

THE INTRODUCTION OF A CERAMIC PANEL VENTILATED FAÇADE SYSTEM IN BRAZIL: FROM THE IDEA TO THE PRACTICE

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SUMMARY

The ventilated façade has been a topic of discussion among architects and building engineers in Brazil for at least the last decade. Several attempts have been made, in particular by the ceramic industry, to introduce the technology in the country but very few results have been seen. This paper presents the introduction of the first ventilated system with extruded ceramic panels in the country and show how key attributes were taken into consideration in its selection process. Some important features of the ventilated façade are discussed as well. Some aspects of designing and detailing of a building façade are also shown.

1. CONSTRUCTION MARKET IN BRAZIL NOWADAYS

In 2004 we discussed the possibility of introducing a ventilated façade system in Brazil (SIQUEIRA; MEDEIROS, 2004). Since that time several attempts have been made, especially by the local ceramic industry, to introduce the technology in the country.

Although some jobs have been done, none of those initiatives have succeeded since no system has been established. Why has it taken so long to introduce a technology that is already widely established in Europe? Was it a technical or commercial issue? What exactly has changed?

Brazil is now a “rising star” in the global market. In the last eight years the Brazilian building construction market has experienced a growth never seen before. A recently review of *The New York Times Magazine* (ROMERO, 2011) explains that “Brazil’s economy soars — partly as a result of China’s great appetite for its commodities, like iron ore and soybeans, not to mention the oil recently found in abundance offshore. A surge in deal-making and the resilience of Brazil’s currency, the real, has attracted foreign investment bankers, hedge fund managers and venture capitalists.”

A good example of the local booming economy is Sao Paulo, the largest city in the country located in the southeast of Brazil. It is a huge metropolis with about 20 million inhabitants which means around 10% of the population of the whole country. CASTELO (2011)

The metropolitan area of Sao Paulo represents about 35% of the country’s construction market share and every year about 700 buildings are delivered. REVISTA CONJUNTURA DA CONSTRUÇÃO (2011).

A great diversity of solutions for façade covering can be found but most residential buildings in the city are covered with decorative renders and painting. On the other hand, in the northeast coast where high humidity and temperatures are notable, the tile façade is a mandatory solution for coverings. It is a traditional material that has long been used.

Two examples of these booming times in building construction are shown in Figure 1 and Figure 2. The first shows the evolution of the number of shopping centers in the country. More than 50 new centers are being built now and must be finished by the end of 2012. On the other side of the market, the internal market is growing so fast that the industry is breaking historical sales records. ABRASCE (2011), ANFACER (2011)

This new scenario combines for the first time unique features that open up a wide range of opportunities in the country. These include the introduction of new technologies for building construction and the development of a new paradigm in terms of feasibility for the building industry that cannot be neglected.

Evolution of Shopping Centers in Brazil

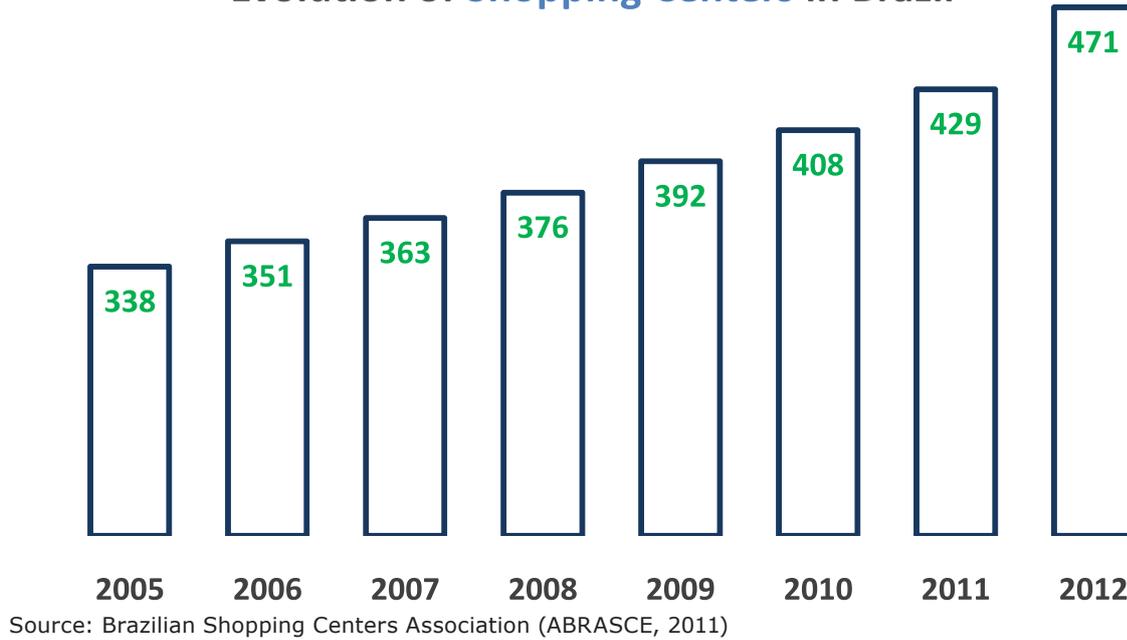
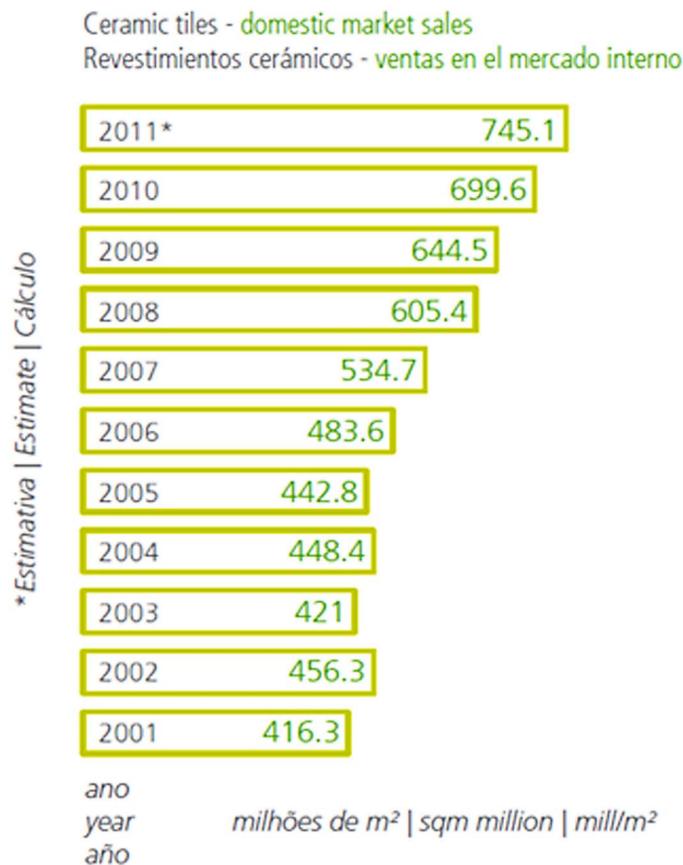


Figure 1. Evolution of the number of shopping centers in Brazil.



Source: Brazilian Association of Ceramic Tile Manufacturers (ANFACER, 2011)

Figure 2. Sales of ceramic tiles for the internal Brazilian market.

2. THE IMPORTANCE OF THE FAÇADE IN THE BUILDING

The façade plays an important role in the building system not only because it directly affects the aesthetics but also because of its impact on the final performance. It is also responsible for an important part of the building cost. Depending on type of material and construction characteristics, this is usually between 6% and 20%.

The exterior envelope is the main part of the building that controls heating and lighting access to the interior. As a matter of fact, the façade also governs the image of the project owner's and contractor's reliability.

Actually, the way the façade and exterior covering behaves as times passes shows in practice how well it has been designed and built. Long term performance is a key factor to any building façade technology especially in term of sustainability.

Most of the façade coverings built in the world involve traditional materials such as bricks, tiles and stones. These materials are normally installed through adhered construction methods.

When well prepared and well installed, adhered covering such as render, tiles and stones can last for many years and behave well. However, a successful covering not only depends on the materials' performance but also on skilled workmanship and supervision.

Particularly in last decade, many improvements have been developed to allow adhered methods to achieve better results in Brazil. Lots of covering defects have been avoided and thousands of buildings have been built successfully, though a number of problematic projects can be found. Figure 3 shows two interesting examples. Figures 4 and 5 show good examples of façade detailing.

Most of Brazilian building façade covering is adhered and installed over a framework of concrete, steel and infilling masonry walls. This means that traditional adhered covering is necessarily installed over a heterogeneous surface where differential movements are expected. Those movements can generate stress and cracks that specifiers and façade designers should consider.

On the other hand, the covering is not homogenous either. It is a combination of layers of adhered materials which harden in variable conditions, and these work mechanically as a monolithic body. Such a multilayer covering adhered to an unstable background is a very complex system to understand, and it is difficult to predict its behaviour and long-term performance.

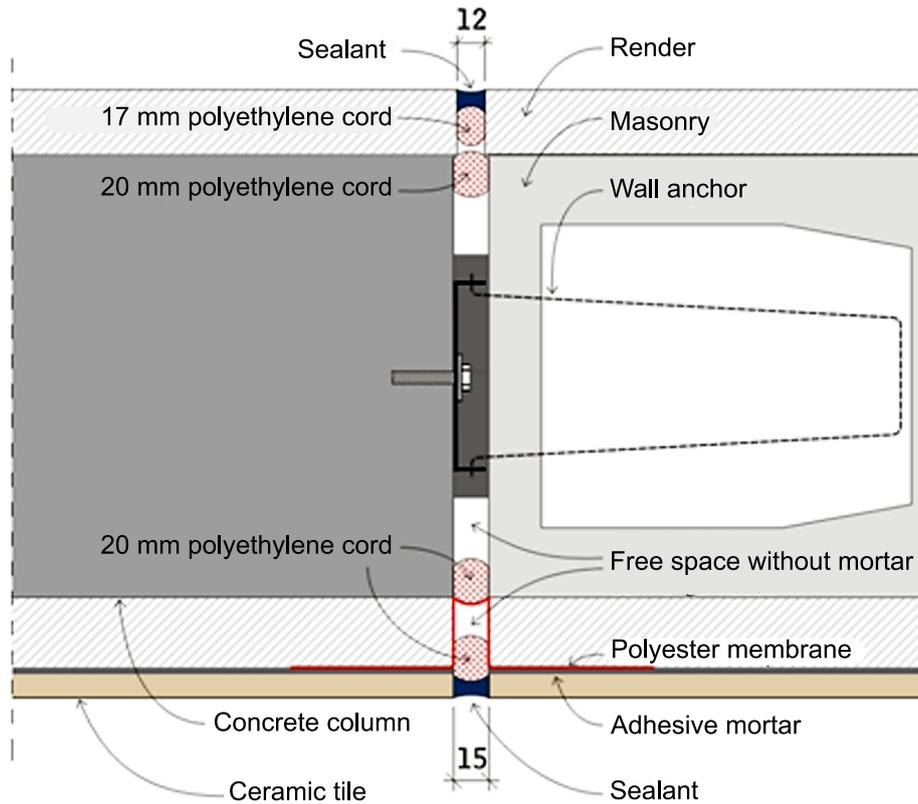
Based on MEDEIROS (2008) these limitations can be summarized as follows:

- a) dependence on human skill and accuracy;
- b) complexity of multi layer adhered materials prepared in the field;
- c) dependence on the curing conditions of the cementitious composite mixes;
- d) difficulty of life-time prediction.



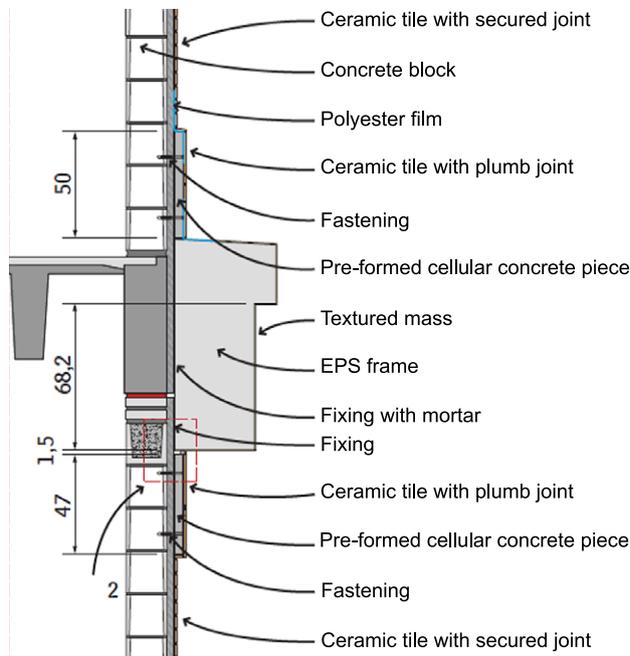
Source: Inovatec Consultores Asociados.

Figure 3. High-rise building built with directly adhered tile.



Source: Inovatec Consultores Asociados.

Figure 4. Façade adhered covering detailing: movement joint with waterproofing membrane



Source: Inovatec Consultores Asociados.

Figure 5. Façade detailing: installation of decorative frames and tiles.

3. WHY VENTILATED FACADE

The concept of a ventilated wall, where a cavity remains empty, looks obvious when applied to façade, but it is not. To be called ventilated a façade envelope of any material must create conditions for the prompt exit of the warm air between the exterior envelope and the building body.

If the warm air remains in the cavity, heat from the exterior can be transported through convection into the building. Therefore, the more efficient the system, the better is the air circulated from the inside to the outside of the inner cavity, as shown in Figure 6.

This efficiency depends on the geometry of the openings (surface, area and distribution) and environment conditions around the building, such as wind velocity, turbulence and air pressure.

In Brazil the ventilated façade can play a very important role since warm weather prevails throughout the country. It can be crucial to saving energy and contributes directly to sustainable projects.

On the other hand, it is not necessary to install insulation material as we usually see in Europe, since heating systems are not very often used in the country. Figure 6 explains graphically how a ventilated façade works.

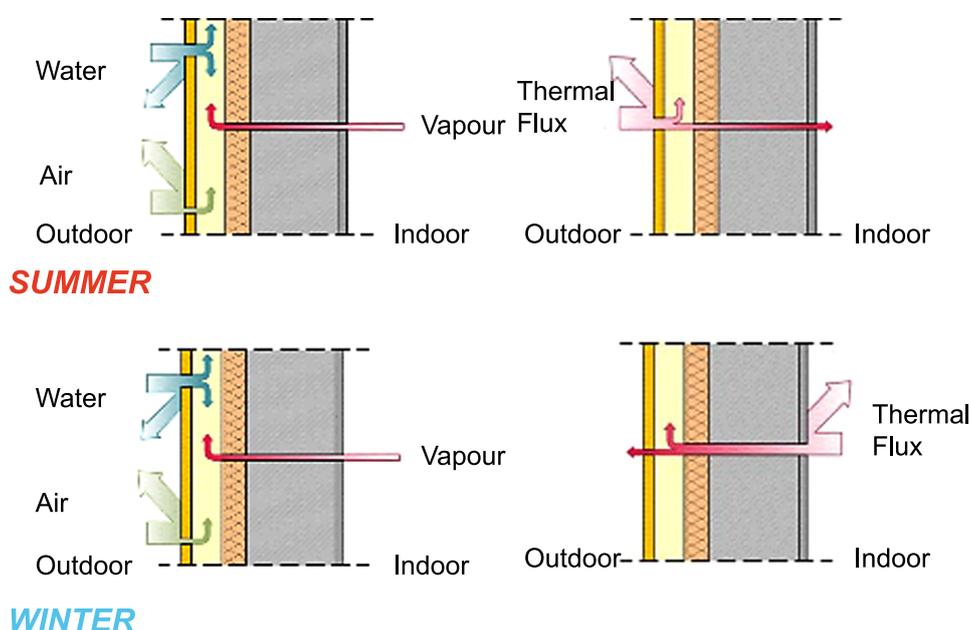


Figure 6. Behaviour of a ventilated façade during summer (above) and winter (below). The heat flows depend on how efficient and well designed the façade envelope is.

Although a ventilated façade can be designed with glass and stone, ceramic panels can contribute better than most materials to keeping heat on the outside. When built with extruded panels other advantages emerge, as shown below.

4. THE SELECTION OF VENTILATED FAÇADE SYSTEMS

Selecting a façade system is not a simple task. There are a large number of alternatives with different performances and prices. Therefore, choosing the best options for a particular project depends not only on the project needs plan but also on features of other building elements such as structure, vertical walls and windows.

In order to deal with a large number of variables it is recommended to classify them into categories. Such categories are mandatory for the selection process and can be detailed as necessary. The specifier, architect or façade designer can create a customized selection table to organize the categories. Technical and commercial attributes can be classified into several categories. Table 1 shows these categories, suggesting how they differ in importance and should therefore be weighted.

Tables 2 to 6 show technical attributes while Tables 7 and 8 show commercial attributes. These tables were designed for the selection of ventilated façade systems by a residential building construction company in Brazil.

ATTRIBUTES CATEGORY	Degree of importance according to project requirements				
	1	2	3	4	5
AESTHETICS					
CONSTRUCTABILITY					
MAINTAINABILITY					
PERFORMANCE					
VENTILATION CAPACITY					
SUPPLY CHAIN					
PRICE					
CONTRACT					

Table 1. Importance (weight) of technical and commercial attributes for the selection of a ventilated façade system for a residential building.

AESTHETIC ATTRIBUTES	Degree of importance according to project requirements				
	1	2	3	4	5
Panel maximum length					
Panel maximum width					
Customized size					
Colour availability					
Surface textures and patterns					
Vertical joint alignment precision					
Visibility of vertical profile behind the joints					
Panel geometry tolerances					
Water absorption (temporary stain)					
Panel stain resistance					

Table 2. Aesthetic attributes relevant to the selection of a ventilated façade system for a residential building.

CONSTRUCTABILITY ATTRIBUTES	Degree of importance according to project requirements				
	1	2	3	4	5
System weight					
Anchorage system "smartness"					
Horizontal joint alignment precision					
Vertical adjustment tolerance					
Potential productivity					
Pre-solved façade detailing					

Table 3. Constructability attributes relevant to the selection of a ventilated façade system for a residential building.

MAINTAINABILITY ATTRIBUTES	Degree of importance according to project requirements				
	1	2	3	4	5
Anti-vandalism protection					
Self-cleaning panel surface					
Panel change and replacement					

Table 4. Maintainability attributes relevant to the selection of a ventilated façade system for a residential building.

PERFORMANCE ATTRIBUTES	Degree of importance according to project requirements				
	1	2	3	4	5
Anti vibration device					
Water leakage susceptibility					
Standard performance evaluation					

Table 5. Performance attributes relevant to the selection of a ventilated façade system for a residential building.

VENTILATION CAPACITY ATTRIBUTES	Degree of importance according to project requirements				
	1	2	3	4	5
Air cavity width					
Opening of horizontal joint					
Opening of vertical joint					

Table 6. Ventilation attributes relevant to the selection process of a ventilated façade system.

SUPPLY CHAIN	Degree of importance according to project requirements				
	1	2	3	4	5
Number of imported parts					
Local project background					
Technical support during research					

Table 7. Supply chain attributes relevant to the selection of a ventilated façade system for a residential building.

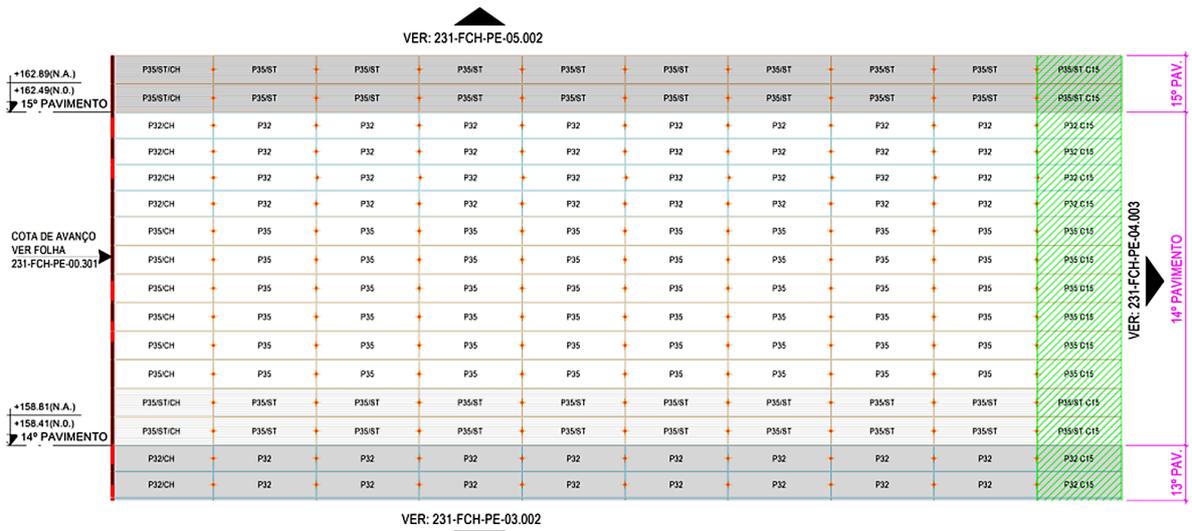
CONTRACT	Degree of importance according to project requirements				
	1	2	3	4	5
Uniqueness responsibility					
Warranty conditions					

Table 8. Contract attributes relevant to the selection of a ventilated façade system for a residential building.

5. DESIGNING AND CONSTRUCTION OF A VENTILATED FAÇADE

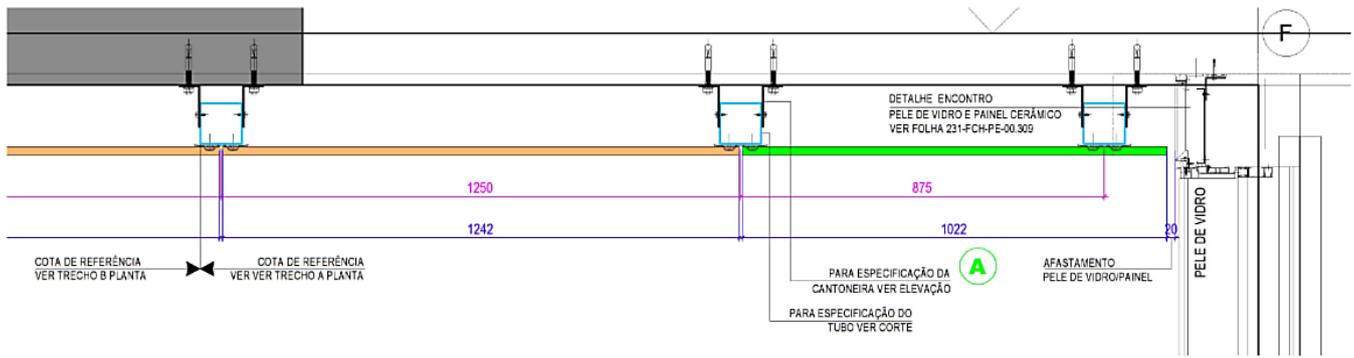
When a ventilated system is well developed, designing is a matter of detailing façade architecture and engineering the system according to the project features.

When detailing, the designer should carefully consider panel modulation according to window frames and the geometry of other systems, such as glass skin due to joint alignments and tolerances. Another key issue is panel positioning for adjustment. Every side of the façade needs to be adjusted due to structural deviations and a panel cutting plan is necessary. This plan shows where to cut and fixes criteria to avoid mistakes as seen in Figure 9.



ELEVATION WITH PANELS - 14th FLOOR - F AXIS / 3-5

ESCALA
1:50



GROUND PLAN WITH PANELS - MEZZANINE ON 13th FLOOR - F AXIS / 3-5 SECTION B

ESCALA
1:10

Figure 9. Elevation and plan of a ventilated façade with extruded panels. The "A" panels are those for adjustment due to structure misalignment.

From a structural point of view, two aspects normally arise: anchorage of the façade framework (typically an aluminium profile understructure) on the building main structure, and design of a framework to resist dead loads and wind pressures. The safety and assembling method depend on these issues. Figure 10 show a typical design using tube profile connected to the building structure by mechanical bolts.

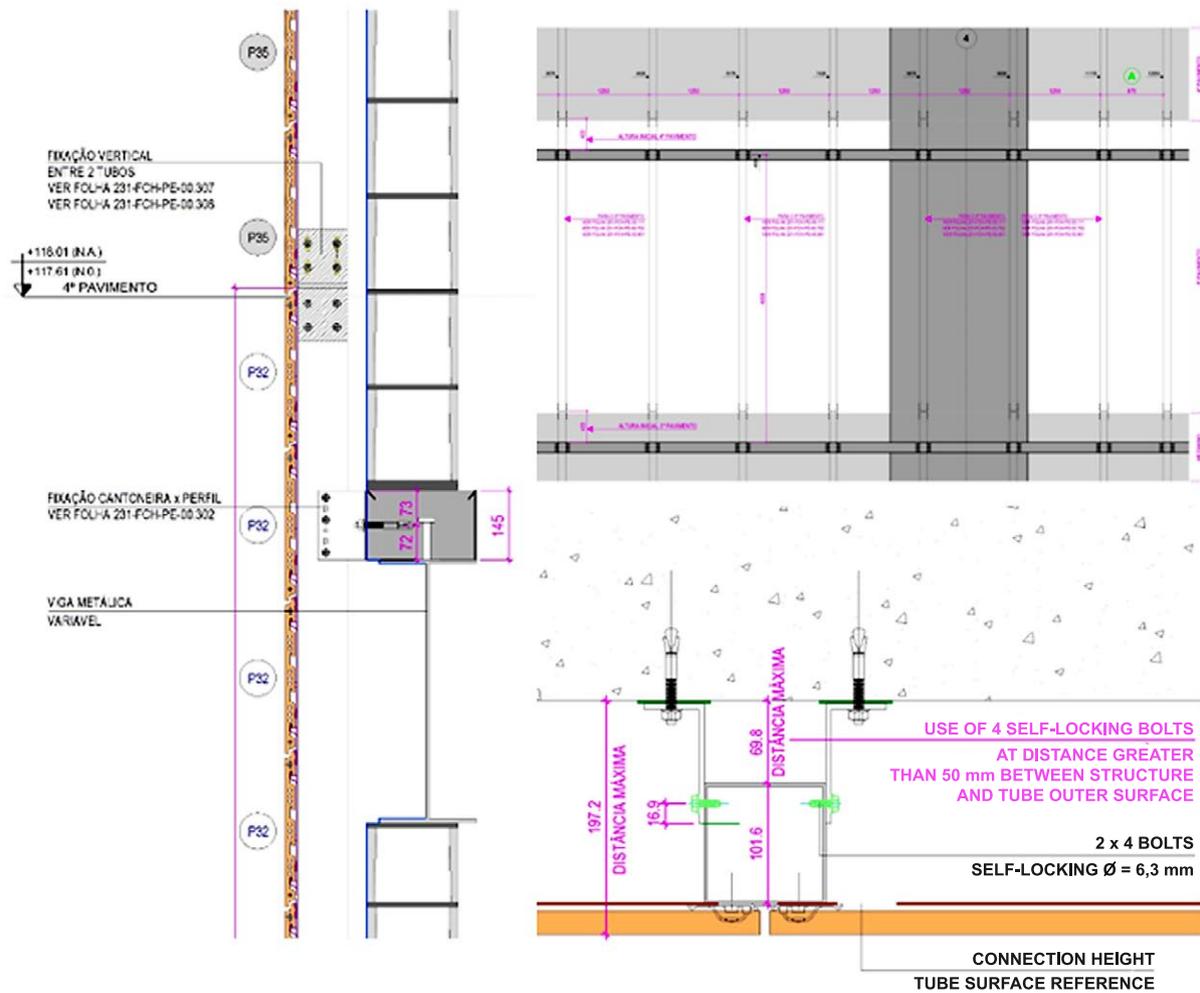


Figure 10. Ventilated system detailing: tube profile connected to the structure by angles and stainless steel bolts.

The whole engineering design of the project shown includes 198 A1 sheets, which provides an idea of how accurate detailing is crucial to achieving a successful installation process. Every floor was designed separately. The cross section on the left of Figure 10 and the plan on the right (bottom) show how vertical profiles were fixed to the building structure. Above, on the right, vertical profiles between two floor levels.

This particular project has already been finished and the installation was fully successful. Figures 11 and 12 show the façade under construction.



Figure 11. Ventilated system installation: vertical tube profile connected to the building structure by angles and stainless steel bolts. Rails fixed to profile are responsible for the ceramic panels fixing.

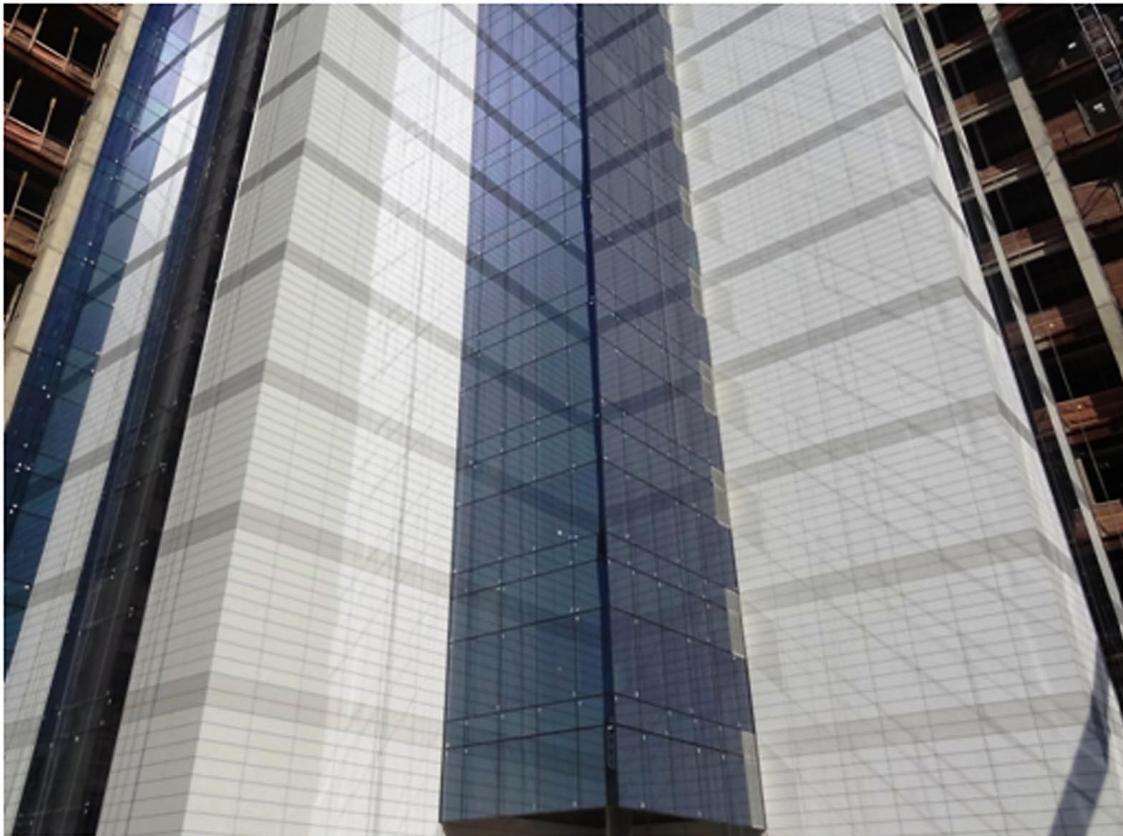


Figure 12. View of building façade under construction: the accuracy of the joints reveals the installation precision.

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