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GUARULHOS INTERNATIONAL AIRPORT EXPANSION

THE PROJECT

The Guarulhos International Airport expansion project represents a paradigm shift in airport infrastructure in Brazil, serving as a reference point for airports across the region.

The Federal Government of Brazil awarded the concession contract to the international group made up of Invepar Group, ACSA (Airports Company South Africa) and Infraero. The project design team consisted of three firms from the TYPSA Group and the construction work was awarded to Brazilian firm OAS, SA.

On the 11th of May, 2014, after just 19 months of record breaking design and construction, Guarulhos International Airport officially opened its new terminal 3 building to passengers. This revolutionary project stands out as one of the overriding success stories in Brazil's infrastructure and transport overhaul, initiated in preparation for the 2014 World Cup and 2016 Olympic Games.

The airport expansion includes the new 5-storey terminal 3 building which provides an additional area of 192,000m^2 and capacity for 12 million passengers a year, new parking areas for an additional 2,644 vehicles and increased apron space for an extra 34 aircraft accessed via 26 new boarding gates.

Brazil now boasts one of Latin America's most modern and exemplary airports which has helped to eliminate the country's principle logistical bottle neck and symbol of underdevelopment in infrastructure.

Standout Achievements:

- Record breaking timeframe for an airport infrastructure project.
- Largest infrastructure project scheduled for the 2014 World Cup.
- Doubling of the airport's terminal capacity from 191,000 m^2 to 383,000 m^2.

In May 2015 Guarulhos International Airport Expansion was awarded with the Honourable Mention in the Agustín de Betancourt International Infrastructure Awards, presented by the Spanish College of Civil Engineers in recognition of the special technical merit of the fast track methodology carried out by the design team.

GUARULHOS INTERNATIONAL AIRPORT EXPANSION *Aeroporto Internacional de São Paulo - Guarulhos* *Rodovia Helio Smidt, s/n.* *CEP 07141-970 - Guarulhos - SP - Brazil*	
Concessionaire:	**Concessionária do Aeropuerto Internacional de Guarulhos, S.A.** ☐ Infraero Aeroportos (Brazil) 49% ☐ Invepar (Brazil) + ACSA (South Africa) 51%
Preliminary Design and Detailed Design:	**TYPSA Group** ☐ Engecorps Engenharia S.A (Brazil) ☐ TYPSA (Spain) ☐ *Tecnofisil S.A. (Portugal)
Construction Company:	OAS S.A. (Brazil)
Electrical Equipment:	Siemens AG (Germany - Brazil)
Baggage Handling System:	Vanderlande Industries (Netherlands - Brazil)
Boarding Bridges:	ThyssenKrup AG (Germany - Brazil)
Project Start Date:	21st August 2012
Start of Construction:	28th August 2012
Terminal put into operation:	11th May 2014
Project Budget:	1.9 billion euros - 3.5 billion Brazilian Real

☐ *Table 1. Project Factsheet.*

THE SERVICES PROVIDED BY THE SUBMITTING FIRMS

*This application is presented jointly by the three companies from TYPSA Group responsible for the project design, ENGECORPS (Brazil), TYPSA (Spain), and *TECNOFISIL (Portugal), with the endorsement of the respective national associations, the Spanish Association of Engineering, Consultancy and Technological Services Companies (TECNIBERIA), the Brazilian Association of Engineering Consultants (ABCE) and the Portuguese Association of Engineering and Management Consultants APPC.*

Due to the vast scale of the project and the time constraints imposed, a huge international work force was in operation around the clock, requiring excellent coordination in order to ensure the smooth running of the project and minimise the risk of delays. More than 300 engineers and technicians from 10 offices in 3 different countries worked in unison, producing over 600,000 project files and 8,900 drawings whilst 14,000 workers were employed by the construction company, all of which enabled the successful execution of the strategy of simultaneous action on several fronts.

** Technical support not directly contracted by the concessionaire*

Topography and Geotechnical fieldwork:	Provided by Concessionária do Aeropuerto Internacional de Guarulhos. S.A.
Project Management:	Engecorps
Architecture:	Engecorps, Typsa
Geotechnical Engineering:	Typsa, *Tecnofisil
Structures:	Typsa, *Tecnofisil
Drainage:	Typsa, Engecorps
MEP & Telecommunications:	Typsa
Airport Engineering:	Typsa
Urbanisation & Roadways:	Engecorps, Typsa
Design Team Fast Track Coordination:	Engecorps
Construction Team Fast Track Coordination. Construction Engineering & Shop Drawings:	OAS, S.A.

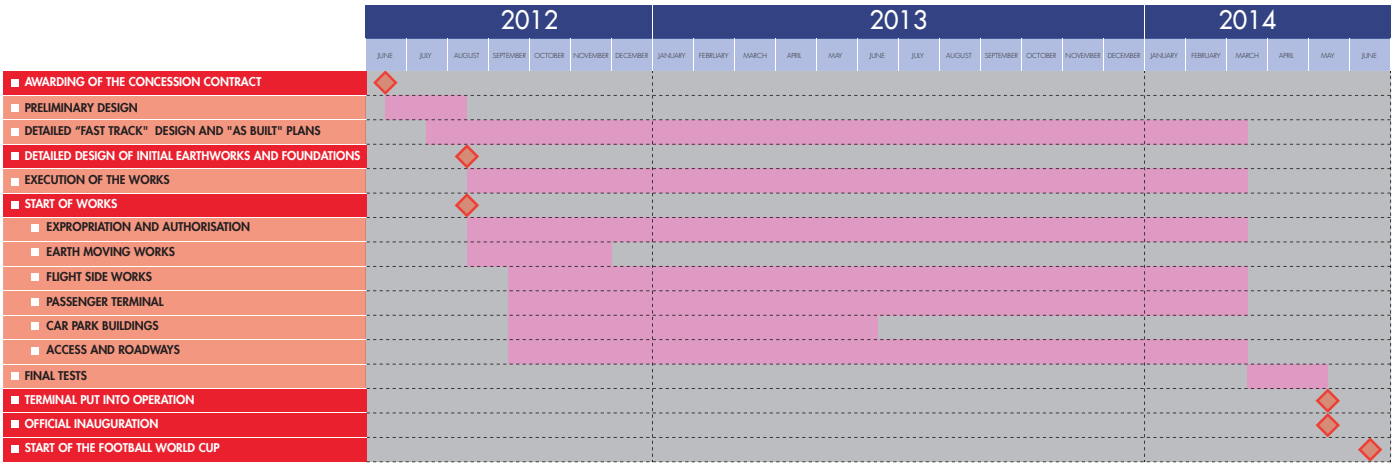
Table 2. Design & Construction Team.

INNOVATION, QUALITY, AND PROFESSIONAL EXCELLENCE

"Fast track" Spanish Engineering for the Gateway to Brazil

The most significant aspect of the project was the speed of its execution whilst still maintaining the high standards of quality established from the outset, combining local experience and global expertise.

- The preliminary design of the project was completed by TYPSA Group within in two months of the awarding the complex concession contract for the design, implementation, maintenance and operation of the expansion works.
- Construction work began immediately after the preliminary design had been submitted meaning that the detailed design of the earthworks and foundations had to be completed before the total completion of the preliminary design.
- The detailed design was developed by TYPSA Group using 'fast-track' principles. This methodology requires the overlapping of design and construction stages and means that the design is essentially driven by the demands of the construction stage.
- The success of the project was fundamentally based on the ability of the different design teams to work in unison. Work was carried out simultaneously between 10 different offices located in South America and Europe.
- The teams showed a high and exemplary level of knowledge and expertise whilst being supported by computer software, work procedures and quality assurance systems.
- Coordination between the designer and the Brazilian construction company was essential. ENGECORPS, the Brazilian subsidiary of TYPSA Group, besides developing the production was responsible for overall coordination. The core production was developed by TYPSA in Spain whilst TECNOFISIL, the Portuguese subsidiary of TYPSA Group, carried out geotechnical studies and translated most of the technical documents. Up to 300 technicians from TYPSA Group, including engineers, architects and draftsmen, worked on the construction project.
- The development of the unit construction projects under the 'fast-track' schedule was the basis for a production chain of construction works in which as many as 14,000 workers took part.



Work Schedule.

* *Technical support not directly contracted by the concessionaire*

TThe design was carried out in parallel with the construction in 19 months, from 10 offices in three different countries by 300 engineers and technicians. Over 600,000 digital files and 8,900 drawings were produced and up to 14,000 workers were employed by the construction company during peak operations.

EXCELLENCE IN DESIGN AND CONSTRUCTION:

Ideal solutions for today's most demanding requirements.

Attention to detail was a key factor in the design and construction of the airport and several innovative and cutting edge design features were incorporated into the project.

- **Structures:** The airport structures were constructed using reinforced concrete, prestressed concrete and structural steel whilst all were designed in accordance with the local construction regulations and techniques. The industrialisation and prefabrication of the structural components was the overall design strategy and the construction of more than 23km of prefabricated beams is testament to the success of this approach. TYPSA´s structural design teams produced 150 unit construction designs in 32 weeks, generating 2,745 construction drawings, averaging 25 new plans per day.

- **Architecture:** One of the principal features of the terminal 3 building is its cathedral-like interior and huge glass facades that allow huge quantities of natural light to penetrate the building whilst providing thermal and acoustic insulation, enhancing user comfort and safety whilst also taking into account architectural aesthetics.

  The roof also features skylights that allow natural light to seep into the public areas and connect to the building's smoke detection system, opening up in the event of a fire. An aluminium sloped deck (<10% gradient) was selected as the constructive solution for the roof, combined with a high-performance rack-type connection joint, composed of a lower support plate of galvanised sheet steel, elastomeric elastic membrane with an aluminium-coated water vapour barrier with a multi-layered core for thermal and acoustic insulation composed of laminated plasterboard and high-density Rockwool panels.

- **Aerodrome, taxiways and runways:** Work started with geotechnical reports based on land surveying and analysis of the cadastral topography of the existing pavement structures that subsequently enabled the development of a complete airport engineering project. The executive project details the expansion of the manoeuvring area of the airport, including the runways and taxiways as well as the aircrafts parking areas.

- **Drainage:** Both subsurface and surface drainage systems were installed in the aeronautical pavements using guttering and other specialised structures including drainage networks that separate oil and water, thus preventing the impact of fuel spills and other hydrocarbons from maintenance and operational processes performed at the airport apron. Different lengths and types of coatings to optimize and minimize the channel performance were studied and the network of collectors was designed for a return period of T=10 years, ensuring adequate gravitational flows of up to 40 m^3/s.

- **Road System:** Customised software TRAZADO 3.0, a system for linear designs developed by TYPSA for Windows, was used for the road network, allowing the automatic reading of digital terrain models. Geometry was the key element of the road project as the proposals defined, aimed at ensuring the circulation of vehicles in and out of the new terminal TPS3, and the levels of loading and unloading prefixed by this new infrastructure limited the free choice of the proposed route. In addition, some of the roads were required to deviate or extend existing ones, justifying the tight parameters that were applied to comply with the existing roads.

- **Flight Protection installations:** Defining the geometric and operational characteristics of the aerodrome required aircraft positions and other aircraft support and service infrastructure to be defined, such as the position of the fuelling pits, the technical specifications for the procurement of Passenger Boarding Bridges (PBB), 400 Hz power systems and aircraft air conditioning systems. A specific study of virtual operation simulation was conducted using PathPlanner software developed by Simtra. In addition to the operational study, protection facilities included the definition of apron night lighting and road markings, taxiways and runways, classification of the main and auxiliary taxiways, indicative routes and other compulsory boundaries to achieve the level of service required by ICAO (International Civil Aviation Organization).

- **Electrical system:** For the 1-B expansion phase of Guarulhos Airport it was necessary to revise the existing electrical system, setting up a new 13.8 kV medium voltage system as well as the expansion of the installed capacity to service the new Terminal TPS3 through the construction of a new Utilities Centre (CUT1) provided with a substation for ancillary services with two 1,250 kVA power transformers, a capacitor bank and a 200 kVA diesel generator and a No Break UPS of 20 kVA. High performance and efficiency luminaries were defined as internal lighting of the Terminal TPS3, considering factors such as energy saving and architectural lighting. Efficient visual comfort (EVC) was obtained by vertical illumination, effective lighting technology and efficient light sources. The influence of sunlight was regarded as one of the characteristic features of architectural design which, in turn, determined the function, design and required efficiency of the lighting system.

- **Electronic equipment:** he new terminal was equipped with modern electronic systems such as SDH (Universal Data and Time System), SISOM (Sound System), SIDO (Aircraft Docking System), SDTV (System for TV and FM signal Distribution), and SIGUE (System for management of Utilities and Energy).

- **Mechanical installations:** These include the air conditioning and ventilation system of the new TPS3 passenger terminal building and ventilation of the access tunnel to the loading and unloading docks as well as the automated baggage handling system (BHS).

- **Equipment:** The project included the installation of 62 elevators, 21 escalators and 27 moving walkways. The elevators are electric traction elevators designed for heavy passenger traffic without the need for engine room and all are fitted with fire doors. High performance motors with gearless synchronized drives, frequency converters and energy recovery systems are used to aid energy efficiency. All escalators have a maximum inclination of 30 °, speed of 0.5 m/s, 3 horizontal steps in the landing areas and a width of 1000mm. Moving walkways of varying lengths were installed all with a width of 1200mm.

THE PRINCIPLES OF TRANSPARENCY AND INTEGRITY

The Brazilian government decided to grant airport concessions as a way of expanding the country´s existing airport infrastructure, allowing for greater efficiency and improving the quality of service on offer. The airports under concession would be subject to continued monitoring by the National Civil Aviation Agency (ANAC) whilst the airspace would remain under state control.

The objective was to annually recuperate the financial contributions offered by the winning bidders and reinvest them in projects aimed at strengthening and promoting Brazil´s civil aviation and airport infrastructure through the national Civil Aviation Fund (FNAC). In this way, the Federal Government has assured that other airports in the national aviation network, especially the regional airports, will also benefit from private sector funds.

In December 2011, the announcement for the concessions of Guarulhos, Brasilia and Campinas international airports was published by the Brazilian Government in country´s Official Gazette. The three airports had been included in the National Privatisation Plan. The process took 6 months to complete and included, among others, the participation of the Presidential Department of Civil Aviation, the Chief of Staff, the Ministry of Economy, the Ministry of Planning, Budget and Administration, the National Civil Aviation Agency (ANAC) and the Air-Force High Command.

The minutes of the tender process and of the contract, along with the technical, economic and environmental feasibility studies, were presented to the general public and ´face-to-face´ sessions were held in Brasilia and Sao Paulo in order to guarantee a participative and transparent process. As a result of these measures, several alterations were made to the concession documentation, such as the inclusion of a stipulation requiring the obligatory use of an airport operator with proven experience in the sector along with various other changes aimed at making the announcement and contract clearer and in line with the societal interests.

The environmental and economic feasibility studies were sent to the Union Court of Auditors (TCU) and were approved by the tribunal with the corresponding recommendations and determinations. Additionally, the announcement of the concession contract was also sent to the TCU for consideration.

The public bidding processes took place in February, 2012 at the Sao Paulo Stock Exchange and was conducted in such a way that firms were able to compete for the contracts of all three airports but could only win the operational rights to one. This model was chosen in order to stimulate competition between the participating firms. Minimum bid levels were established and the firm with the project showing the most valuable contribution to the airport network was chosen as the successful bidder. All firms involved in the bidding process, or at least one of the bidding group members, were required to have at least 5 years' experience in airport operations management. Bidding was open to Brazilian and foreign companies, either as consortiums or individual firms.

Additionally, the signed contracts also included the establishment of international quality regulations, such as adequate levels of comfort and security.

Winning bidders had to complete the construction projects for the FIFA 2014 World Cup in a maximum period of 18 months from the signing of the contract. The contract also stipulated that large fines would be issued for failure to comply with this time frame.

The World Cup has served as a catalyst for investments in Brazil that otherwise wouldn´t have taken place. There has been significant investment in urban mobility projects, in airport modernization projects, in port modernization projects, telecommunications infrastructure and security infrastructure that have provided jobs for hundreds of thousands of Brazilians, and have benefited people in terms of the services provided. Sao Paulo, like many Brazilian cities, saw the exposure that it was going to gain hosting matches as an opportunity to position the city as an attractive destination to potential investors and tourists, in the present and in the future.

In accordance with FIDIC Policies of Transparency and Integrity, the companies from TYPSA Group participating in the development of the project at all times:

- Provided services of high technical and professional quality.
- Followed the standards of ethical professional conduct.
- Did their upmost to safeguard public interests and the environment.
- Sought sustainable solutions in the application of their activities.
- Maintained the dignity, prestige and reputation of the consulting industry.

SUSTAINABILITY AND RESPECT FOR THE ENVIRONMENT

As important as improving mobility within cities is the need for increased efficiency of airport systems. Guarulhos International Airport has the advantage of being the country's largest whilst possessing improved facilities and design solutions that reduce environmental impact and at the same time generate operational and financial benefits as well as wider benefits for society and the local community.

- **Centralisation of long-haul flights:** The terminal change has been a strategy not only to provide more comfort and convenience to passengers, but also to promote the creation of new routes and increasing air traffic in the area. This new infrastructure has improved the mobility of citizens in a large city and encouraged tourists to visit the area, besides arousing investor interest enabling the realization of large projects. In addition, the centralization of flights on the terminal allows greater efficiency in the management of airport operations by reducing the dispersion of routes.

- **Ease of movement:** Solutions were designed and implemented to support a larger number of passengers and improve the distribution and transfer of passengers embarking and disembarking. Circulation inside the terminal is performed via lifts, fixed stairs, escalators and moving walkways. All designed with the objective of minimizing long distances and saving time for passengers. Among the technologies implemented to facilitate the flow of passengers and accelerate boarding kiosks are self-check-in, baggage handling and automatic electronic immigration and emigration gates (e-gate).

- **Sustainable design:** Various measures implementing the concept of sustainability and reduced environmental impact have been adopted. Building design and construction materials focused on reducing energy costs over the life of the building. The use of natural lighting, materials with higher thermal efficiency, capturing rainwater for reuse, integrated solid waste management and elevators which recover energy generated from the own movement all help to reduce resource consumption and reduce the airport's carbon footprint.

  High performance double glazing was installed in all the buildings facades. Both external faces of the glass are laminated with a butyral film whilst the internal gap between the panes is 20 mm, decreasing the heat exchange between the inside and outside and thus economizing the use of air conditioning systems. This composition allows the entry of light and acts as thermal and acoustic insulation, providing greater comfort inside the building. According to Andrei Almeida, an Engercorps architect, the glass facade allows a light transmission of 50% with a solar factor of 30% and an acoustic attenuation of 40 dB.

- **User well-being:** Firstly, natural lighting of the terminal building through the installation of large glazed facades was made a priority. The design has enabled the efficient use of energy and allowed expansive views of the runways as well as putting increased value on internal spaces helping to provide a feeling of comfort for passengers. Secondly, meticulously designed internal gardens were created making use, exclusively, of native species adding to the feeling of comfort and tranquillity.

- **Reduce, Reuse, Recycle:** As well as the efforts to reduce energy and resource consumption, designs were also incorporated that reuse and recycle materials. The terminal roof has been designed to harvest rainwater which, along with grey water from gentle uses, is treated, stored and reused for cleaning, sewage discharges and other compatible uses. This has resulted in a substantial reduction in water demand at the airport and helped to achieve significant economic savings. The terminal building also has recycling systems and solid waste compactors, incorporated into the basement units.

- **Economic legacy:** The nature of the concession model approved by the Brazilian government for Guarulhos Airport planned for the inclusion of Infraero as a minority shareholder with a 49% stake in the concession. The dividends received from this stake will be used for reinvestment in other airports in the country ensuring the redistribution of wealth in the domestic economy.

CONCLUSION

The importance of the Guarulhos International Airport Expansion project for the country and the quality of the work carried out were highlighted by the Brazilian President, Dilma Vana Rousseff, during the official inauguration ceremony.

"This is a special moment in which we are starting to see the fruits of the investments made in the airport industry. And we know that it was worth it when we see a work like this."