

TECHNICAL REFERENCE



The Algiers Metro

a modern means of transport

Alger, Algeria



Bored Piles
Cased Secant Piles
Ground anchors,
jet grouting, micropiles
Diaphragm Wall
(Hydromill)

Owner:

L'Entreprise du Métro d'Alger (EMA)

Main Contractor:

Groupement GAAMA - Groupement GDTC - Groupement GDC

Duration of works:

2006 (Section Hamma - Hai El Badr) - 2012 (Hai El Badr-El Harrach)
2014 (Hai El Badr-Ain Naadja)
2021 (El Harrach centre - Algiers Airport)
in progress 2022 (Ain Naadja - Baraki)

Introduction

Like all major capitals in the world, the city of Algiers has developed its underground railway system. Regardless of the circumstantial uncertainties that this project has coped with, today the Algiers Metro has blossomed into reality.

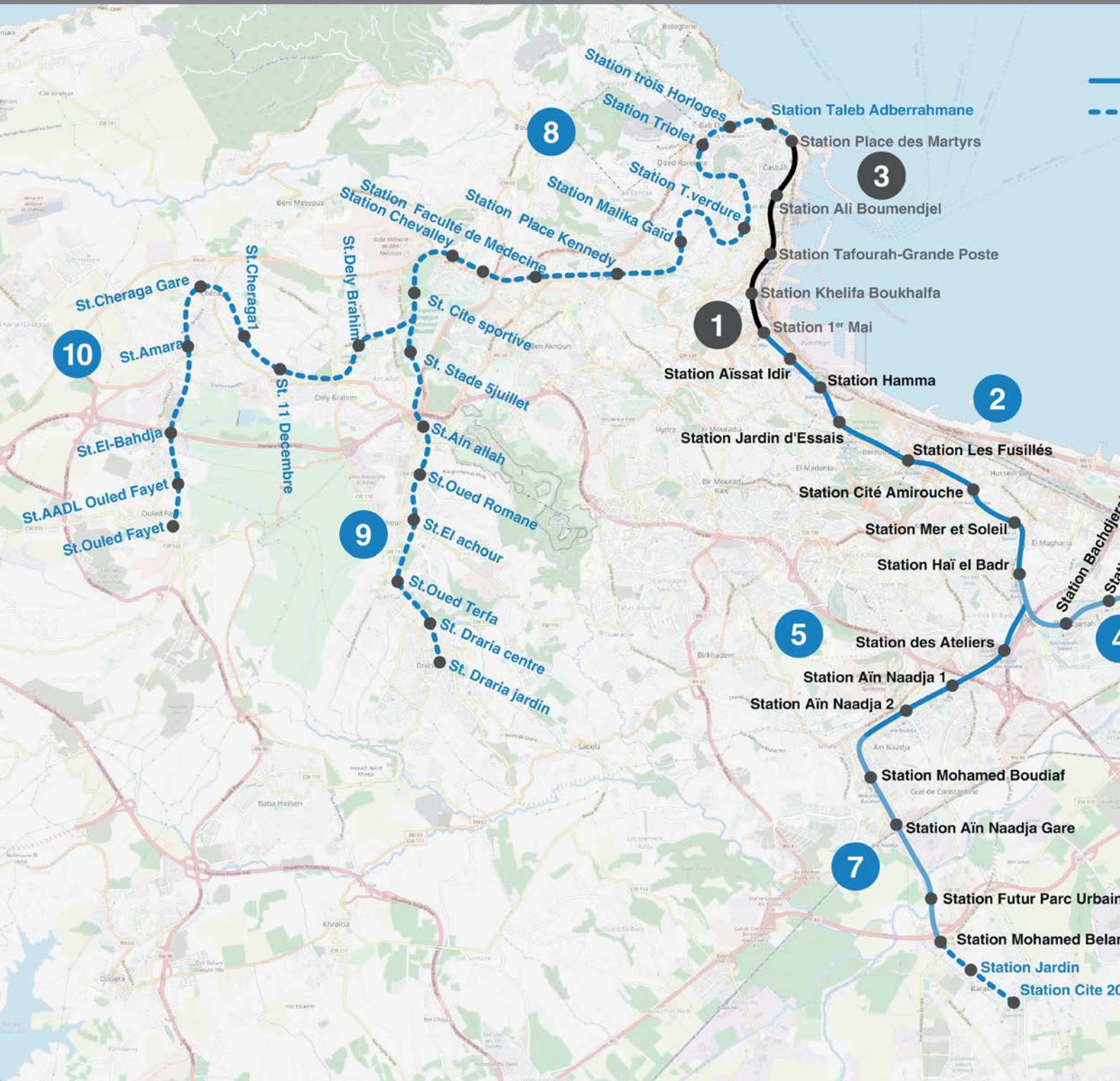
The **first project of the Algiers Metro dates back to 1928**, but it was not until the end of the 1970s that the actual metro initiative was launched to face the demographic explosion of the city and the resulting need for public transport. Started in the 1980s, its construction was slowed down due to financial difficulties and a sense of insecurity that marked the 1990s. The project was relaunched in 2003.

Geology

Trevi has played a key role in the development of this challenging scheme. **Indeed, since 2004, Trevi has been involved in the construction of all foundations and soil consolidation activities associated to the project.**

Due to the high heterogeneity of the soils underlying the city of Algiers, different technical solutions and equipment have been adopted for the construction of the retaining walls in correspondence of the stations and service shafts.

Continuous diaphragm walls and cased secant pile walls (CSP) have been implemented in the areas where the sub-soil was characterized by fine-grained formations associated to a high water table, while contiguous bored pile walls



were generally executed in cohesive soils.

Next generation equipment and tools have been used to this purpose.

The diaphragm walls have been performed by means of compact and semi-compact hydromills, thanks to their capability to cross and penetrate into dense and hard formations without producing noise and vibrations.

Similarly, advanced rotary or CSP piling rigs have been used to execute the piles in the other locations. Temporary or permanent strand anchors have been generally adopted for anchoring the retaining structures.

All ground anchors were performed step by step by following the excavation of the soil within the retaining structure and were subsequently assembled in dedicated sheltered areas

established at site.

The double-fluid jet grouting technique has been widely adopted to improve the characteristics of the soil around the profile of the mined tunnels to be excavated or to create “impervious” plugs at the bottom of some stations in order to counteract the hydrostatic pressure.



- 1** **Ligne 1 :**
Tunnels : 3,4 km & 4 Stations
COSIDER - GENISIDER
(1988 - 1996)
- 2** **Extension ligne 1**
Tunnels : 5,6 km / 6 Stations
COSIDER - INFRAFER - DYWIDAG
(Avec participation de TREVI)
(2003 - 2008)
- 3** **Extension A**
2 Stations
GROUPEMENT PORTUGAIS
(2009 - 2018)
- 4** **Extension B**
Tunnels : 4,4 km / 4 Stations
DYWIDAG - COSIDER - TREVI
(Avec participation de TREVI)
(2008 - 2012)
- 5** **Extension C**
Tunnels : 3,1 km / 3 Stations
COSIDER - DYWIDAG
(Avec participation de TREVI)
(2011 - 2014)
- 6** **LOT1 - Extension B1**
Tunnels : 10,7 km / 9 Stations
COSIDER
(Avec participation de TREVI)
(2014 - En cours)
- 7** **LOT2 - Extension C1**
Tunnels : 4,3 km 1,5 km Viaduc & 6 Stations
COSIDER
(Avec participation de TREVI)
(2015 - En cours)
- 8** **LOT3 - Bab El Oued - Chevalley**
Tunnels : 8 km & 8 Stations
Extension future
- 9** **LOT4.1 - Chevalley - Draria**
Tunnels : 8 km & 8 Stations
Extension future
- 10** **LOT4.2 - Chevalley - Ouled Fayet**
Tunnels : 6 km & 6 Stations
Extension future



Chérif Grira,
PDG Cosider TP
Cabassa Riccardo,
Branch Manager Trevi Algeria

Works carried out

Line 01 - Phase 01

Section Hamma - Haï El Badr

TREVI was involved in the execution of foundations for the stations **Hamma, Jardin d'Essai, Les Fusillés, Amirouche, Mer et Soleil and Haï El Badr**, making part of the first section of Line 1.

With a linear length of 9.5 km, this section includes 10 stations connecting Grande Poste to Haï El Badr.

This phase involved the execution of an exploration drilling campaign, bored piles, secant piles, a diaphragm wall with hydromill, ground anchors, jet grouting and micropiles.

Algiers Metro Line 1 extension

Haï El Badr - El Harrach Centre

This 4-km-long section covers four stations (*Bachdjarah Tennis, Bachdjarah, El Harrach Gare and El Harrach Centre*), a 280-m-long viaduct, a 408.48-m-long rectangular tunnel, a 2166.54-m-long underground arched tunnel and three air extraction plants.

The Algerian-German consortium GDCT, made up of DIWY-DAG, COSIDER and TREVI, carried out the civil engineering works for this extension.

The project was completed in 47 months.



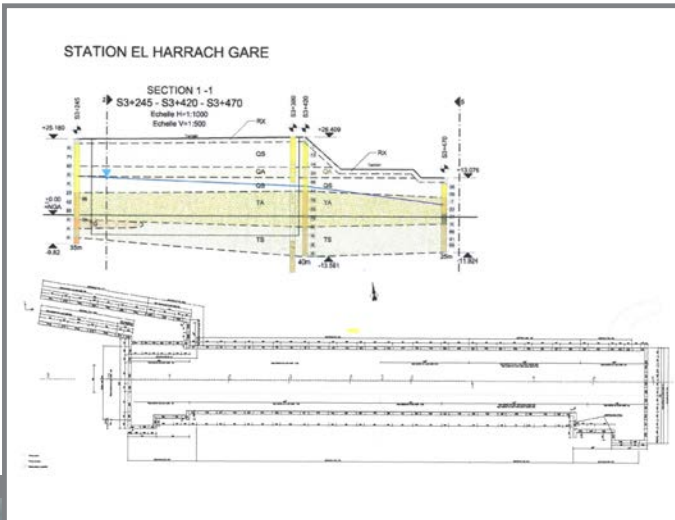
Works lasted from September 2003 to February 2006 and were entrusted to the Algerian-German consortium Gama, composed of Dywidag International (51%), Cosider TP (35%) and Infrafer (14%) for a total of Euro 145 million.

The project management was entrusted to the French company SYSTRA.

Diaphragm wall	600-700 mm _20,586 m ²
Ground anchors	39,134 LM
Jet Grouting	29,217 m ³
Bored piles	12,398 LM
Secant piles	2,545 m ²
Micropiles	1,133 LM

Works carried out:

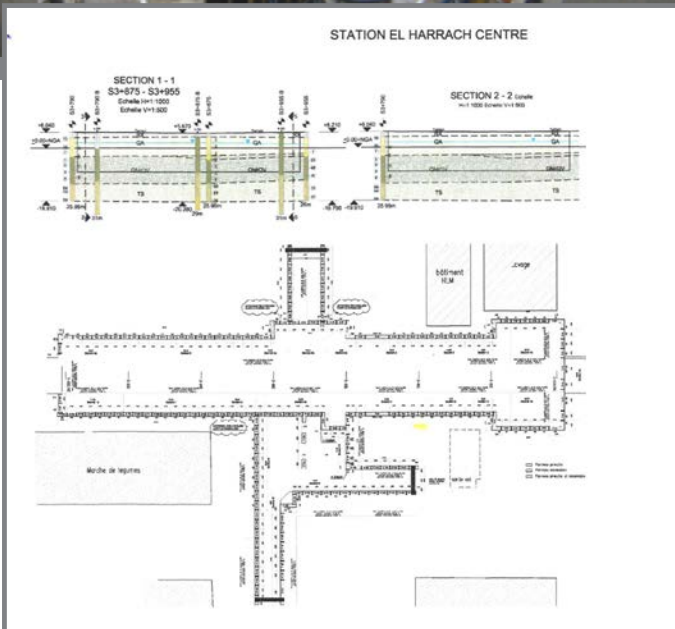
Diaphragm wall	1000 mm _46,788 m ²
Piles	24,047 LM
Ground anchors	118,749 LM
Jet Grouting	26,729 m ³
Micropiles	5216 LM
Sheet piles	2925 m ²
Soldier pile wall	2520 LM



Algiers Metro Line 1 extension Haï El Badr - Aïn Naadja

This section includes platform works, a 132,5-m-long viaduct, a 241,5-m-long rectangular tunnel, three stations (Des Ateliers - Aïn Naadja 1 - Aïn Naadja 2), a 1840,88-m-long underground arched tunnel and three air extraction plants.

The Algerian-German consortium GDC carried out the civil engineering works for this extension, for a total length of 3.6 km.



Works were executed from July 2011 to July 2014:

Piles (ø 600-800-1000-1200 mm): 39,773.88 LM

Soldier pile wall: 979 m²

Ground anchors: 114,042.65 LM

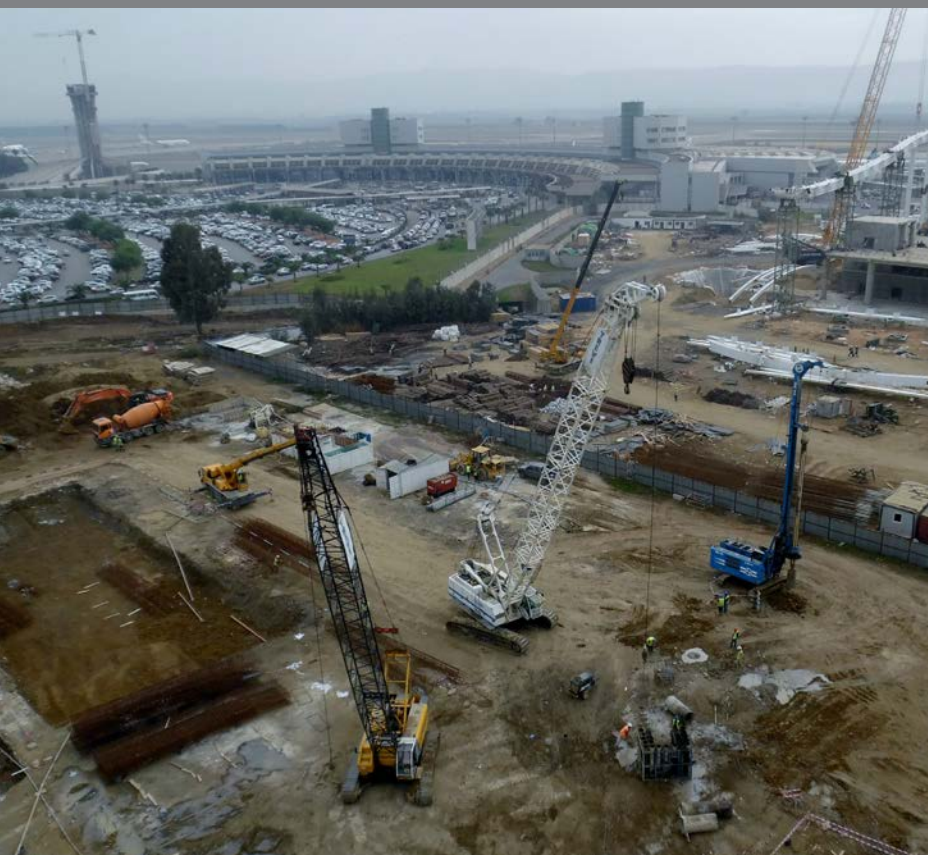
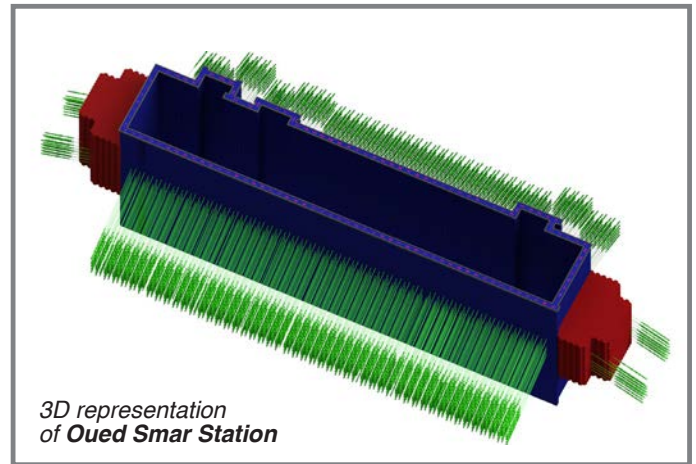
Sheet piles: 212 m²

**Algiers Metro Line 1 extension
El Harrach - Bab Ezzouar - Algiers Airport**

The construction works for the extension of Line 1 of the Algiers Metro, connecting the city centre of El Harrach to the Houari Boumédiène International Airport, were entrusted to Cosider TP and have been underway since June 2015.

With a length of 9.5 km and 9 stations, this line will serve densely populated areas such as Beaulieu, Oued Smar, Cité 5 juillet, Bab Ezzouar, the University Centre of El Harrach, the Business Centre of Bab Ezzouar and the Houari Boumédiène University.

This line will also link the tramway to the Houari Boumédiène

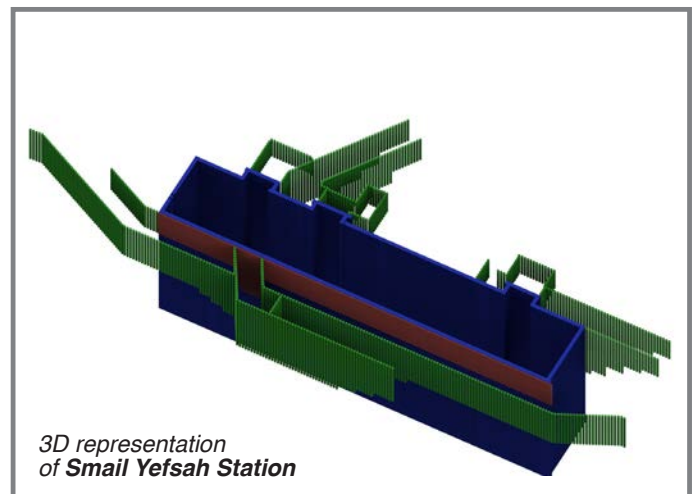


University intersection and will provide this station with a multimodal transportation.

The ten stations making part of this extension are: Hassan Badi, Pôle Universitaire, Beaulieu, Oued Smar, Université Houari Boumediene, Rabia Tahar, Smail Yefsah, Centre des Affaires and Aéroport.

Works carried out:

Diaphragm wall:	111 096.04 m²
Piles:	52 076.10 LM
Micropiles:	7 810.85 LM
Anchors:	19 514 LM
Jet Grouting:	87 576.278 m³



Algiers Metro Line 1 extension Aïn Nâadja - Baraki

The extension of the Algiers Metro going from Aïn Nâadja to Baraki stretches over 6 km with 3 stations and a 1,453.50-m-long viaduct that connects the Mohamed Boudiaf station to the Mohamed Belarbi station.

It crosses the SNTF railway line, the National Road N°38 and Oued El Harrach and comprises two elevated stations: the Aïn Nâadja Gare station and the Futur Parc Urbain station.

This extension provides accessibility to the centre of Baraki and also allows connecting the train at the level of the

Test

Static load tests on Piles according to standard NF P94 150-1: Static load tests were carried out on four (04) piles of the Viaduct making part of the Algiers Metro, line AIN NAA-DJA - BARAKI, the pillar N° 05, N° 11, N° 20 and N° 30 with maximum test loads respectively:

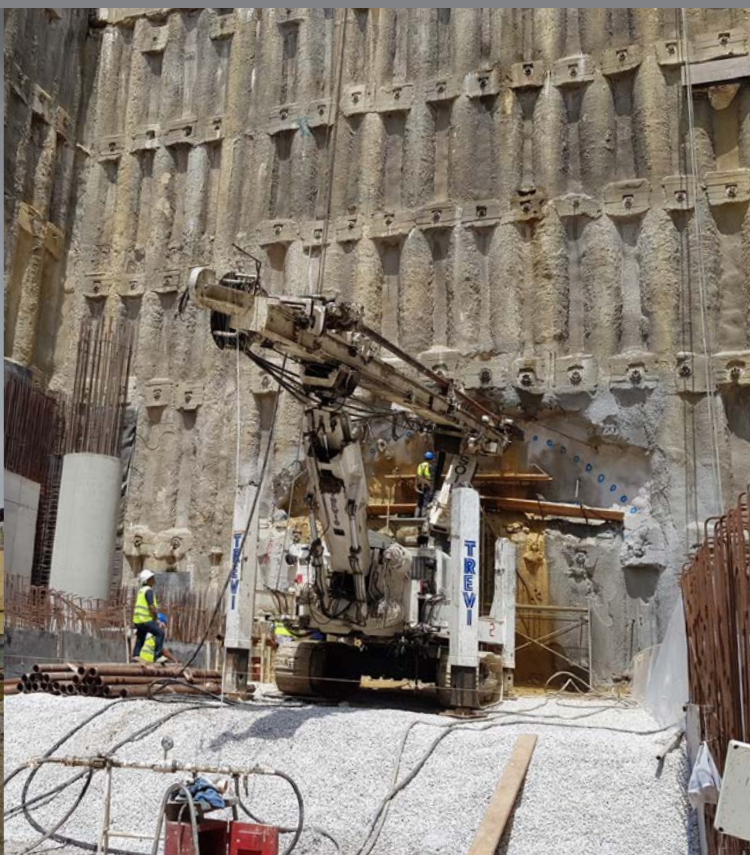
Q05 = 4079 KN

Q11 = 4366.35 KN

Q20 = 4900 KN

and **Q30 = 4034 KN**

and the maximum displacement measured at the end of the last stage under the maximum of test load is 2.65 mm, 5 mm, 2.20 mm and 2.06 mm respectively, comfortably away



Railway Station of Gué de Constantine and the future intermodal station of this municipality. COSIDER TP was awarded the civil engineering contract for this extension.

The stations of this extension currently under construction are: Mohamed Boudiaf, Aïn Nâadja, Futur Parc Urbain and Mohamed Belarbi.

Works for the following stations have not started yet:
Station Jardin - Station Cité 2004

Works carried out:

Piles (ø 800-1000-1200 and 1500 mm): 46,024.27 LM

Ground anchors: 91,200 LM

Forepoling: 42 838.73 LM

Diaphragm wall: 42800 m²

from 120 mm of the conventional failure.

The critical creep load has not been reached (*no significant creep was measured*).

Total quantities:

174.320 km
of bored piles
(\varnothing 1000 - 1500 mm, max depth 71 m)

143.521 m³
of jet grouting

221.270 m²
of diaphragm walls
(1000-1500 mm of thickness, max depth 51,4 m)

382.640 km
of anchors



(December 2020)

Luigi Di Maio, Italian Foreign Minister, visiting the Trevi Algeria construction site for the “**extension of Line 1**” of the Algiers metro.



5819, via Dismano - 47522 Cesena (FC) - Italy
Tel. +39.0547.319311
Fax +39.0547.318542
e-mail: intdept@trevispa.com
www.trevispa.com



09, Rue de jardins, Hydra - Alger - Algeria
Tel. +213 234772 94 / 234772 90
Fax +213 234772 93
e-mail: trevispa@trevispa.com
www.trevispa.com