Herrenknecht

A world leader in groundbreaking tunnelling technology.

Herrenknecht is a technology and market leader in the area of mechanized tunnelling systems. As the only company worldwide, Herrenknecht delivers cutting-edge tunnel boring machines for all ground conditions and in all diameters – ranging from 0.10 to 19 meters. Under the umbrella of the Herrenknecht Group, a team of innovative specialists has formed to provide integrated solutions around mechanized tunnel construction with project-specific additional equipment and services.
Pioneering technology by Herrenknecht is always involved when paving the way for the future underground – whether for tunnelling, mining or exploration. Herrenknecht ensures safe and fast progress when constructing modern infrastructures in all areas of application. Exactly where they are needed.

Headquarters in Germany, active worldwide. With more than 3,100 project references, we are a market leader all around the globe.

Pioneering Underground Technologies

HERRENKNECHT ISP

Making the invisible visible with Integrated Seismic Prediction

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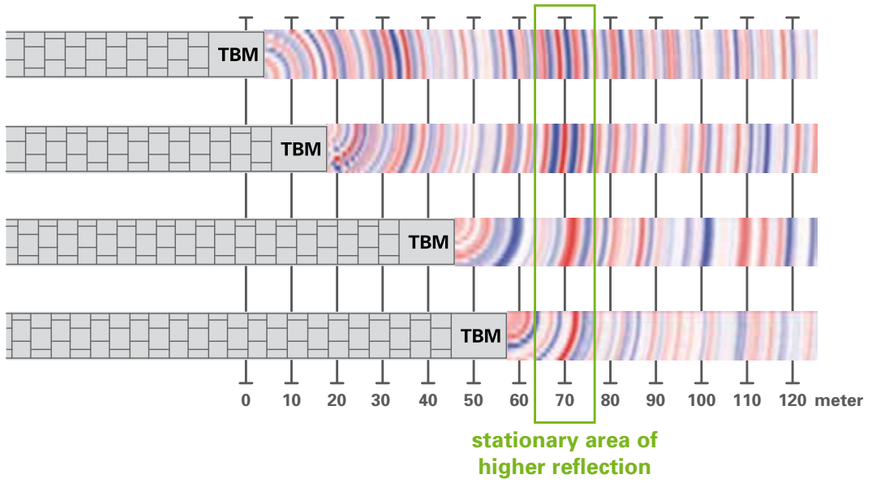
Herrenknecht ISP
Discovering safety-relevant obstacles.

Two factors are extremely important in mechanized tunnelling: underground safety, to ensure there is no danger to personnel or machinery and rapid construction progress, to ensure that the project schedule and the budget are met. To support both of these, it is essential for the underlying geological conditions to be known as exactly as possible. Despite intensive preliminary geological investigations, the ground along the tunnel route repeatedly throws up safety-relevant surprises. In hard-rock conditions, these are primarily water and air-filled cavities, zones of weakness in the rock or faults caused by abruptly changing degrees of rock fragmentation.

Looking inside the rock – for increased safety and fast tunnelling.

Using the Integrated Seismic Prediction (ISP), Herrenknecht is able to make geological hazards visible. A major advantage of this procedure is that it is largely integrated in the boring process, enabling continuous preliminary exploration parallel to tunnelling. The measured data is processed and evaluated in near real time. ISP detects awaiting sources of danger or geological peculiarities at an early stage, enabling the machine crew to initiate a prompt response. This largely avoids unforeseen interruptions, increases safety for personnel and machinery and also ensures swift tunnelling operations.

ISP result: Continuous preliminary exploration with ISP parallel to tunnelling allows a reliable detection of geological peculiarities, e.g. a karst cave, illustrated by a stationary area of higher reflection in several successive measurements in the 2-D visualization of seismic anomalies.



PRODUCT HIGHLIGHTS

- High degree of safety for personnel and machinery.
- High degree of integration in the boring process.
- Continuous availability and visualization of the gathered data in near real time.
- Measurement activity and tunnelling run simultaneously.

TECHNICAL DATA

- **Rock type:** hard rock
- **Machines:** Gripper TBM, Single Shield TBM, Double Shield TBM
- **Range:** in direction of drive: around 120m*
- **Resolution:** 5–15m*

*depending on rock type – may be improved by processing

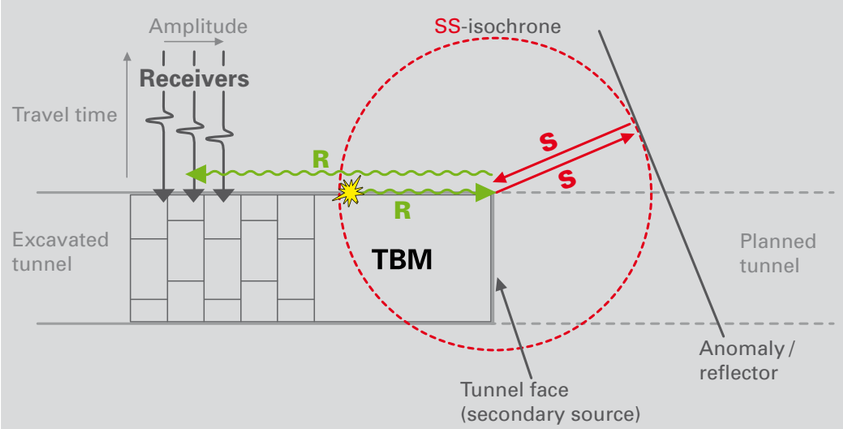
Integrated Seismic Prediction (ISP) – the functional principle.

With ISP, a pneumatically initiated hammer blow from the impact hammer on the tunnel wall sends a surface wave (Rayleigh wave) along the tunnel wall. At the tunnel face, the surface wave transforms to a space wave (Shear wave). If the space wave encounters an obstacle in the rock – that means a difference of density in the rock – the reflected space wave generates a "response", which again travels along the tunnel surface where it can be registered by the geophones placed in the tunnel wall. Data recording itself is carried out using autonomous, battery-powered WiFi data loggers which are located in the immediate vicinity of the measuring anchors. The data acquired are then sent to the computer unit for further processing. Both water and air-filled cavities and geological faults or weakness zones in the rock can be detected by the system and are made visible in a 2-D or 3-D result.

The impact hammer generates seismic waves into the tunnel rock wall after each stroke or ring.

The WiFi data loggers at the end of the geophone anchors transmit the acquired data to the computer unit.

Functional principle of ISP – RSSR Propagation Principle



REFERENCES

Tel Aviv – Jerusalem Israel
Double Shield TBM, S-612/S-614
- Shield diameter: 9,990 mm
- Tunnel length: 11,598 m each
- Detection of karst caves

Coca Codo Sinclair Hydropower Project, Ecuador:
Double Shield TBM, S-672
- Shield diameter: 9,040 mm
- Tunnel length: 13,746 m
- Detection of fault zones

Project X-1, China:
Double Shield TBM, X-1
- Shield diameter: 9,130 mm
- Tunnel length: 4,480 m
- Detection of fault zones