Green Building" certificate. UNIQA tower's double-skin façade allows the natural ventilation inside through windows. At the same time provide sound and thermal insulation, provide natural light inside the building throughout the year, and use the sun's heat during the winter, through the greenhouse effect achieved within the cavity. In order to maximize natural light without too much heat building, building management system adjusts the blinds, light according to need.

2.5. Germany

In Germany, at Nuremberg have been visited two double glass façade buildings: Business Tower and NCC Nuremberg building (Nürnberg Convention Center) from Nürnberg Messe.

Nuremberg Convention Center (NCC) is one of the most modern facilities for conducting conferences and one of the 20 largest sites in the world, to support international exhibitions. This building is complemented by 160,000 m^2 of exhibition space adjacent and offers seating capacity for 11,000 participants.

NCC building from Nürnberg Messe is built with double-skin façade that allows natural light into a very high proportion, thus providing an open and communicative atmosphere, thus achieving optimal conditions for events for which it was made construction, but is also energy saving.

Fig. 13. *Photo from inside the double glass facade of NCC building from Nürnberg Messe complex and view of floor heating unit.*

In the pictures above you can see some details of the double façade, such as inside the cavity, air intake valves from the bottom of the cavity, indoor unit for heating, embedded in the floor, right next to the inner glass of double facade.

To monitor double glass facade NCC has its own weather station, so regardless of the weather outside, inside the climate is pleasant and comfortable one.

The building was designed by S + P Gesellschaft von Architekten mbH, led by architect Heinz Seipel and was completed in 2005.

The next building viewed from Nuremberg, Germany, was the tower of 135 meters and 34 floors Nürnberg Business Tower, designed by architects Friedrich Biefang, Dürschinger and Jörg Peter Spengler and was built in June 1996 - October 2000.

The tower is equipped with double glass façade, allowing its natural ventilation, at every level, despite its height and it was no longer necessary to install an air conditioning system, thereby achieving maximum economic and environmental efficiency.

Fig. 14. *Overview of Business Tower Nuremberg, Germany (left) and double-skin facade detail (right).*

The building has one of the largest and most powerful type network LON (Local Operating Network) in Europe, whereby Building Management System (BMS) process the data coming from the 120,000

points of the network hardware and software. This system allows individual control, each room lighting levels, heating system, air exchange, etc.

2.6. Romania

In our country until now have been realised 2 experiments with double skin façade, both in Iasi city, one conducted by Mr. Nelu-Cristian Cherecheş at Building Services Faculty from Gh. Asachi University of Iaşi and the other conducted by Mrs. Cherecheş Monica at INCERC Iaşi.

Now it's in development the third experiment for a PhD thesis in Braşov, at Building Services Faculty from Transilvania University of Braşov.

Fig. 3. *All three experiment of double-skin façade in Romania*

It can be seen in the pictures above those three experiments, which are all focused to determine the heat transfer through such system in our climatic conditions.

Conclusions

Since the concept of double-skin facade is complicated, and the use and operation of such a system affects internal parameters of the building (which often interact with each other, such as energy use, natural ventilation, lighting, indoor air quality, acoustics, environmental, visual and thermal comfort, etc.) literature studies it from various directions. It was considered important to overview a few important buildings in Europe, which have installed this type of system, to see similarities and differences between them so they to be analyzed from several points of view.

References

1. Dirk SAELENS: Energy performance assessment of single storey multiple-skin facades, Katholieke Universiteit Leuven – Faculteit Toegepaste Wetenschappen Arenbergkasteel, September 2002;
2. http://www.google.ro
3. http://www.batlleiroig.com
4. http://en.wikipedia.org
5. http://www.cstc.be
6. http://web.byv.kth.se
7. http://www.samynandpartners.be
8. http://www.dowcorning.com
9. http://clientarea.vkgroup.be
10. http://www.ibjobfair.be
11. http://www.quer-magazin.at
12. http://www.raiffeisen.at
13. http://www.raiffeisen-klimaschutz.at
14. http://www.johnsoncontrols.co.uk
15. http://knauf-integral.de
16. http://de.wikipedia.org
17. http://digitallibrary.usc.edu