From Guanabara Bay to the upper seats of the Maracanã stadium, PENETRON technology stands behind much of the new infrastructure built for the 2016 Olympic Games in Rio de Janeiro, Brazil opening on Friday, August 5th.

Officially called the Games of the XXXI Olympiad, the Rio 2016 Olympics, brings together 206 participating countries to compete across 42 sports in 306 events at 37 venues in and around Rio de Janeiro. It’s easily the biggest sports event on the planet! The prospect of the Rio 2016 Olympics unleashed a decade-long construction effort to expand local infrastructure for the half million tourists expected to show up during 16 days this month.

Cláudio Neves Ouirves and his PENETRON team in Brazil have unveiled many individual projects over the past year. Our PENETRON Industry Newsletter gives an overview of the projects that feature PENETRON crystalline technology. See our website for more information on the recent projects we’ve completed.

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This new aquatic facility will host the swimming and water polo events for the Rio 2016 Olympics as well as the swimming events for the Rio 2016 Paraplegic Games. The stadium features sustainable functions such as natural ventilation instead of a closed air conditioning system. The grandstand is closer to the athletes with the first row is only 10m (33 feet) from the pool. The facade, made of 66 panels and about 27m (90 feet) high, reproduces Adriana Varejao’s ‘Coelacanth Causes Tsunami.’
The facility has two pools, one for competition and one for training, each with about 3.7 million liters (977,440 gallons) of water. There is also a special filter that reduces by 25% the use of chemicals and removes impurities from the water. The concrete pool structures of the facility offices were treated with PENETRON ADMIX; the construction joints are sealed with PENEBAR SW-55 waterstop.

**Rio Olympics Media Center**

This LEED Silver-certified office building serves as the media center for the Rio 2016 Olympics; it combines a press and broadcasting center – the Main Press Center (MPC) and the International Broadcasting Center (IBC) – in a 17-floor tower with a two-floor basement, a total of 78,450 m² (844,430 square feet). After the Rio Olympics, the facility will be repurposed as a business office complex.

The IBC occupies both underground floors and five aboveground floors, about 23,100 m² (248,650 square feet). The MPC is housed on the remaining floors.

PENETRON ADMIX and PENEBAR SW-55 waterstops was extensively used to protect the concrete of the basement slab of the Rio Olympics Media Center.

**Olympic Promenade**
The "Olympic Promenade" or pedestrian zone is an allusion to the walkway of the famous Copacabana, a landmark of Rio de Janeiro as well as an allusion to the rays of an athletic track.

The promenade begins at the entrance of the Olympic Park, near the Olympic Games Bus Terminal (BRT) and trails through the entire Olympic Park along the Press Centre, the Imprenssa Hotel as well as the International Broadcast Centre (IBC) and ends at a large "live" stage.

The "Olympic Promenade" and Olympic Park are connected to the BRT bus terminal by an underground passage. This passage was waterproofed and protected by the use of PENETRON ADMIX, PENETRON and PENEBAR SW-55 waterstops.

Maravilha Port District

Managed by the Concessionaire Porto Novo (including Odebrecht Infraestrutura-Brasil, OAS and Carioca Engenharia), this massive redevelopment project is one of the largest public/private partnerships in Brazil. With an area of 5 million m² (2 square miles), a previously run-down port area of Rio de Janeiro has been transformed into a modern urban center.
PENETRON technology has been applied extensively throughout the project, especially in construction of the new infrastructure – street lighting, electricity, sewage, gas, water, telecommunications and drainage – as well as for commercial, residential and corporate buildings. The addition of public squares, sidewalks and bike paths has created a people-friendly environment. Traffic flow was improved with the Expressa and Binário roads, and these improvements have helped realize the new Light Rail Vehicle (VLT) public transport line, also a PENETRON project.

The centerpiece of the Porto Maravilha revival is the "Museu do Amanhã" (Museum of Tomorrow), described below in detail.
Museum of Tomorrow / Museu do Amanhã
Designed by renowned Spanish architect Santiago Calatrava, this new museum is the centerpiece of the huge revitalization effort for the Maravilha port area. Located on the Mauá Pier on the shores of Guanabara Bay, the museum (15,000 m² /162,000 square feet) combines the rigor of science and the expressive language of art, with supporting technologies to create immersive environments, audiovisual installations and interactive games to give visitors a look at the past and imagine possible futures.

The building architecture of organic shapes (inspired by bromeliads from the Rio Botanical Garden) integrates sustainable functions, such as using water from the Guanabara Bay to supply the reflecting pools and for the air conditioning system; the museum roof also moves to track the sun’s position and maximize the efficiency of the solar arrays. The rainwater captured by the roof is used to supplement the irrigation of gardens, water for toilets and to wash the museum floors.
The museum was built with 55,000 tons of structural concrete. The basement houses machinery and water pumps for water transport, cooling and treatment. **PENETRON ADMIX** was specified for the concrete used in all belowground structures and the ground floor slabs and reflecting pools to ensure a self-healing capability, effective even in high water pressure situations. The admixture ensures impermeability of the pores and fissures found in concrete, especially important when the concrete is exposed to aggressive agents from seawater, such as chloride and sulfates. The concrete joints were sealed with **PENEBAR SW-55**; the basement walls were covered with **PENETRON** for added protection from negative hydrostatic pressure. Finally, concrete repairs were done with **PENETRON V/O PATCH**, a high adherence polymeric mortar.
Porto 2016 Gamboa

An ambitious port district revitalization project similar to the Porto Maravilha effort, this complex will host the Village of Arbitrators and Media of the Rio 2016 Olympic Games. In 2017, this complex of commercial, residential and service buildings will open to residents and private companies.

Comprising 1,333 apartments and 33 retail stores covering 19,000 m² (204,510 square feet), PENETRON provided a crystalline waterproofing solution (PENETRON ADMIX) for the water tanks used in the project’s water supply system, and PENEBAR SW-55 waterstop for the construction joints. PENETRON ADMIX is approved for potable water applications as specified in the NBR 12170:09 guidelines.
Porto Atlântico

This LEED-certified urban revitalization project of the Porto Atlântico area comprises office and retail buildings, and a hotel housed in seven towers on two adjacent lots. The East Atlântico Port (16,000 m² / 172,220 square feet) features IBIS and NOVOTEL hotels (450 rooms), a commercial tower (330 units), a corporate tower (54 corporate units) and 50 stores; the West Atlântico Port (and 12,000 m² / 129,200 square feet) has three corporate towers with a private area of about 66,000 m² (710,420 square feet).

The basement structure was treated with PENETRON ADMIX to provide concrete waterproofing protection against the negative pressure of the groundwater. In addition, with 0% VOC content, PENETRON ADMIX contributed points toward the project’s LEED certification.
Brazil made sizeable investments in Rio’s public transportation system to help meet the expected spike of visitors to the Rio 2016 Olympic Games. The most significant projects focused on the subway system, such as the wholly new Line 4 that connects Barra da Tijuca in the western part of the Rio with Ipanema in the south. The new subway line is 16 km (10 miles) long, with six stations and a daily capacity of over 300,000 people.

**PENETRON** topical crystalline material and **PENEbar SW-55** waterstop were used to waterproof the walls and seal the construction joints of the subway stations.

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**Rio Light Rail Line**

Connecting the Rio city center with the Maravilha Port area, the new light railway (VLT) is 28 km (17½ miles) long and has 32 stops. As part of an integrated public transport system connecting metro, trains, cable car, BRT, conventional bus networks and an airport (Santos Dumont), the rail line is a 24/7 public transportation system with a capacity of 300,000 passengers per day.

To optimize the durability of the concrete sub-base and the rail galleries, **PENETRON ADMIX** was used to treat all concrete used in the sub-base, line galleries and the VLT workshops.
Copa Star Hospital

Set to open in the second half of 2016, the Copa Star is one of the most modern medical facilities in Brazil. The hospital will feature smart operating rooms, hybrid treatment areas, a neurosurgery facility with MRI equipment, robotic medicine capabilities and telemedicine. With 150 beds, 45 ICU and 105 apartments, nine operating rooms and a diagnostic sector, the hospital was chosen by several countries participating in the Rio 2016 Olympic Games as a reference medical facility.

**PENETRON ADMIX** was used throughout the concrete of the hydrostatic slab and the poured-in-place retaining walls, to ensure the low permeability of the concrete and the structural durability. **PENEBAR SW-55** waterstop was used for the concrete construction joints.

Rio 450 Tunnel

Named in honor of Rio’s 450th anniversary, the Rio 450 is the first underground traffic tunnel in the city. The tunnel is 1,480m (4,860 feet) long with a projected flow of 55,000 vehicles per day to connect the city with the Maravilha port area. It is the second largest tunnel of the Porto Maravilha region, surpassed only by the Via Marcello Alencar Tunnel (see below). The tunnel features a high-tech traffic and safety management system.

Using the NATM (New Austrian Tunneling Method), primary and secondary coatings of shotcrete were applied; **PENETRON ADMIX** was added to the secondary shotcrete coating. A coat of **PENETRON** topical material was applied to the rocky areas as a thin shotcrete layer.
The new Marcello Alencar Tunnel is the longest tunnel in the country (3,370m / 11,060 feet long) and is expected to reduce traffic by 20-30% during rush hour. A key artery for the Maravilha Port area, it replaces the Elevado da Perimetral Highway. The tunnel connects with Via Expressa near Armazém 8 and stretches out to Avenida General Justo near Santos Dumont Airport. Its deepest depth reaches 46m (150 feet) below sea level. Each direction of the tunnel has three lanes with a capacity to move 50,000 cars daily.

The two tunnels (1.2 km / ¾ mile) used the NATM for construction. The first tunnel layer was cast in-situ, while the second layer was a shotcrete application treated with PENETRON ADMIX. Nine km (5.6 miles) of PENEBAR SW-55 waterstop was used to seal the construction joints.
Rio's Galeão International Airport has undergone a massive infrastructure expansion, including expanded terminals, a new lobby building, a network of connecting bridges and a doubling of the parking areas (now 6,450 spaces). Currently, the airport processes about 17 million passengers annually; it will now be able to accommodate 3x more passengers expected within the next 10 years.

A major part of the project is the new lobby building that helps streamline passenger loading and unloading through a network of 26 bridges that connect to the aircraft. The new infrastructure enables the processing of simultaneous flights without the need for a new runway for takeoff and landing. The doubling of parking spaces was completed by adding four floors to the Terminal 1 Parking and construction of a new Terminal 2 Parking facility. PENETRON ADMIX was added to all ground-level and below-ground concrete.
The largest marine aquarium in South America, Aqua Rio has 28 tanks (4.5 million liters / 1.19 million gallons of salt water) on two floors that provide living space to 8,000 creatures from 350 different species. The largest tank is 7m (23 feet) deep with a 500 m² (5,590 square feet) footprint; the acrylic tunnel functions as a visitors’ entrance.

To ensure absolute resistance to the chloride penetration from the salt water and long-term durability of the tanks, all concrete structures were treated with PENETRON ADMIX and the construction joints were sealed with PENEBAR SW-55.
The Hotel Arena Leme, a 164-room hotel (16,845 m² / 181,318 square feet) in the south of Rio de Janeiro, was built adjacent to the Copacabana Beach. Initially, diaphragm walls were considered to secure a job site with sandy soil and a high water table, and also ensure a stable concrete foundation. The engineers at Lafem then looked to alternate, more efficient technologies. Finally, a “white tank system” was chosen to ensure an impermeable structure. A “dry pile” method used smaller excavations at the job site and poured concrete in smaller batches. PENETRON ADMIX was added to the new concrete; PENEBAR SW-55 waterstop, PENETRON crystalline topical material, PENECRETE MORTAR and PENEPLUG were also applied.
Hilton Hotel Barra Rio de Janeiro

Just minutes away from the Olympic Park and ideally located in the business district of Barra da Tijuca, the new Hilton Hotel has 298 rooms and offers in-house restaurants, bars, five meeting rooms, two ballrooms and a 24-hour business center. The rooftop pool has views of the lagoon.

Due to the high water table in Barra da Tijuca, an impermeable basement structure was needed. PENETRON ADMIX was used to treat all concrete used in the belowground structures.
Trump Hotel Rio de Janeiro

The first Trump-branded building in Latin America, this beachside hotel in Barra da Tijuca was built on 16,000 m² (172,250 square feet) of floor space stacked on 13 floors and two basement levels. The hotel offers 170 units, with rooms of 34 m² to suites of 450 m², and a heated swimming pool with a view of the ocean.

The high water table (due to the proximity to the sea) and the belowground job site presented Lafem Engenharia, the project builders, with formidable challenges. Before a foundation could be poured, the water table needed to be lowered; over 2,170,800 m³ of water (76,661,080 cubic feet) were drained from the site, enough water for more than 6,400 families of five people for nine months!

A “white tank system” was chosen for the belowground waterproofing solution, using PENETRON ADMIX to treat the concrete and PENEBAR SW-55 to seal the construction joints. PENETRON crystalline topical material, PENECRETE MORTAR and PENEPLUG were also applied.
Barra da Tijuca, an exclusive district in Rio famous for its beautiful beaches, luxury condos and large office complexes, also offers shopping, restaurants and cultural attractions. It is also near famous Rio districts such as Copacabana, Ipanema and Leblon, while the Galeão International Airport is about 50 minutes by car.

This luxury beachside hotel has 436 rooms, including 40 suites and three large penthouse suites, and a pool. The ground floor features three restaurants, a leisure area and two large convention centers; the mezzanine offers nine meeting rooms, a business center; the spa and gym are on the 1st basement level. Guests can enjoy the seaside location of the hotel, overlooking the greenish-blue Atlantic Ocean and surrounded by the Lagoa de Marapendi (Marapendi Lagoon).

The basement area lies under the water table. PENETRON supplied a solution for the construction joints (PENEBAR SW-55) in the hydrostatic slab; PENEPLUG was used to seal all leaks at the foundation anchor points.