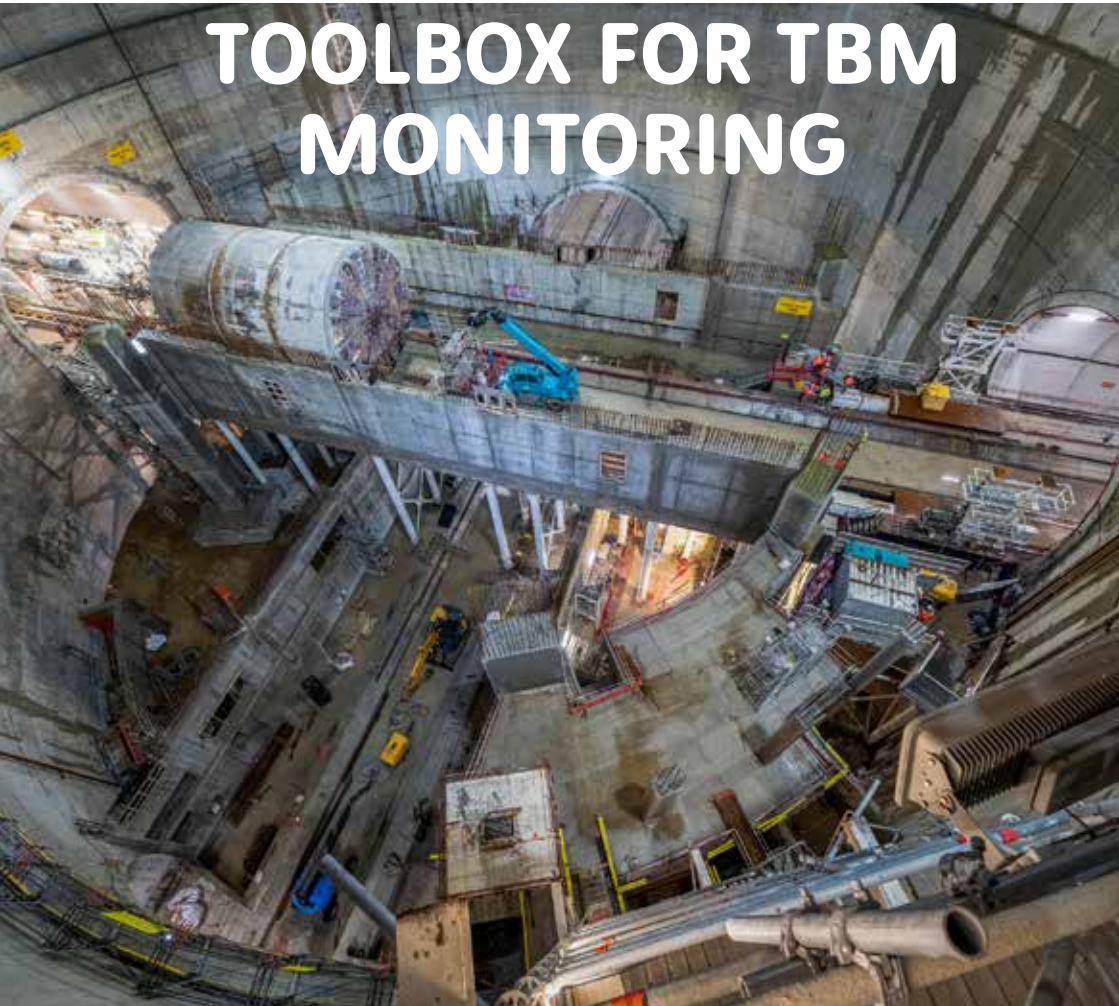




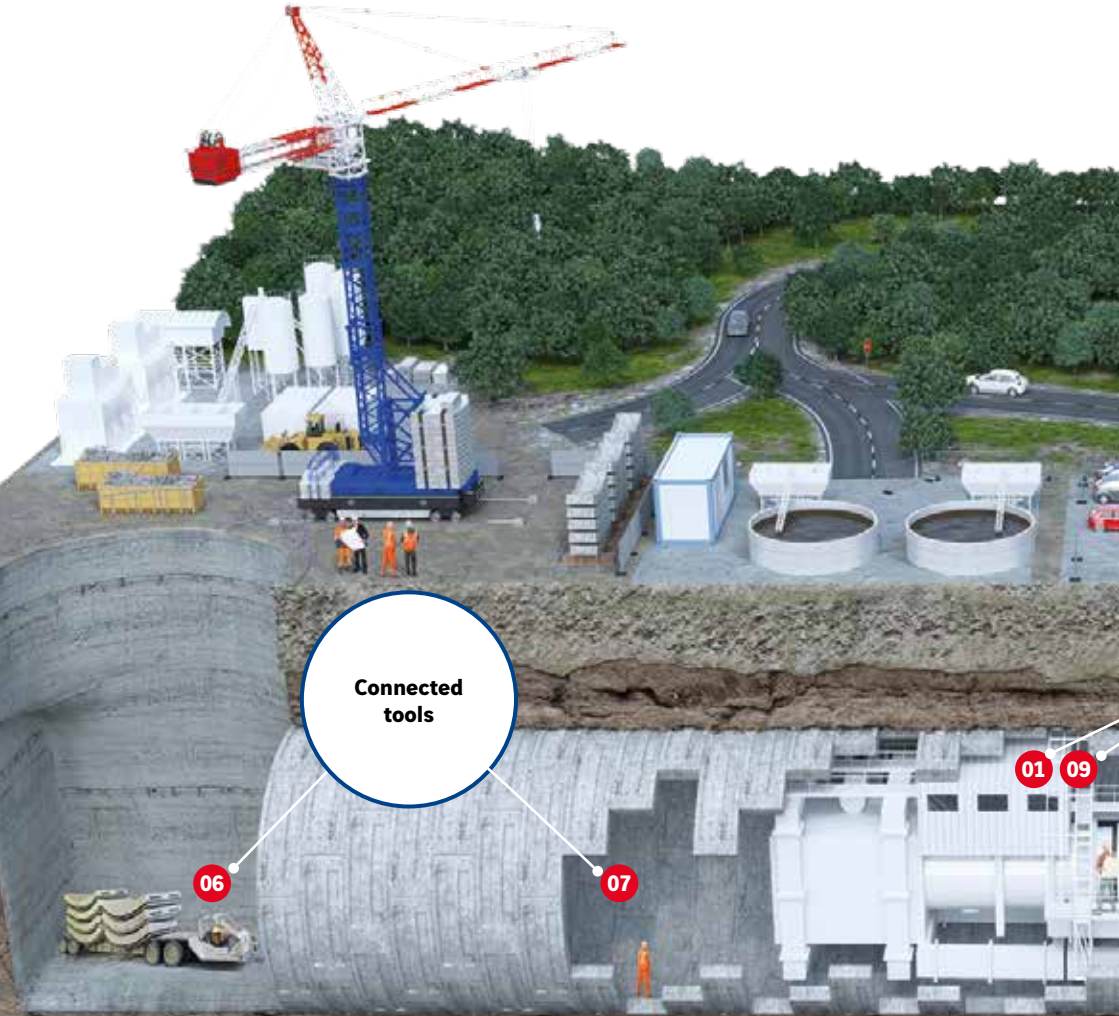
Taking tunnel
excavation to the next level

DISCOVER THE CONNECTED TOOLBOX FOR TBM MONITORING



CAP: THE COMPREHENSIVE, MODULAR SOLUTION FOR TBM STEERING AND MONITORING

Our system gives you a set of modules that make the job easier for teams on construction sites.



01 TBM steering

NEW **02** Automatic tailskin clearance measurement system

03 Real-time supervision

NEW **04** Calculation of indicators based on TBM parameters

05 Data recording and analysis

06 Scan enabling segment traceability

07 Survey and analysis of tunnel cracks using a connected tablet

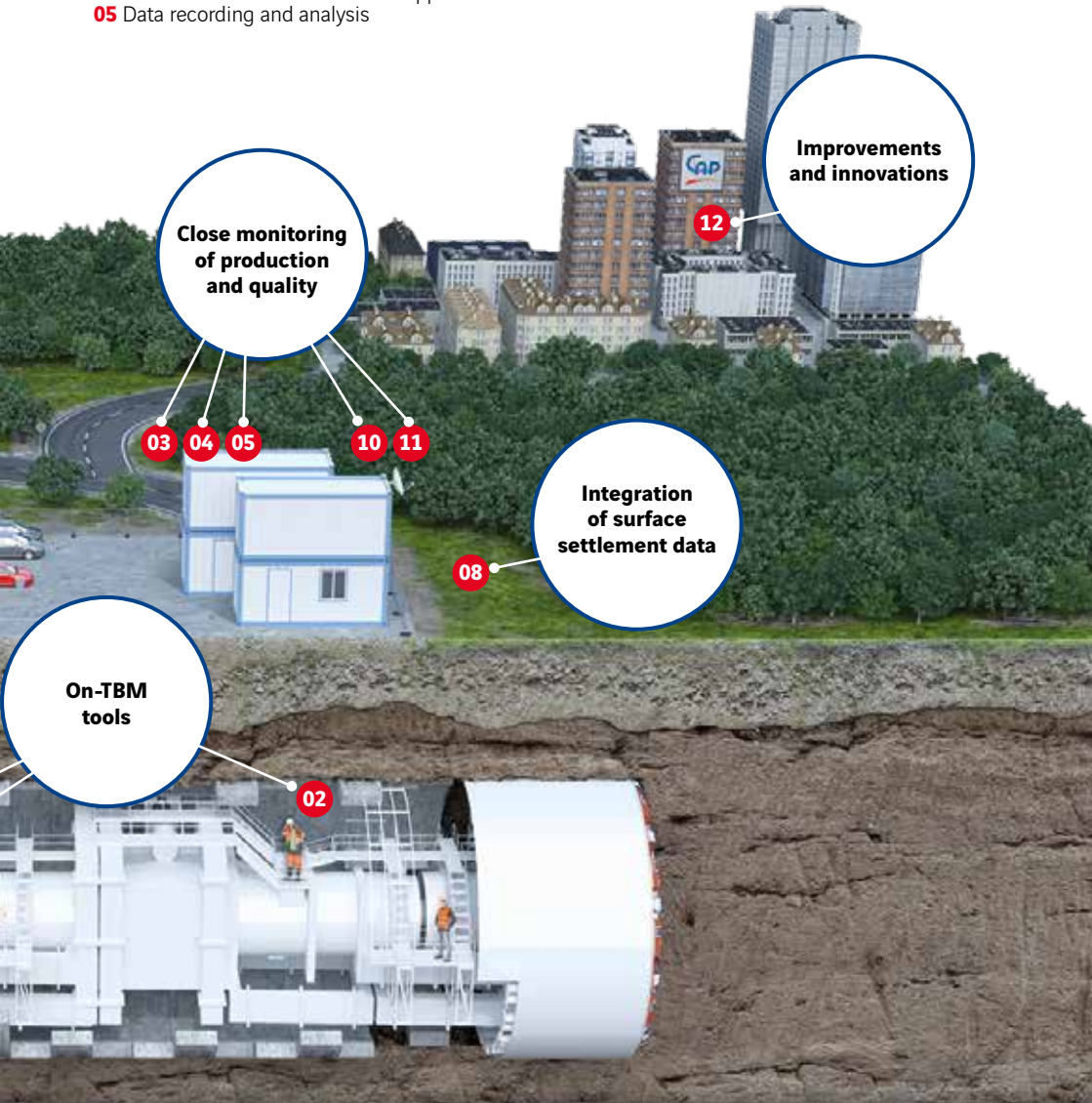
08 Integration of surface settlement data

NEW **09** Digital shift reporting application

10 Representation of TBM axis and position on Google Maps

11 3D modelling of construction site

12 Improvements and innovations



Close monitoring of production and quality

Integration of surface settlement data

Improvements and innovations

On-TBM tools

WITH CAP, NO DETAIL ESCAPES YOU

TO MONITOR YOUR WORKSITE
TO THE MILLIMETRE...



Steering and piloting by CAP

Real-time navigation and position monitoring

The navigation module automatically keeps track of the TBM's position in real time with respect to the theoretical axis.

A motorized total station fixed to the tunnel lining determines the coordinates of two prisms on the TBM, using a reference prism whose coordinates are known. The coordinates of these two prisms are then used to calculate the TBM's position.

A two-axis inclinometer determines the roll and pitch of the TBM. These data are used to determine the front position of the TBM and to check the accuracy of measurements from the theodolite on the two navigation prisms.

The data are transmitted to the system's computer to display the front and rear position of the TBM on a screen in the control cabin.

Ring sequence calculation software

This software pre-calculates the ring sequences according to the trajectory and generates a daily laying plan. These instruction sheets provide to the pilot the characteristics of the adopted catch-up curve, ring positions and associated steering orders.



PILOTING A TBM HAS NEVER BEEN SIMPLER



Piloting assistance

This module enables the pilot to precisely follow the steering orders from the laying plan via an interface that constantly indicates a point representing the drift between the TBM's desired (target) and current position.

It also features an **automatic steering option** to enable precise plane distribution of thrust in the different groups of cylinders in line with the steering orders.

Automatic tailskin clearance measurement

For steering, CAP takes into account the gap between the last ring built and the tailskin over 360°. To access the available space data in real time, our system features an automated tailskin clearance measurement tool that offers many benefits.

This tool replaces manual measurement by the operator, which is unsafe and often

inaccurate because it is difficult to reach inside the space. The proposed system determines the exact clearance values and ensures safety. Measurements are continuously recorded to keep track of them during excavation.

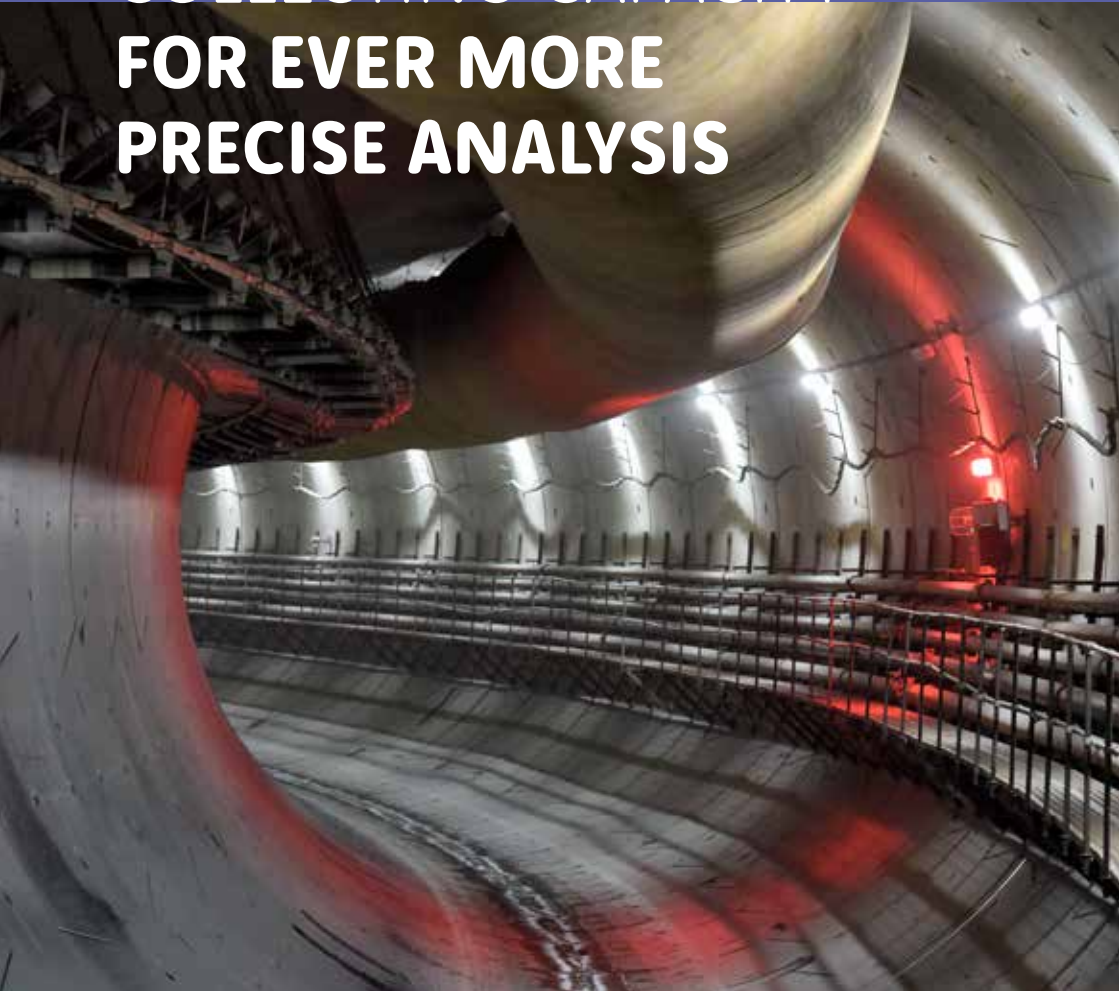
Ultrasonic sensors in the tailskin continuously measure the gap all around the last ring built and are oriented towards it. These sensors gauge the distance to the ring and send this information to a unit inside the shield. The data are processed to determine the exact shape of the complete ring and its position relative to the tailskin axis. The results are transmitted to the piloting computer, which then calculates the new steering instructions.

Steering analysis

A steering analysis report is provided for the pilot and surveyors to support decision-making at the end of each excavation.



EXTENSIVE DATA
COLLECTING CAPACITY
**FOR EVER MORE
PRECISE ANALYSIS**



Continuous task supervision

The supervision modules record all parameters from the sensors on the TBM. It is also possible to communicate with other programmable logic controllers (PLCs), such as a station treatment plant or belt conveyor.

This tool provides real-time animated synoptics for effective supervision of all tasks during excavation phases, and lets you save and print graphs, generate daily reports, export and record data in Excel® format and set e-mail or text alerts.

Integration of indicators

All synoptics and reports are accessible online.

Calculation and display of the following indicators are also included in supervision on dedicated synoptics:

Chamber filling rate for an EPB tunnel boring machine

Clogging indicator for all types of TBM

Database and analysis interface

The database tool collects and stores the data from the acquisition system to enable later in-depth analysis. Our system also features an interface designed to exploit data over long periods, in the form of graphs or synoptic tables.

Parameters can be set for specific tables or graphs, for example to show production parameters, topographic data, the number of rings built per day or excavation and building time.



DIGITAL DATA FOR GREATER EFFICIENCY

Connected tools for close monitoring of production and quality

Additional tools let you mine all TBM excavation information.

Segment traceability and scanning with a connected reader

The segment scan module lets you scan tags containing information on the segments for optimal traceability. These tags can be RFID chips, barcodes or QR codes. The scan tool optimizes management and quality control of segments from reception through to storage and quarantine. This can be done from the moment a segment leaves the factory, as well as at staging sites, before on-site reception. The module can thus record scanned segment data in the database and associate them with a tunnel ring number. The aim is to track each segment from reception to laying with the manufacturing data and any damage and repairs they may have undergone.

Survey and analysis of tunnel cracks with a connected tablet

The module for recording anomalies enables defects and anomalies detected on segments to be identified and reported in the form of drawings, using a tablet. All defects found are recorded in the database and can be consulted and exploited from there, saving time tracking damage and repairs, while documenting the rings' history for ever more precise quality assurance.



Integration of surface settlement data

Controlling surface settlements when operating a TBM, particularly in urban areas, is key to tunnel excavation. These data can now be acquired through an automated surveying process.

CAP offers a new interface integrating analysis of surface settlements to be able to record in its database all excavation parameters for cross-analysis of data from the TBM and surface settlement data.

This tool lets you visualize and analyse any changes in surface settlement during TBM operation using simple and automatic graphics, so you can cross-check with TBM data.

Displaying TBM axis and position in Google Maps

This tool displays the TBM's axis and position in real time in Google Maps so you know exactly where it is with respect to surface buildings.



Shift report application

All tasks performed during TBM operation are entered and recorded in this application, which also helps you analyse them.

How it works



Input interface

All tasks to be performed are pre-configured via the interface at the start of the project. They will then be entered, time-stamped and commented on as the shift progresses by the pilot and/or shift manager, who will also be free to add more if they wish.



Raw data analysis interface

Information entered can be extracted and visualized graphically in a simple way over a given time slot.



Accessibility and connection

The tool is accessible online from the construction site via a secure server (login/password). An «offline» mode is also available to continue entering data even if your connection is down.



Data recording and storage

Data are stored in a remote database. They are accessible for the duration of the project and can be exported when work is complete.



Report creation interface

Data entered are compiled in the form of reports comprising a Gantt chart, a summary of information relating to the shift, performance indicators, dynamic graphs and progress reports. These reports are updated as information is entered and can be downloaded in PDF format or printed directly from the interface.

CAP3D for deeper insight into each project

CAP3D is a decision-support tool combining in succinct form in a 3D digital model all essential information for project management: geology, surface settlements, buildings, stations, TBM, tunnels, tunnel logistics and so on. It federates and breaks down silos, enabling stakeholders on site to see the big picture and thus make decisions with full knowledge of the issues facing the other stakeholders. CAP3D features planning/feedback functions to represent the site in the past or the future.

INNOVATION & DEVELOPMENT



A strategy focused on innovation and development

CAP continues to be a pioneer in its field. To remain at the cutting edge and stay in tune with customers' needs, our team of software engineers and developers is constantly evolving applications to offer new features and innovative digital solutions.

Here are just some examples of the innovations we have in development and on the way.

Reducing TBM downtime

We are developing a tool to troubleshoot failures and enable easy and effective diagnostics to reduce TBM downtime. This tool aims to facilitate diagnostics without tying up an automation engineer and without being directly connected to the PLC.

Automated tailskin and shield deformation monitoring

To meet customers' need to effectively monitor any deformation of the tailskin and shield that may occur during excavation, we are working at one of our sites to set up an automatic tool for monitoring deformations using connected laser distance meters.

Simplified steering solution

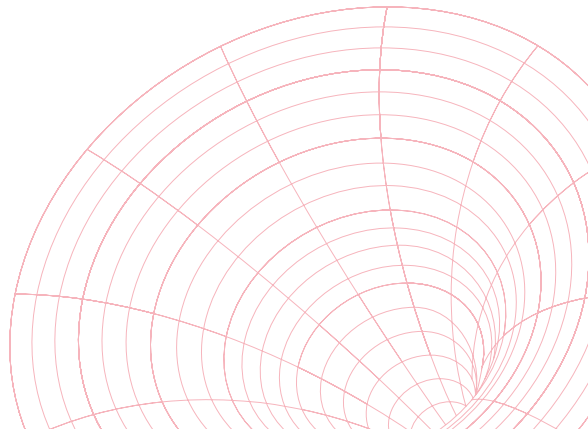
A new, simplified steering solution is under study for projects where the path of the TBM axis isn't complex.

CAP TUNNEL BORING SPECIALISTS SINCE 1985

Our history

CAP is today among the **world leaders** in tunnel boring, offering state-of-the-art solutions for supervising and analysing TBM parameters. We are working on major tunnel projects all over the world, constantly tracking the very latest technologies in our field and regularly deploying new and innovative digital features.

CAP's dedicated solution for closely controlling TBM operations can be tailored to each project's specific requirements. Our **smart data display** provides a picture of the tunnel environment and clear insight into the effects of the excavation process, while significantly enhancing safety.



Solid and agile

A subsidiary of Dodin Campenon Bernard, VINCI Construction, CAP brings the backing of a major group while remaining fully independent to conduct its projects. Our young and dynamic team is attuned to the market and its latest innovations to offer customers constantly enhanced solutions. We provide an end-to-end service from system configuration to on-site set-up, as well as operator training and product support.

The human dimension drives everything we do and we work to forge close relationships with our customers.

CAP's solutions

A system that adapts to all types of TBM and environment

Small - and large-diameter TBMs

Earth pressure balance (EPB), slurry, variable density and hard rock TBMs

A team in tune with project needs

Work definition and costing adapted to your project

Custom solutions

Databases, tunnel segment identification

On-site operator training

Production managers, surveyors, TBM pilots, customer, etc.

Technical support throughout your project

Our values

The five values that define and drive CAP's teams since 1985:

01 Adaptability

04 Expertise

02 Customer satisfaction

05 Technical support

03 Responsiveness



LATEST REFERENCES

From small structures to large-scale projects, here are just some of those who have turned to CAP for their excavation requirements.

Greater Paris

Paris Metro

- Line 15, WP T3C
- 2 Herrenknecht EPB TBMs
- 8,000 m - diameter 9.87 m
- Customer: VINCI/SPIE Batignolles

Paris Metro

- Line 15, WP T2B
- 2 Herrenknecht EPB TBMs
- 7,450 m - diameter 9.87 m
- Customer: Eiffage/Razel

Paris Metro

- Line 14, WP GC02
- 1 Herrenknecht EPB TBM
- 4,800 m - diameter 8.83 m
- Customer: VINCI/SPIE Batignolles

Paris Metro

- Line 14, WP GC03
- 1 Herrenknecht EPB TBM
- 4,200 m - diameter 8.92 m
- Customer: Eiffage/Razel

Paris Metro

- Line 16, WP 1
- 6 Herrenknecht EPB TBMs
- 18,500 m - diameter 8.92 m/9.87 m/7.75 m
- Customer: Eiffage

International

COMOL5 Leiden

- (Netherlands)
- 1 Herrenknecht slurry TBM
- 4,400 m - diameter 10.96 m

TTT London (UK)

- 2 Herrenknecht slurry TBMs
- 10,000 m - diameter 6.44 m 8.88 m

CRL3 Auckland (NZ)

- 1 Herrenknecht EPB TBM
- 3,750 m - diameter 7.15 m

HS2 Birmingham (UK)

- 2 Herrenknecht variable density TBMs
- 8,750 m - diameter 8.7 m/9.95 m

HRBT Norfolk (USA)

- 1 Herrenknecht variable density TBM
- 4,200 m - diameter 14 m

Annacis Vancouver (Canada)

- 1 Bessac slurry TBM
- 11,000 m - diameter 5.01 m

CML3 Cairo (Egypt)

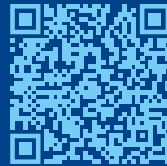
- 2 NFM/Herrenknecht TBMs
- 5,500 m - diameter 9.47 m







[cap-tunnel.fr](https://www.cap-tunnel.fr)



[linkedin.com/company/cap-tunnel](https://www.linkedin.com/company/cap-tunnel)

ensemble @ VINCI 