



BH-Profile In Place Inclonometer head
Thessaloniki Metro - Greece



BH-Profile chain installation

FOCUS ON Grand Paris Express project

The Grand Paris Express is the largest urban project in Europe with the construction of 200 km of automatic lines, as much as the current metro, and 68 stations. The four new lines of the Grand Paris Express (15, 16, 17 and 18), as well as the line 14 extended to the north and south, will be connected to the existing transport network. The new network, essentially underground, will cross the territories of Grand Paris to connect them to each other and to the capital. The civil works of lines 15, 16 and 17 have been in progress since 2017. The quantity of TBMs simultaneously digging could reach 21 machines and equal the Doha record (Qatar). The commissioning of all lines is scheduled for 2030 but some strategic lines will be in service for the Paris Olympic Games by 2024. Alongside this gigantic project, several existing lines are also extended such as line 11, line 12 and EOLE (RER E).

THE PROJECT IN NUMBERS

4797 TOTAL
INSTRUMENTS

12 KM OF INCLINOMETERS
CASING

1200 BH - PROFILE

900 H - LEVEL



Settlement and supporting wall monitoring
Doha Metro - Qatar



Madrid M30 Motorway - Spain

REFERENCE PROJECTS

Europe

Frejus tunnel - France
CERN cavern - Switzerland
Mont Blanc tunnel - France
Brennero tunnel - Italy
Limfjords tunnel - Denmark
Visnove tunnel - Slovakia
Islisberg tunnel - Switzerland
Renaix tunnel - Belgium
Gubristunnel - Switzerland
San Bernardino tunnel - Switzerland
Cantanghel hydraulic tunnel - Italy
Capodichino tunnel - Italy
Panagopoula tunnels - Greece
Dolonne tunnel - Italy
San Julian Line, Lugo - Spain
Swinoujscie tunnel - Poland
Trinberg tunnel - Germany
Trojane tunnel - Slovenia
Pajares tunnel Lot 3 - Spain
Cantanghel hydraulic tunnel, access tunnel and main tunnels - Italy

America & Africa

Riachuelo plant Lot 1&3 - Argentina
El Toyo tunnel, Antioquia - Colombia
Cucuta-Pamplona 4G highway - Colombia
Rio Subteraneo tunnel, Lomas - Argentina
Atiz-Atla tunnels - Mexico
Microtunnel Linea Impulsadora - Ecuador
Tizi Ouzou tunnel - Algeria
La Linea tunnel - Colombia
Tuy Medio Caracas-Charallave - Venezuela

Asia & Oceania

Pir Panjal tunnel - India
Makkah service tunnel - Saudi Arabia
West Gate tunnel - Australia
Esfahan-Shiraz tunnel - Iran
5th Waterline tunneling, Tel Aviv - Israel
Albrikah tunnel - Saudi Arabia
Koohrang tunnel, Esfahan - Iran

METRO PROJECTS

Gran Paris, Lines 14, 15, 16 & 18 - France
Rome metro, Line C - Italy
LA subway, Purple Line - USA
Melbourne metro - Australia
Bogotá metro - Colombia
Sidney metro West - Australia
Porto metro - Portugal
Lima metro, Line 1 - Perú
Frankfurt U5 subway - Germany
Doha metro - Qatar
Milan metro, MM4 Line - Italy
Amsterdam metro - Netherlands
Milan metro, MM5 Line - Italy
Rome metro, Line B - Italy
Madrid metro, Line 5 - Spain
Singapore MRT - Singapore
Bangkok MRT, Blue Line - Thailand
Thessaloniki metro - Greece
São Paulo metro - Brazil

Riyadh metro - Saudi Arabia
Bangkok MRT, Orange Line - Thailand
Lisboa metro, Terreiro do Paço - Portugal
Warsaw metro, 2nd Line - Poland
Tel Aviv metro, Red Line - Israel
Marmaray project - Turkey
Algeri metro extension, lot 1 - Algeria
Bucharest metro, Line 5 - Romania
Panama metro, Line 1 - Panama
Los Teques metro, Line 2 - Venezuela
Otogar-Bagcilar light metro - Turkey
St. Petersburg metro - Russia
Barcelona metro, Line 9 - Spain
Milan metro, MM2 - Italy
Fortaleza metro - Brazil
Paris metro, Line 11 - France
Napoli metro, Line 1 - Italy
Athens metro - Greece
Genova metro - Italy

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TUNNELS SAFETY AND MONITORING

TUNNELS SAFETY AND MONITORING

The planning and design of a monitoring programme is an essential component of a successful tunnel construction.



Riachuelo Environmental Recovery Plant, sub-fluvial tunnel - Buenos Aires, Argentina

Tunnel monitoring is recommended to determine the behavior of the surrounding soil during excavation and to ensure the stability and safety of above ground structures.

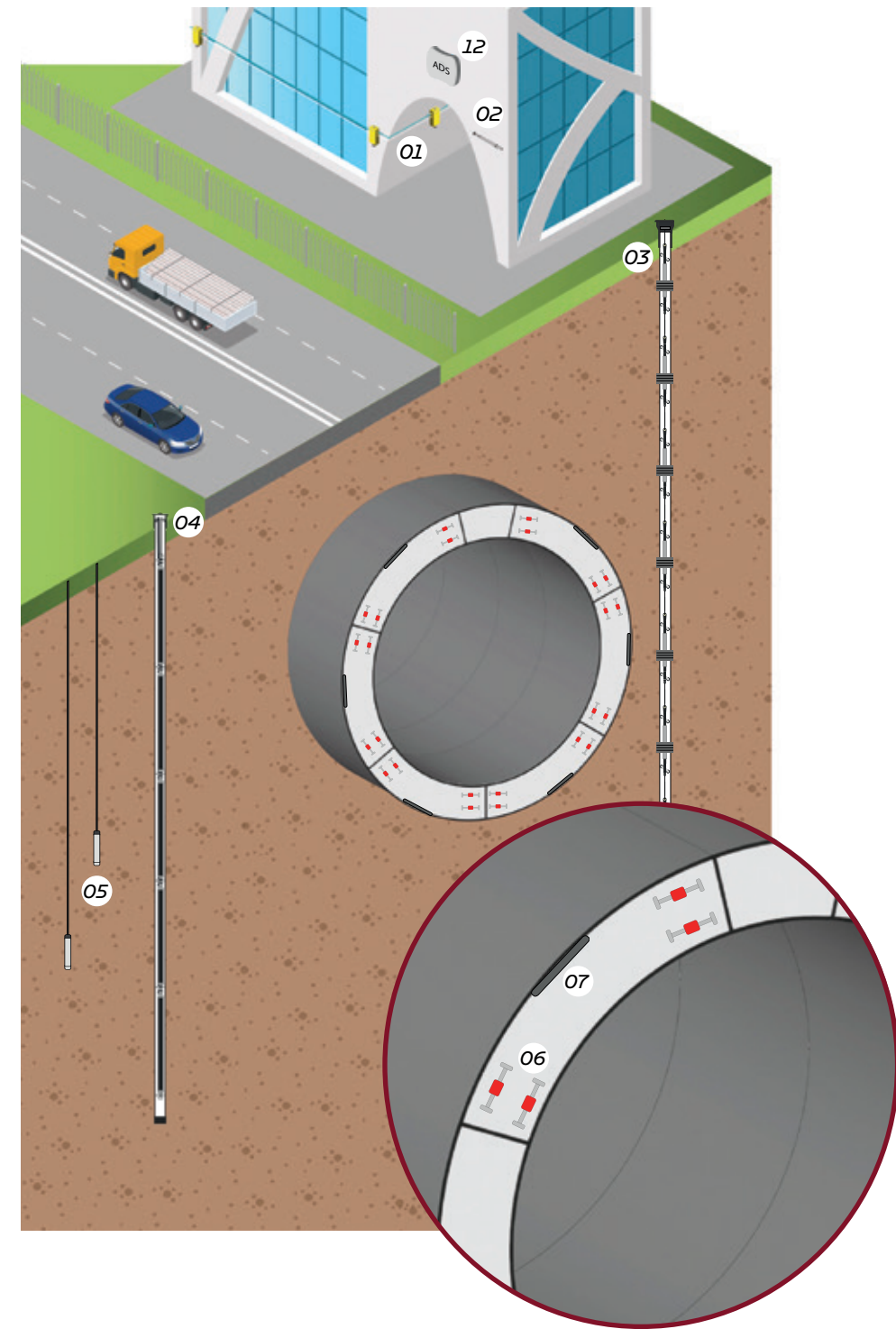
Tunnels and underground works monitoring should always take in consideration the type of excavation (TBM, NATM, drill and blast, cut and cover, etc.), their different stages and the surrounding environment:

- monitoring of tunnel entrances
- monitoring of first phase NATM excavation (steel linings)
- monitoring of the final concrete lining
- monitoring of the shafts and deep excavations for the stations
- monitoring of the precast TBM segments
- monitoring of surrounding soil/rock in case of both low and high coverage
- monitoring of buildings on the surface in case of low cover and/or heavily man-made environment

Monitoring of underground projects both during and after construction allows designers and owners to take the right decisions, manage risks, increase safety, increase productivity, optimize designs and reduce costs.

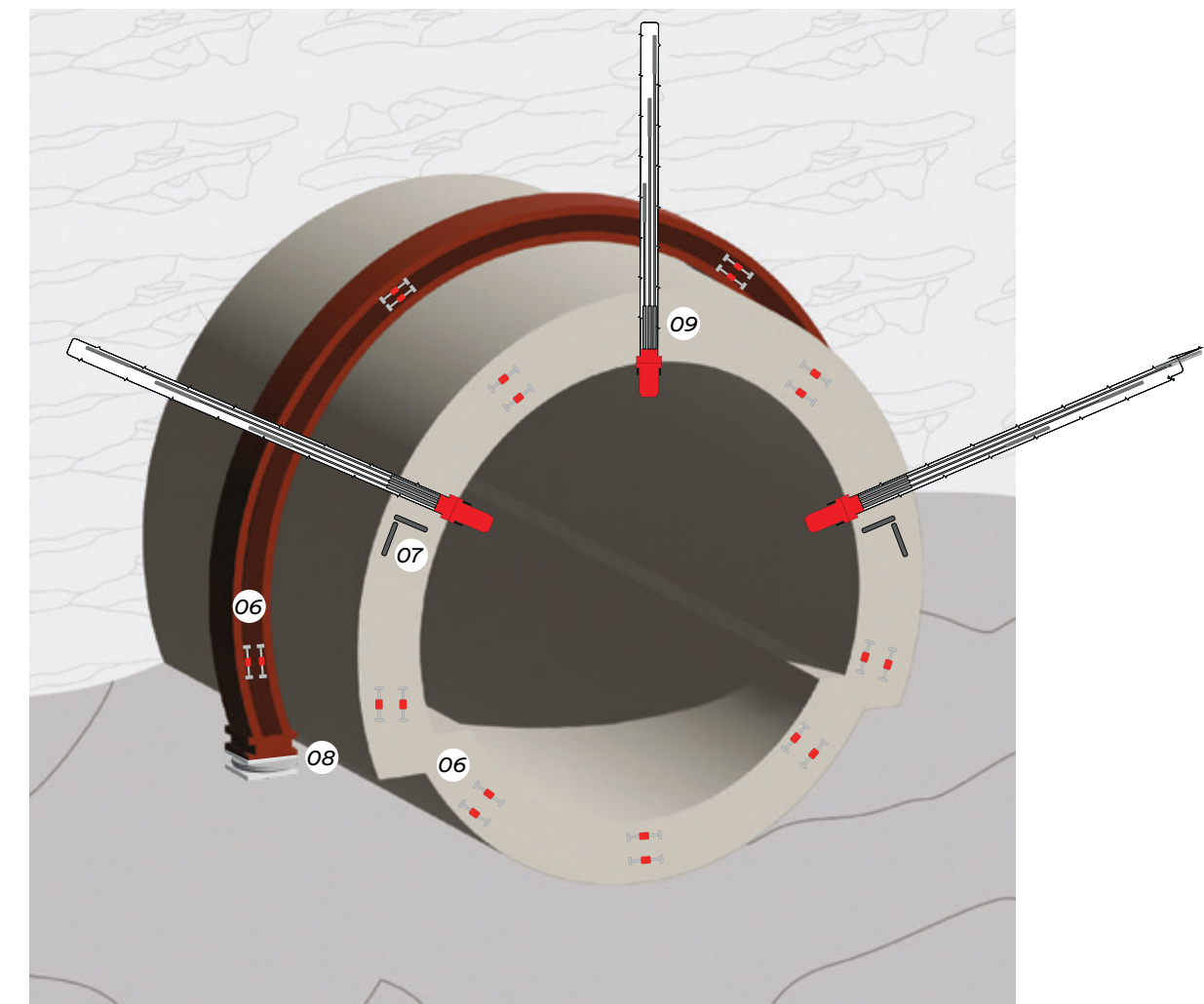
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TBM TUNNEL IN URBAN AREA



Drawings not in scale

TUNNELING WITH NATM METHOD



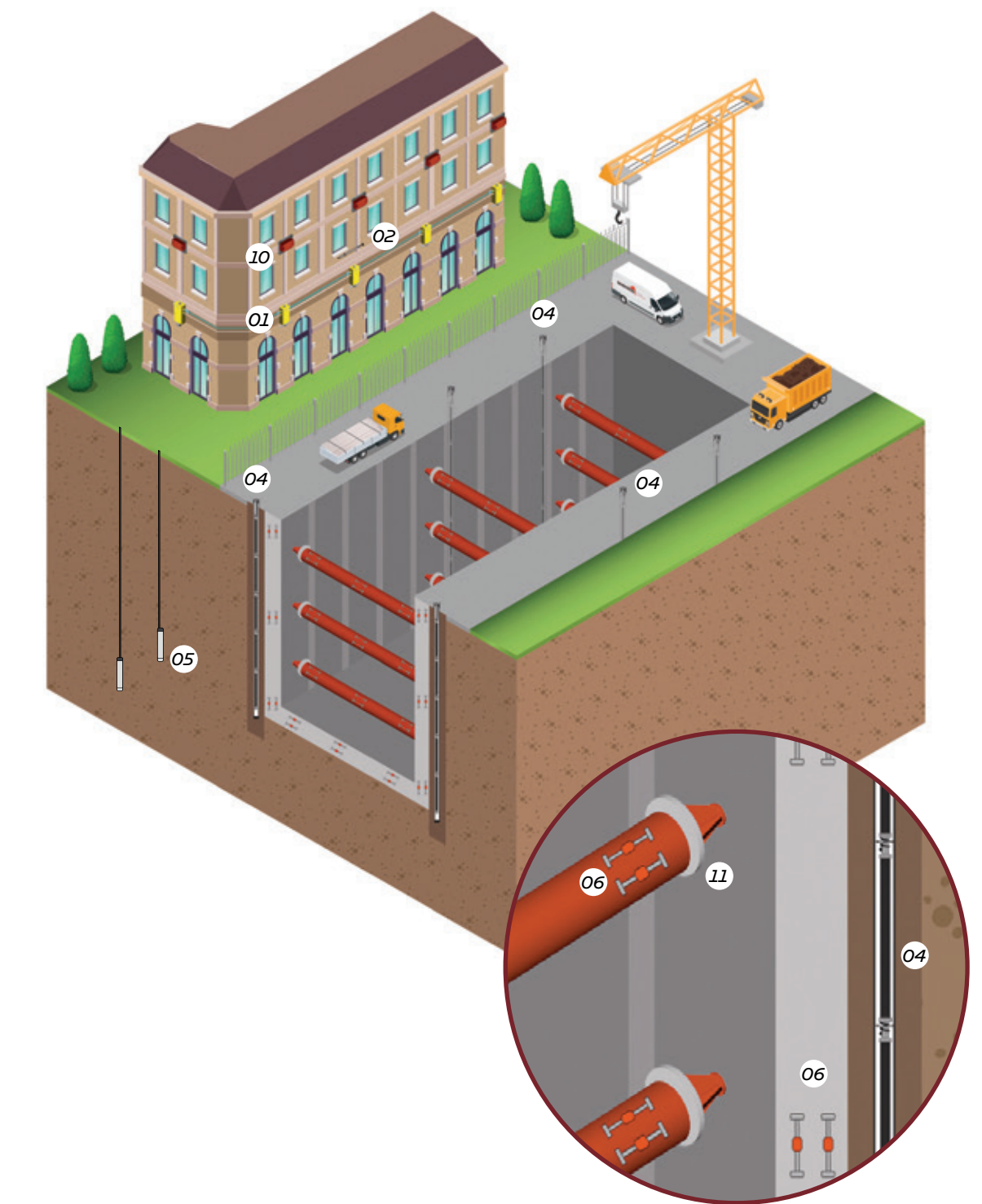
Reading solutions and data collection

The readout units and dataloggers are an essential part of the monitoring system. The readouts are needed during the installation procedures, in order to check any instruments before and after their installation, or when an automatic monitoring solution is not required. MIND readout is the new portable multichannel readout unit able to read and store data from both digital and analogue instruments, via its MIND App.

Dataloggers and wireless solutions are ideal for the automatic and remote monitoring in any geotechnical conditions. OMNIAlog and WRLog dataloggers offer precise measurement and reliable data acquisition from various sensor types and gauges supporting vibrating wire, MEMS and digital sensors, and all major geotechnical instruments. Sisgeo can also offer a dedicated service for data/measurement management from automatic and manual monitoring systems called AIDA IoT (powered by Field Srl).

The electric signals of the instruments are captured by the Data Acquisition Units, sent to a Server and later imported to a dedicated Database, where they are divided by project, instruments and measurements. Data are then converted into engineering units, validated, processed and represented in charts and table format.

DEEP EXCAVATION WITH TOP-DOWN METHOD



INSTRUMENTS

- 01 Digital H-Level settlement system: Differential settlement monitoring of structures
- 02 Vibrating wire crackmeters: Monitoring of the cracks opening
- 03 Digital DEX-S inclino-extensometer: 3D borehole automatic profiling
- 04 MD-Profile array: High accuracy horizontal deformation monitoring in boreholes
- 05 Vibrating wire piezometer: Monitoring of the pore water pressure
- 06 Vibrating wire strain gauge: Check the stress conditions of concrete mass or steel structures

INSTRUMENTS

- 07 Pressure cells: Monitoring the radial and tangential stresses
- 08 Electro-hydraulic load cells: Monitor the load applied to steel linings or struts
- 09 MPBX - Multipoint Borehole Extensometers: Monitoring of displacements and/or settlements at different depths
- 10 Digital tiltmeter: Tilt monitoring of the structures
- 11 Electro-hydraulic load cells for struts: Control the load on steel linings

READOUT AND DATALOGGER

- MIND readout
- OMNIAlog multichannel datalogger
- WR Log wireless system

STRUCTURAL HEALTH MONITORING SYSTEM

- 12 Ad-Signum solution: Continuous monitoring of the global structural state and event detection



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