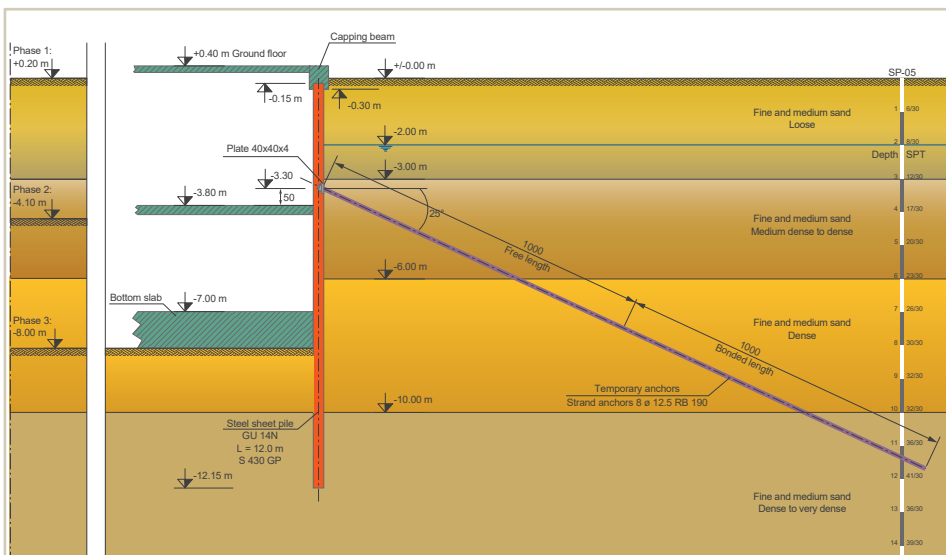




Vogue Square | Underground car park
Rio de Janeiro | Brazil



Typical cross section - Close to borelog SP-05

Recreio dos Bandeirantes is a nice neighbourhood located about 35 km from Rio de Janeiro's city centre. This youngest district of the city, with a population of around 100 000, continues attracting middle and upper-class families looking for an environmentally-friendly and safer place to live.

Being a relatively recent development, the architecture consists primarily of small buildings and residences close to the seafont, with up to three stories. However, like in most urban cities, parking area is a challenge for new residential buildings and shopping malls.

The choice of the two-level underground car park for the new shopping mall and hotel Vogue Square was quite straightforward, and the design engineer proposed to the owner a still quite rare solution in Brazil: *steel sheet piles used as the permanent retaining wall around the parking*, but foremost, the sheet piles stay apparent. To enhance aesthetics, sheet piles are coated.

ArcelorMittal supplied **355 tonnes** of **12.0 m long GU 14N** sheet piles in steel grade **S 430 GP**. According to European standards (EN 1993-5), retaining walls built with U-type sheet piles should be installed as double piles, and each double pile should transfer shear forces, so the double piles were delivered crimped (standard pattern).

The ground consists of **loose fine sands** in the upper layer, and **medium to dense sand** deeper layers, with SPT values ranging from 6 at the top up to 41 at the tip of the sheet pile.



Vogue Square | Underground car park Rio de Janeiro | Brazil

Project owner Construtora Calçada S/A (www.calcada.com.br)
 Consulting engineer ABS Engenharia (www.absfundacoes.com)
 General contractor Construtora Calçada S/A
 Driving contractor ThyssenKrupp Brasil
 Steel sheet piles GU 14N S 430 GP 12.0 m 355 t

During the temporary excavation phase, the sheet pile wall was anchored with one row of **grouted anchors** at elevation -3.30 m. The pre-stressed strand anchors were $8 \varnothing 12.5$ RB 190, 20 m long, with a minimum resistance of 736 kN working load. During the service life, the anchors are released and the **concrete slabs act as permanent struts**. The top slab is 30 cm thick, the second slab is 40 cm thick, and the 100 cm thick bottom slab of the parking was designed as a raft foundation to resist the hydrostatic pressure due to groundwater (Archimede's principle, around 6 m of water pressure difference).

The **design life of 50 years** can be achieved by combining a **coating** protection with an estimated loss of steel thickness of 1.0 mm on the bare steel surface in the atmospheric zone. The coating system is a 180μ thick **epoxy layer on a zinc primer**, applied only on the excavation side, over 60% of the sheet pile length.

The project started in 2014, and the sheet piles were supplied and installed between August and September of 2014. The key advantage of the steel sheet pile solution was definitely its fast execution. It took the contractor only 35 days to install the 230 double piles, with a daily average rate of 6 to 7 double piles. ThyssenKrupp Brasil drove the sheet piles using a **vibratory hammer ABI MRZV 30VV** with a centrifugal force of 1 500 kN, and a variable static moment of 30 kgm, mounted on an excavator ABI MOBILRAM TM 20/25 SD. It is worthwhile to note that the sheet piles were driven close to an

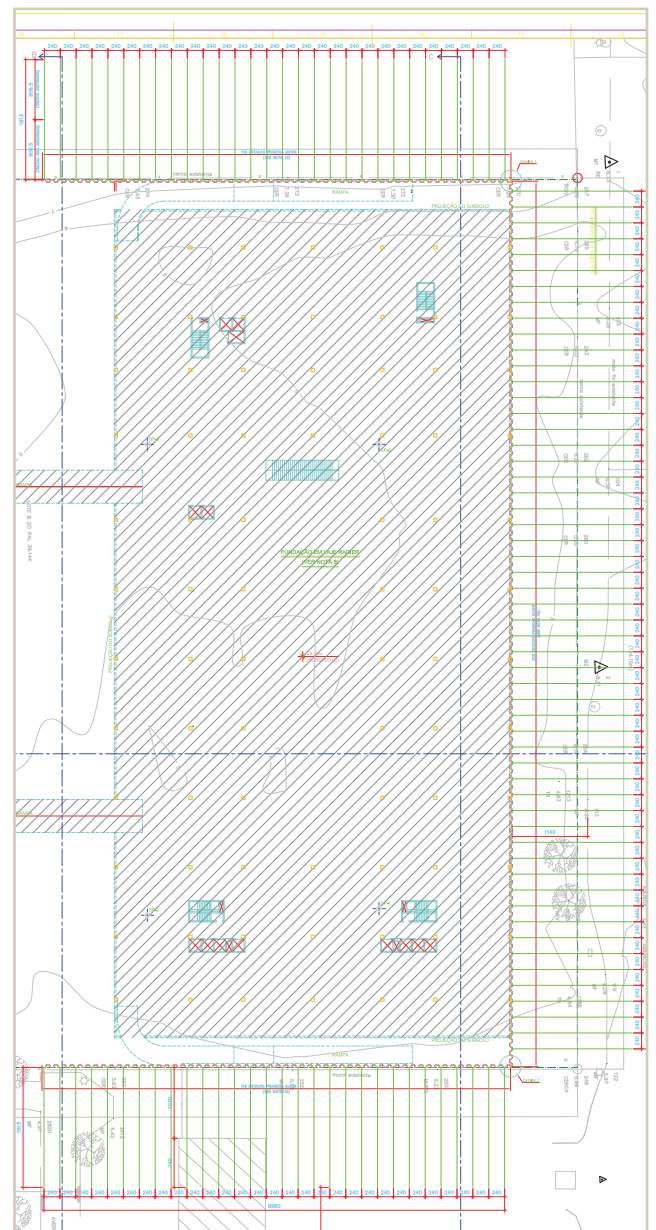
existing building without affecting its operations nor its foundations.

The groundwater was lowered during the various execution phases by using wells inside the excavation.

Additional key advantages of the sheet pile solution were the **high watertightness of the wall**, the great, yet uncommon aesthetic aspect, the reduced number of workers required to execute the retaining wall, and the fact that being a prefabricated element, there is no need for curing time or inspection of the quality of in-situ poured material. Besides, such a work environment is quite clean for a construction site.

A concrete capping beam on the head of the sheet piles allows for an impeccable finish, and for transmission of vertical loads from the superstructure to the soil.

The mall and the hotel opened in 2016.



Layout

ArcelorMittal Commercial RPS S.à r.l.

Sheet Piling | 66, rue de Luxembourg | L-4221 Esch-sur-Alzette | Luxembourg
 T (+352) 5313 3105 | sheetpiling@arcelormittal.com | sheetpiling.arcelormittal.com