

Pipe Jacking. Technology, application and perspective.

Bruno Roeker, Sales Manager Latin America.

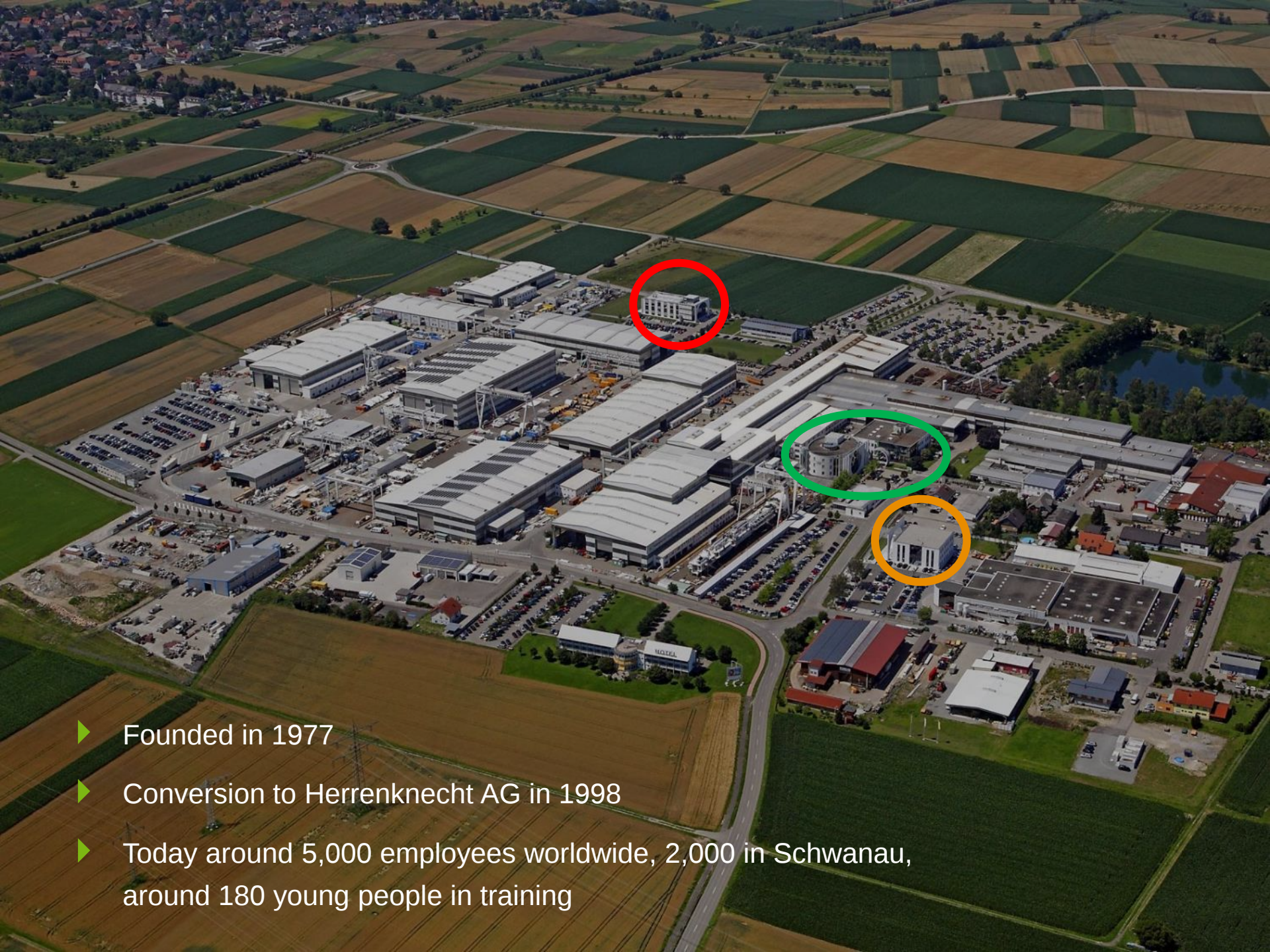
Buenos Aires, September 7th, 2017

Content.



Introduction

- ▶ Pipe Jacking: procedure and machine portfolio
- ▶ Slurry versus dry excavation: AVN & EPB (Auger Machines)
- ▶ Trends in Pipe Jacking
 - ▶ Applications & references
- ▶ Situation and perspective Latin America & Argentina

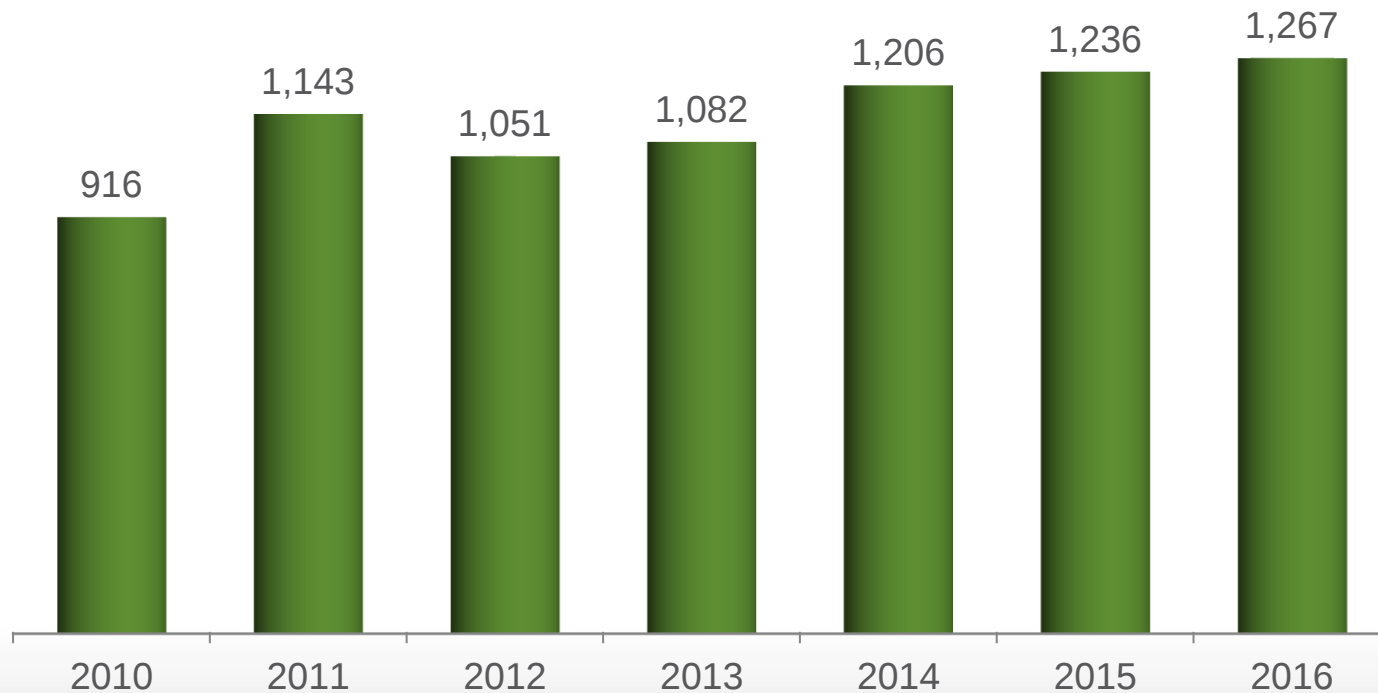


- ▶ Founded in 1977
- ▶ Conversion to Herrenknecht AG in 1998
- ▶ Today around 5,000 employees worldwide, 2,000 in Schwanau, around 180 young people in training

Herrenknecht Group.

Company figures.

► Order inflow in billion Euro



Herrenknecht Group.

Brands and business areas.

Corporate
Brand

HERRENKNECHT

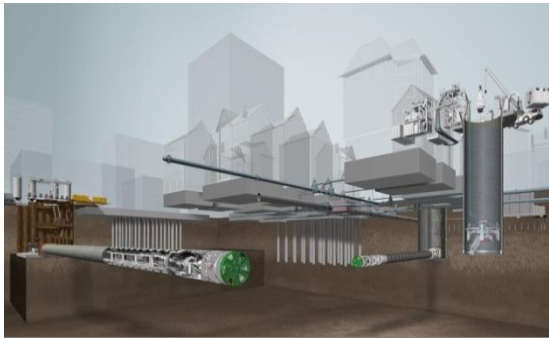
Core Markets	  		
Core Brands	  		
Group Brands	Additional Equipment H+E LOGISTIK  VMT  MASCHINEN- UND STAHLBAU DRESDEN  HERRENKNECHT FORMWORK  TECHNI-METAL SYSTEMES  EUROFORM  BOHRTEC 	Additional Equipment H+E LOGISTIK  VMT  MASCHINEN- UND STAHLBAU DRESDEN  SCHÄFER URBACH  TECHNI-METAL SYSTEMES  EUROFORM 	Additional Equipment SCHÄFER URBACH  BOHRTEC VERTICAL 
	Services GLOBAL TUNNELLING EXPERTS 	Services GLOBAL TUNNELLING EXPERTS 	Services GLOBAL TUNNELLING EXPERTS 

Herrenknecht. Pioneering Underground Technologies



Herrenknecht Utility Tunnelling.

Business Segments and machine portfolio.



Tunneling & Shafts



Pipeline



Energy



AVN Machine



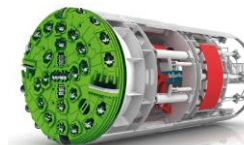
Partial-face Excavation Machine



EPB Shield



Single Shield TBM



Double Shield TBM



Gripper TBM



AVNS Machine



Direct Pipe®



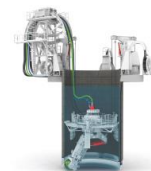
Pipe Express®



HDD Rig



SDD Rig



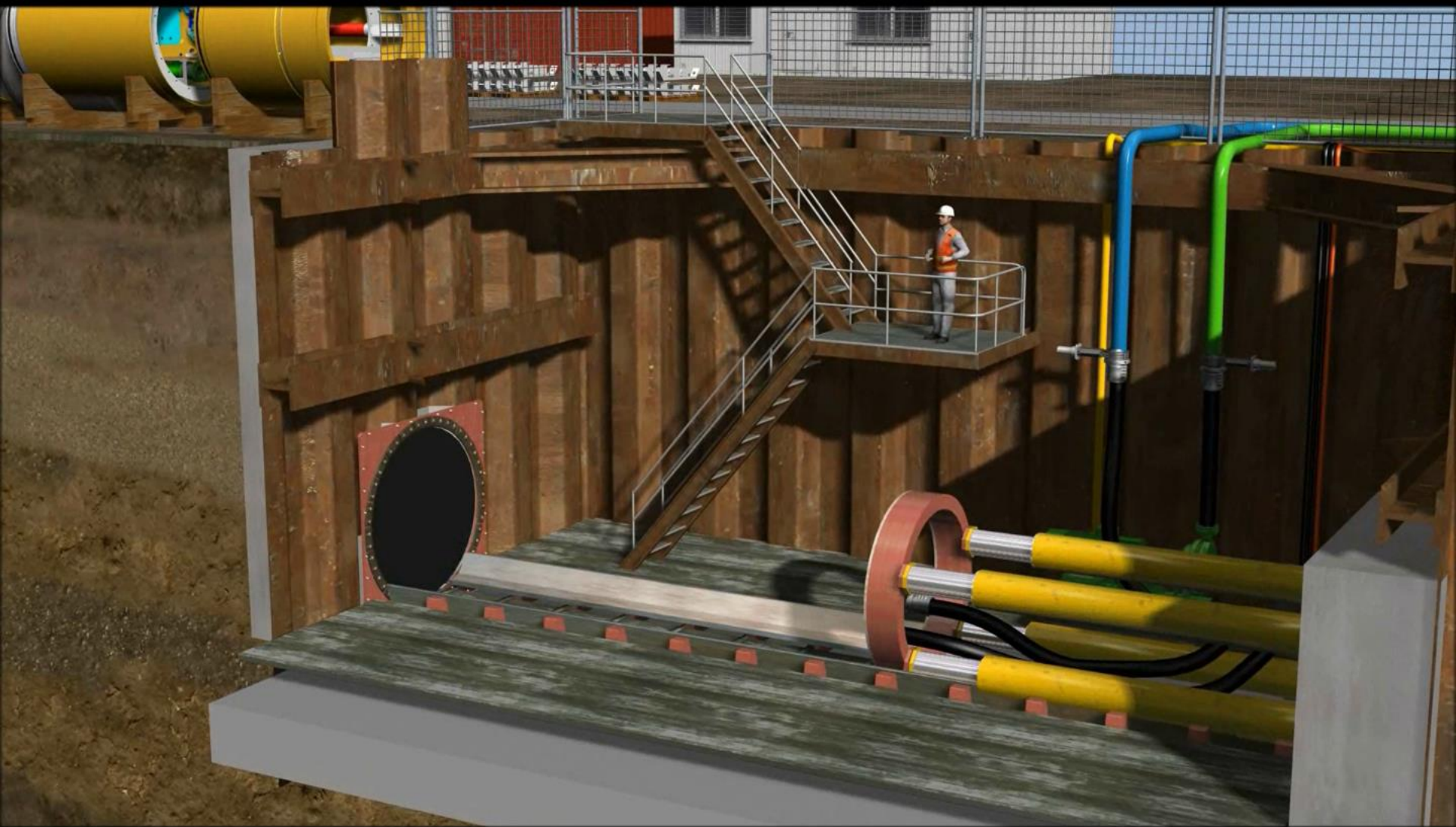
Vertical Shaft Sinking Machine VSM

Herrenknecht. Pioneering Underground Technologies

Content.

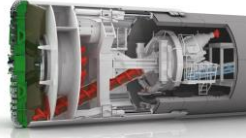
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General Pipe Jacking Procedure.



Overview of machine technologies.

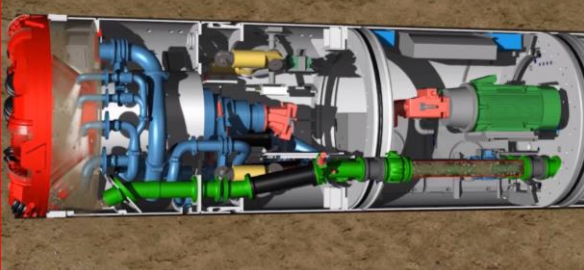
According to geology and hydrology.

	ID in mm		clay	silt	sand	mixed soil	gravel	boulders	rock
									
AVN AVND	250 – 4000								
Auger Boring	200 - 1400								< 40MPa
EPB	1400 – 4000								
MH / MHSM	1800 – 4000								< 80MPa
TBM	1200 – 4000								

Content.

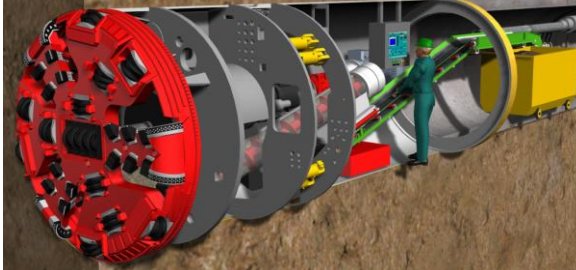
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Overview of machine technologies (focus Buenos Aires).



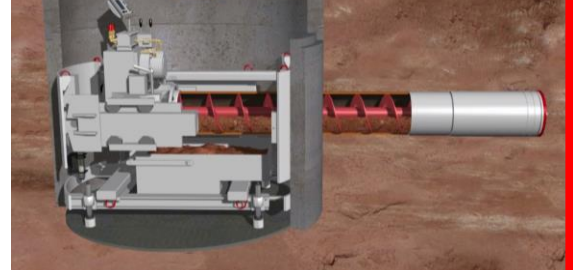
AVN | AVND

Cutting wheel: full face
Face support: slurry suspension
Muck transport: slurry circuit (separation needed)



EPB

Cutting wheel: full face
Face support: earth pressure
Muck transport: screw conveyor, belt, muck skip



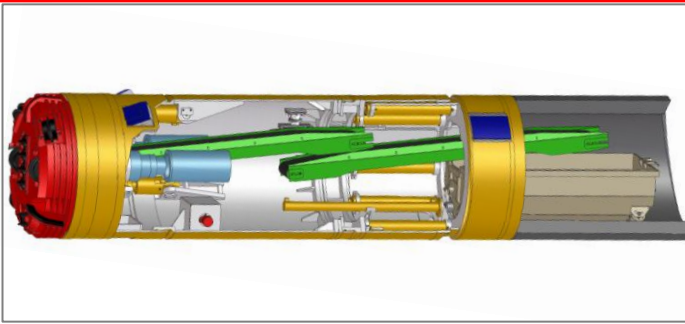
Auger Boring

Cutting wheel: full face
Face support: earth pressure
Muck transport: screw conveyor, belt, muck skip



MH | MHSM

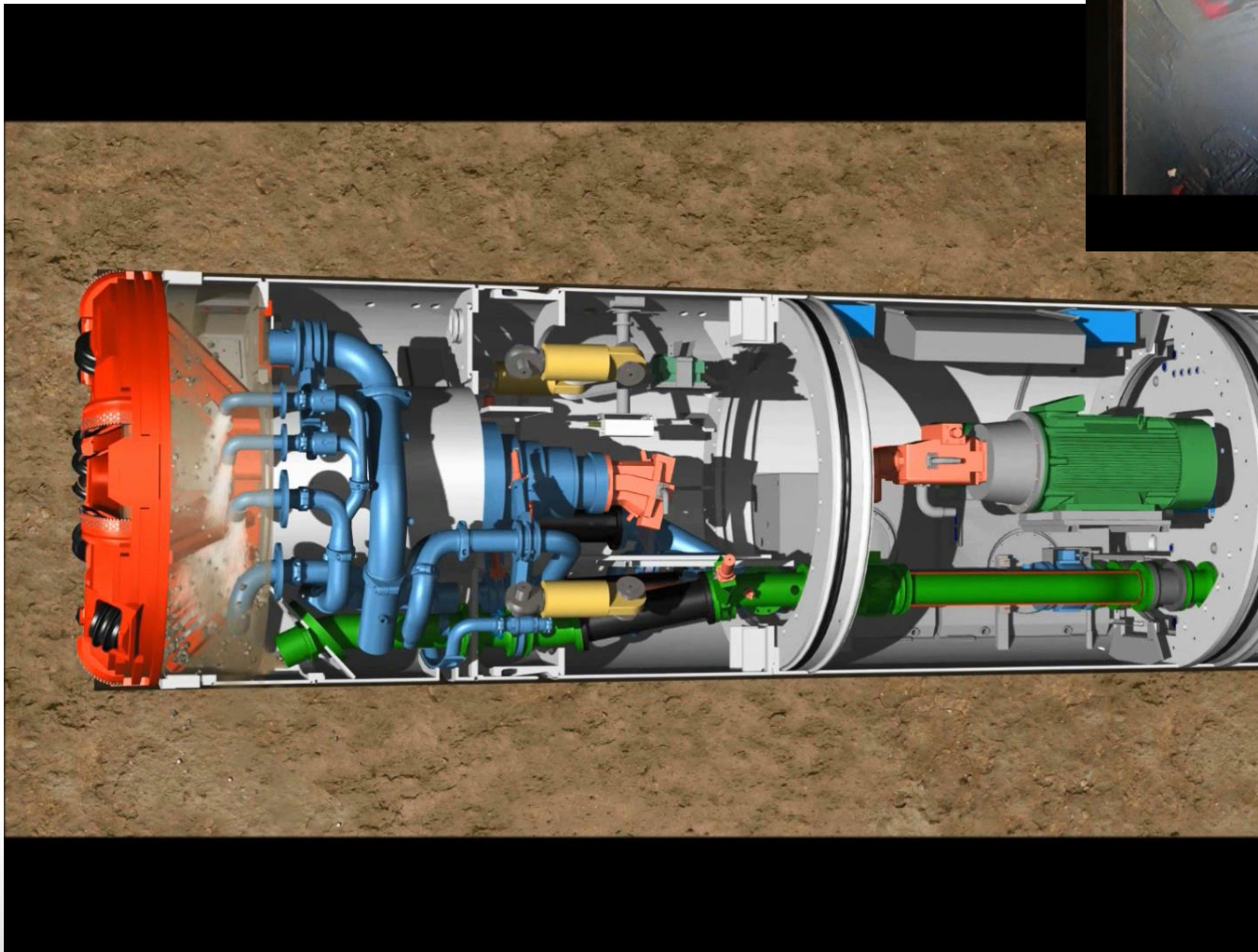
Cutting wheel: Partial face (excavator / roadheader)
Face support: mechanical
Muck transport: conveyor belt, muck skip



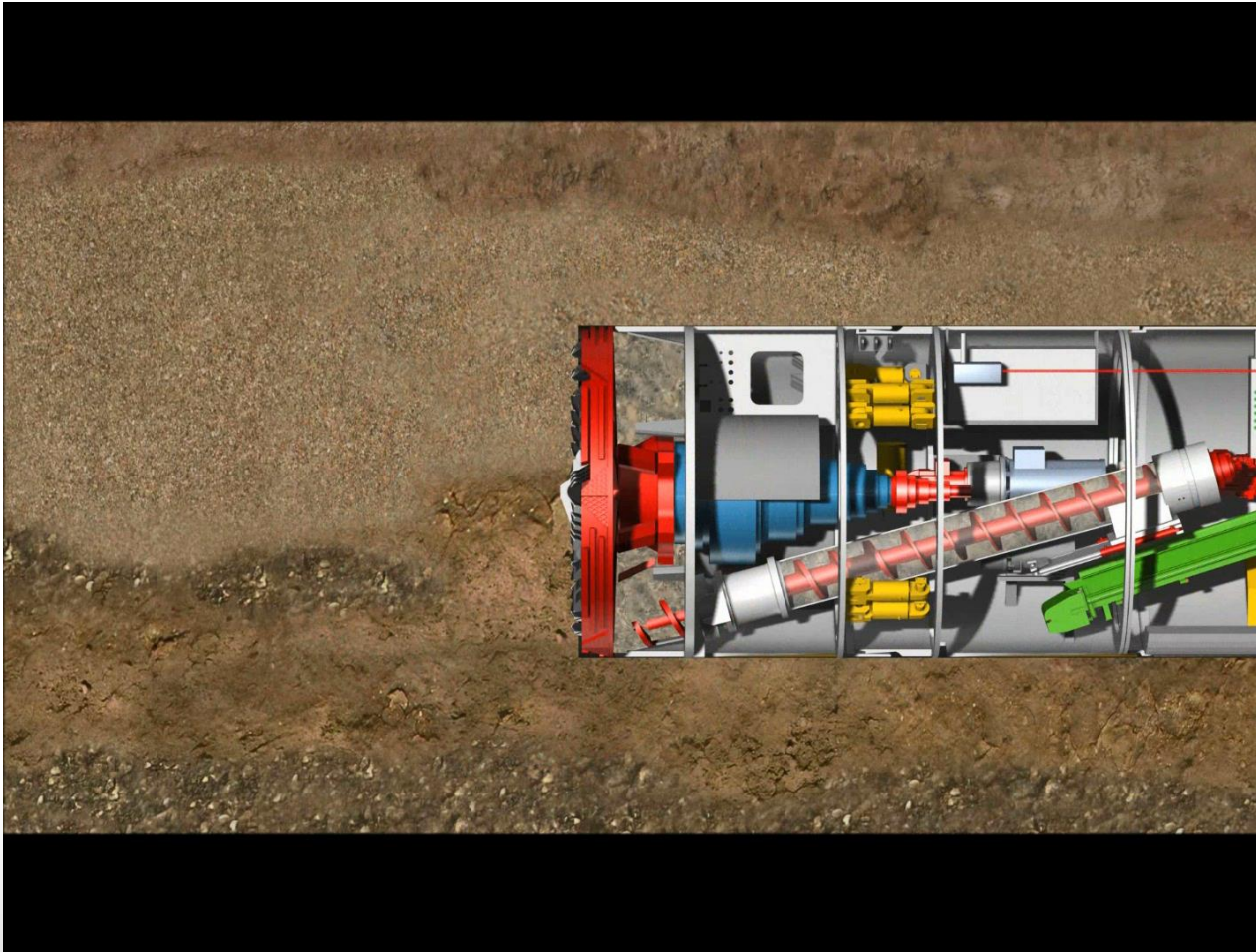
TBM

Cutting wheel: full face
Face support: mechanical by cutting wheel
Muck transport: conveyor belt, muck skip

Herrenknecht AVN/AVND Slurry circuit.

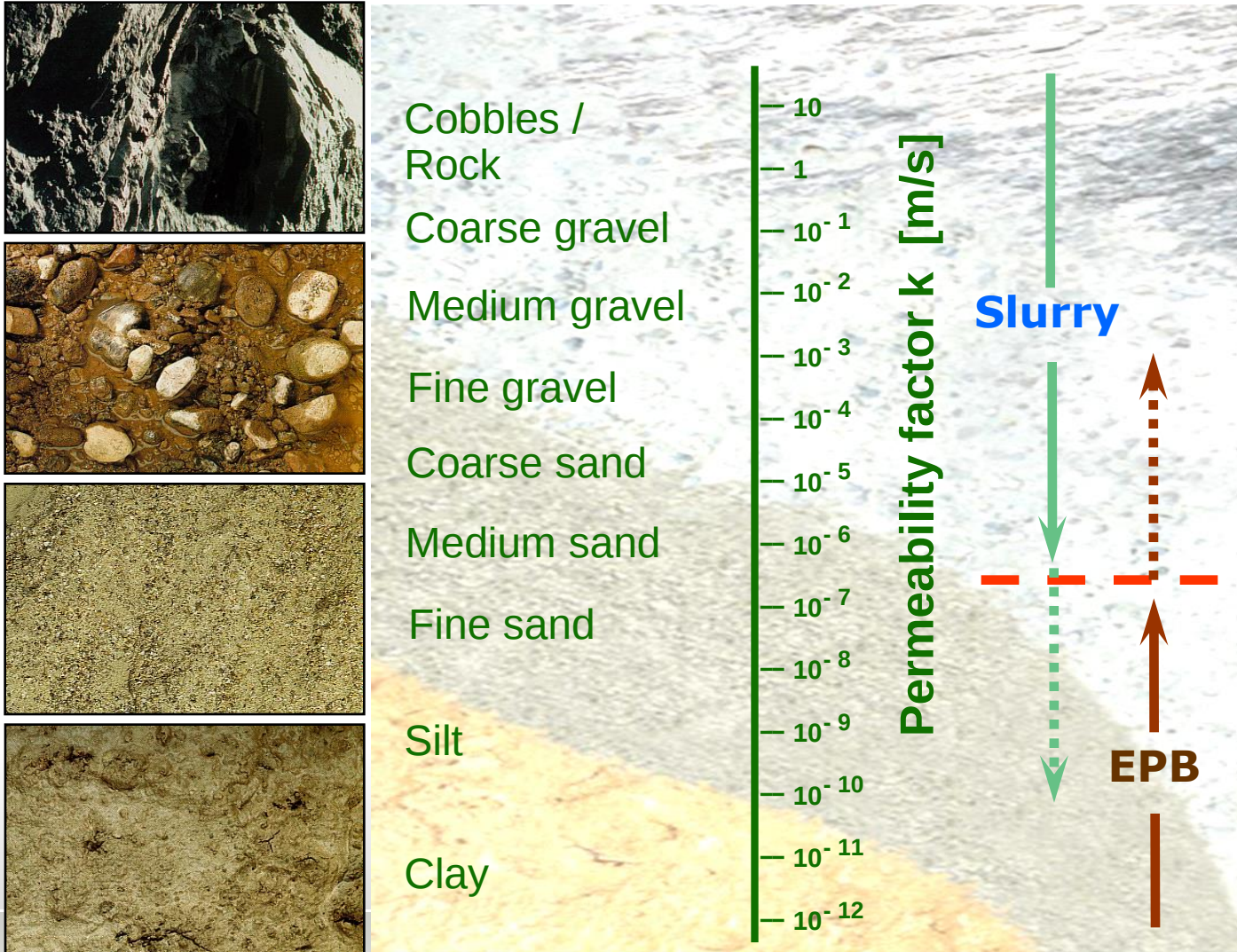


Herrenknecht Earth Pressure Balance Shield (EPB).



Application range of Slurry and EPB Shields.

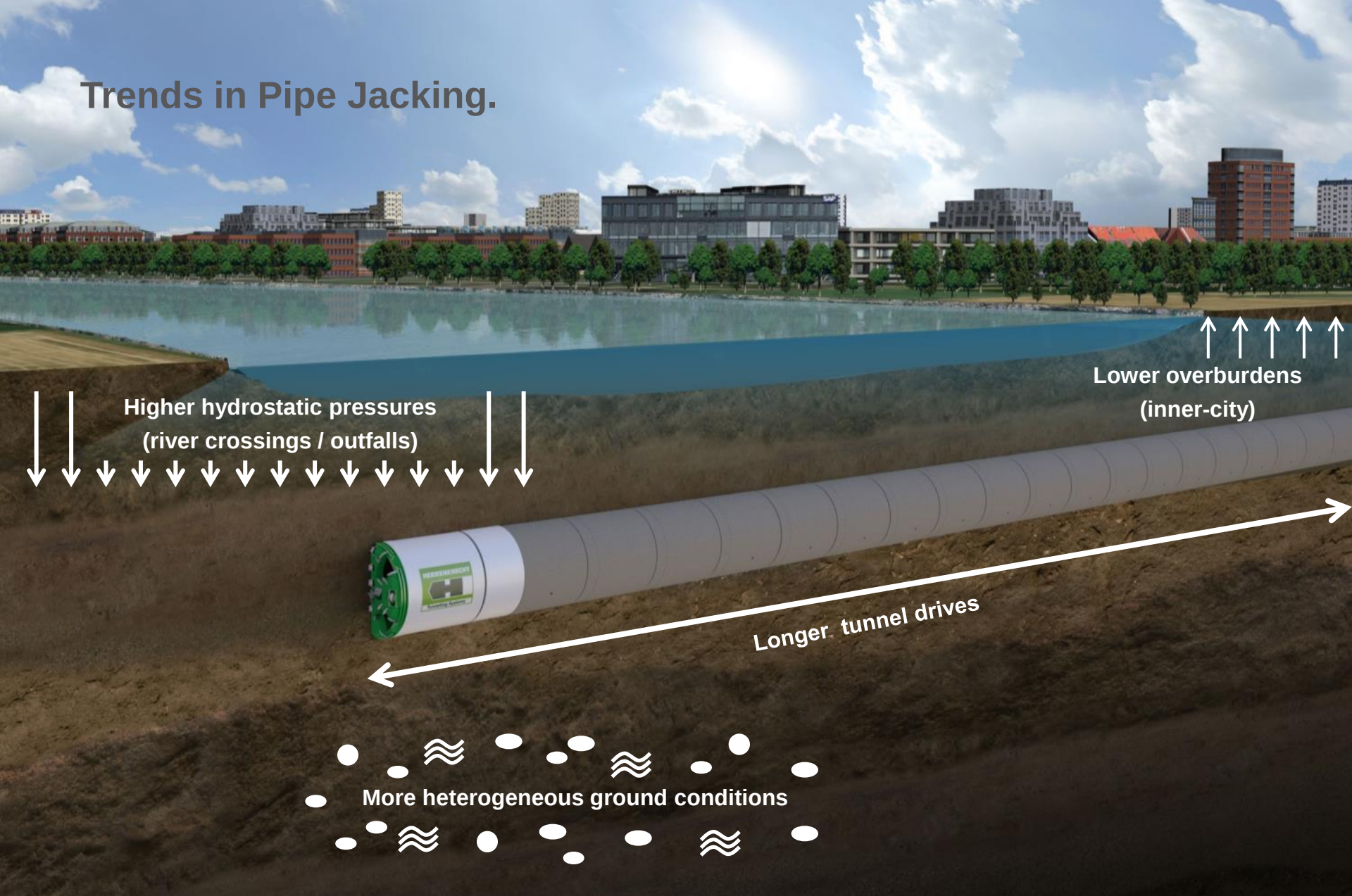
According to the grain distribution line.



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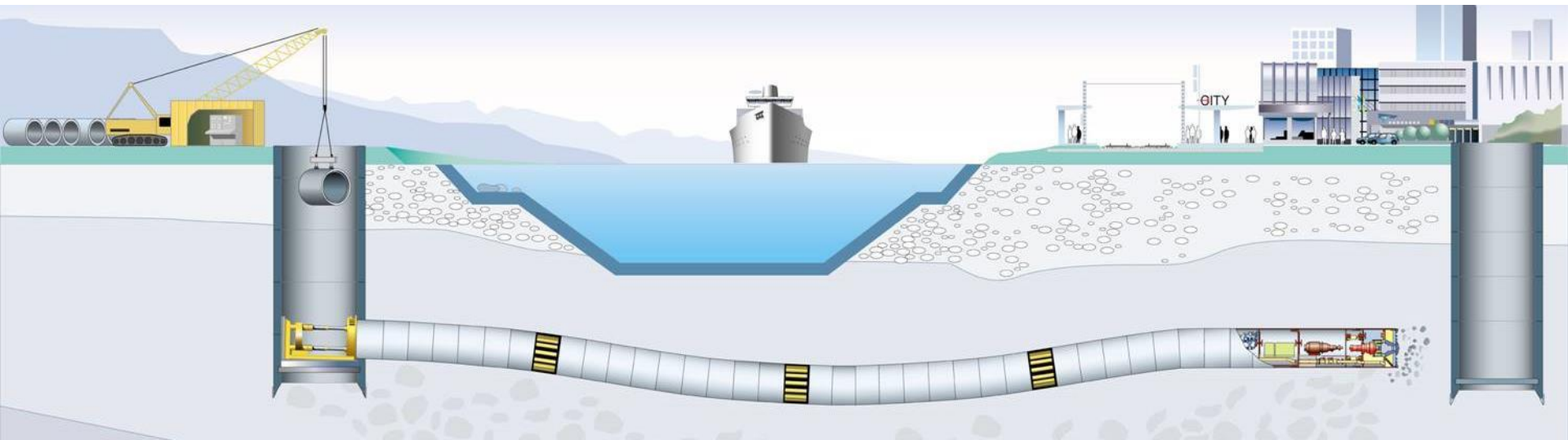
Trends in Pipe Jacking.



Long distance Pipe Jacking.

Increasing number of long distance projects on and offshore.

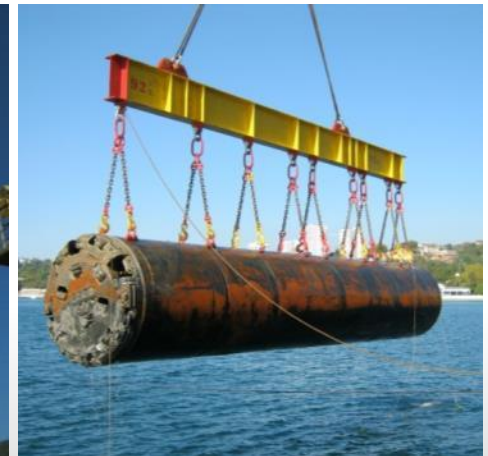
- ▶ More than 60 long distance projects > 1,000m since early 1990s.
- ▶ 50% since 2008, 75% with AVN(D) technology.
- ▶ Europipe 1994: with 2.5km length still world record. ID 3000.
- ▶ Sochi 2013: 2km long outfall tunnel in the Black Sea. ID 2000.



Long distance record in Sochi, Russia.

Two pipe jacked outfalls in the Black Sea.

- ▶ M-1103M, AVND 2000, OD 2525.
- ▶ 2 Sewage tunnels installed under the Black Sea, 1,411m + 2,014m.
- ▶ 2,014m = Long distance record in ID 2000.
- ▶ Performance: 2,014m tunnel installed in 100 days.
- ▶ First Sea Outfall in Russia.



KIPP - Kpone Independent Power Project.

Seawater intake and outlet tunnel.

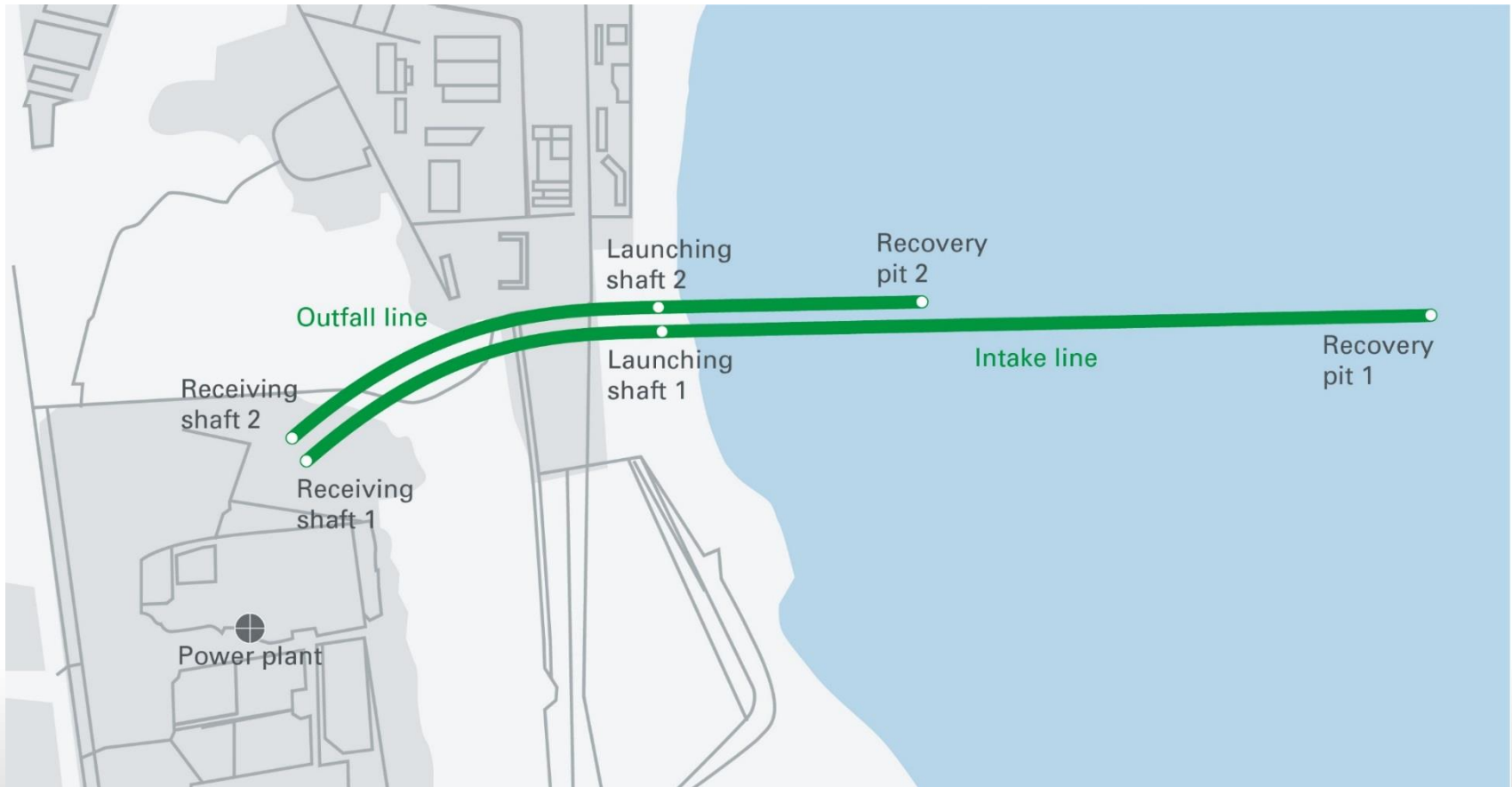
- ▶ M-2041M, AVND 2000, OD 2425
- ▶ Location: Tema Industrial Zone, Ghana
- ▶ 2 onshore tunnels: 545m and 520m length
- ▶ 2 offshore tunnels: 380m and 1085m length
- ▶ Use of tunnel: water intake for PP cooling, brine outlet
- ▶ Geology: weathered gneiss
- ▶ Contractor: JV Bothar Constructions Pty Ltd

& Coleman Tunnelling



KIPP - Kpone Independent Power Project.

Seawater intake and outlet tunnel.



KIPP - Kpone Independent Power Project.

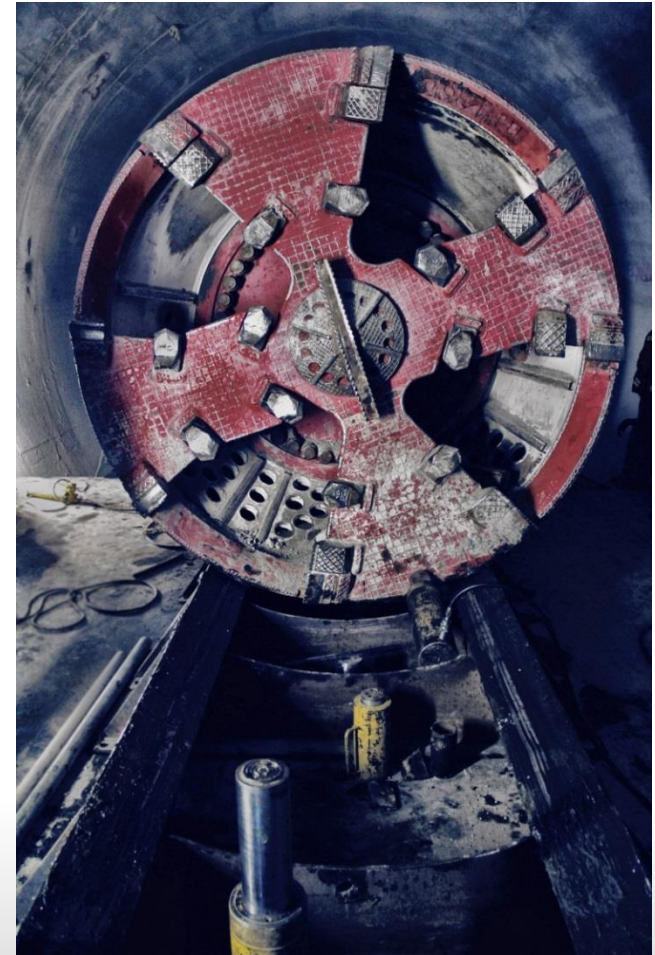
Seawater intake and outlet tunnel.



Mexico City. Emisor oriente.

AVN 1800 builds link sewer.

- ▶ M-1766M | AVN 1800 TB | OD 2210
- ▶ Geology: sand, clay
- ▶ Tunnel Length: 162m + 103m
- ▶ Contractor: COTRISA
- ▶ Machine designed for 3bar water pressure
- ▶ Max. depth on 2nd drive: 42.5m
- ▶ Performance: 103m in 11 days
- ▶ Breakthrough: 4th May 2013
 - ▶ In tunnel of S-497



Mexico City. Emisor oriente.

AVN 1800 builds link sewer.

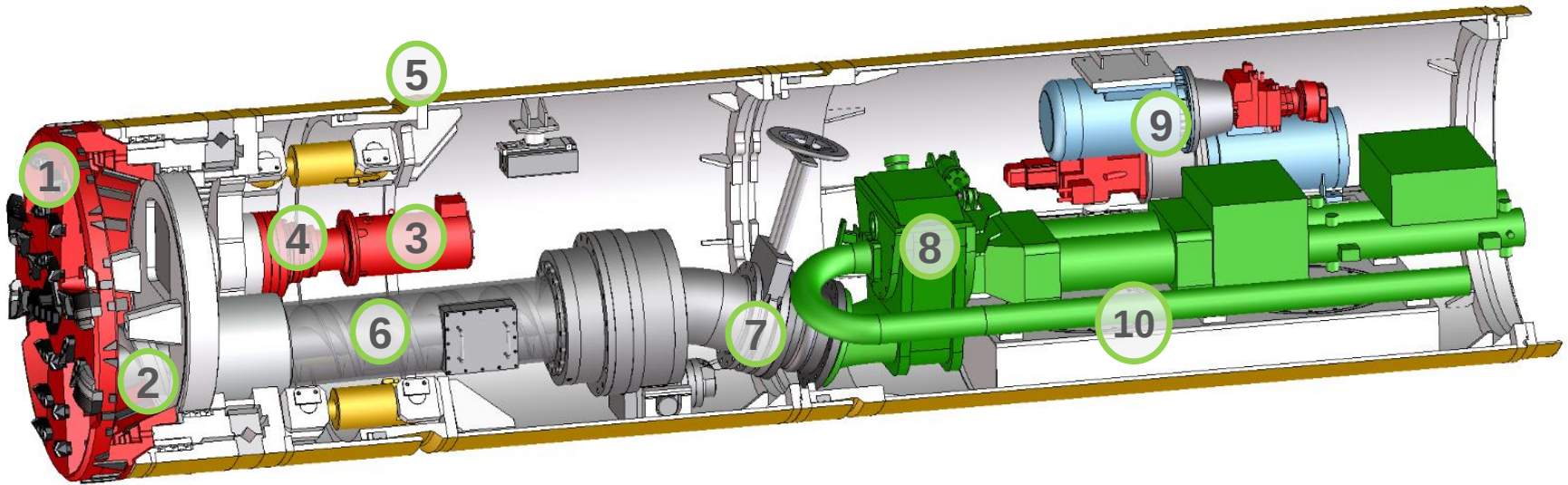


EPB 1800 with muck pump conveyance. Colector Chimalhuacan II.

- ▶ M-2087M, EPB 1800, OD 2150
- ▶ Location: Mexico City
- ▶ Use of tunnel: Sewage
- ▶ Tunnel length: 300m
- ▶ Geology: plastic ground
- ▶ Contractor: Prodemex



EPB muck pump technology.

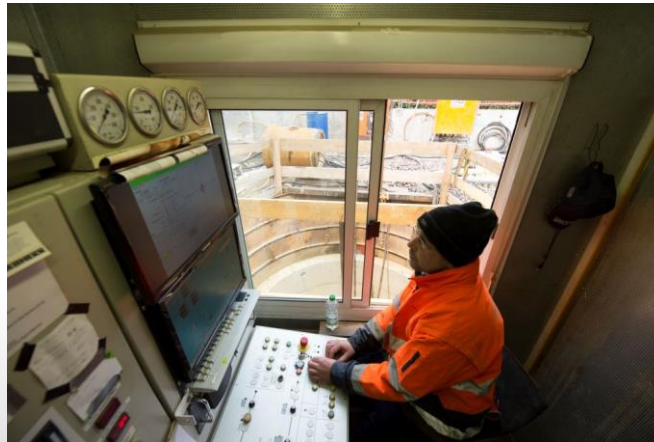


- | | |
|-----------------------|--------------------|
| 1. Cutting Wheel | 6. Screw Conveyor |
| 2. Excavation Chamber | 7. Gate Control |
| 3. Drive Unit | 8. Muck Pump |
| 4. Gear Box | 9. Power Pack |
| 5. Articulation Joint | 10. Discharge Pipe |

EPB muck pump technology.

Advantages of remote-controlled Pipe Jacking.

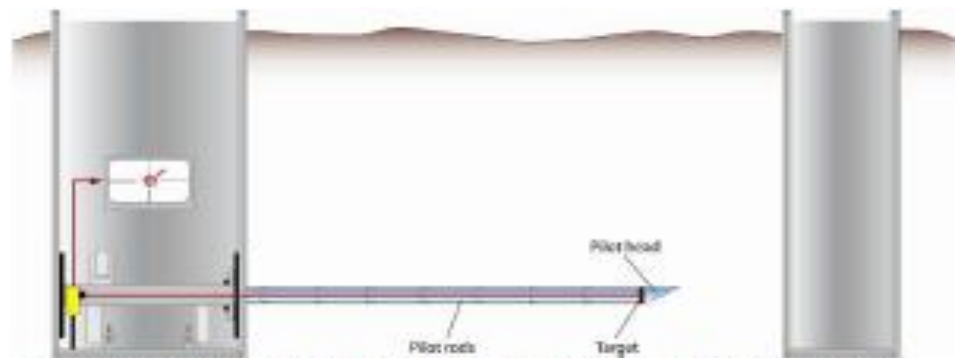
- ▶ No muck skip logistics in tunnel and shaft
 - ▶ Main risk of accidents avoided
- ▶ Only temporary access of personnel
 - ▶ E.g. for inspection and maintenance
 - ▶ No need for ventilation and fire protection



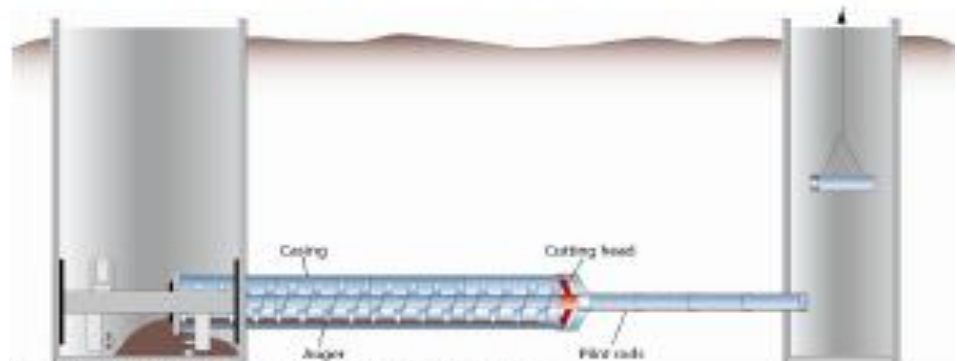
Bohrtec technology.

Method Statement

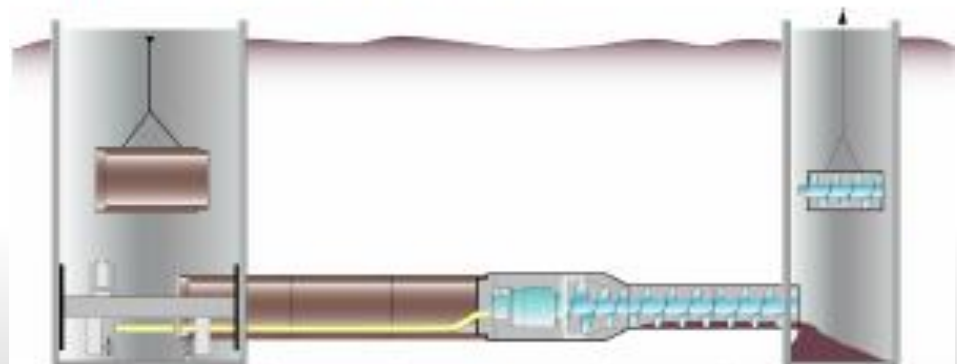
- ▶ **Advantages**
- ▶ Less sophisticated
- ▶ Easy to be operated
- ▶ Less maintainance
- ▶ High Efficiency
- ▶ Lower Investment
- ▶ Universal applications



1. Directionally controlled drilling assisted by pilot pipes in displaceable soil



2. Drilling of casings led by the pilot pipes



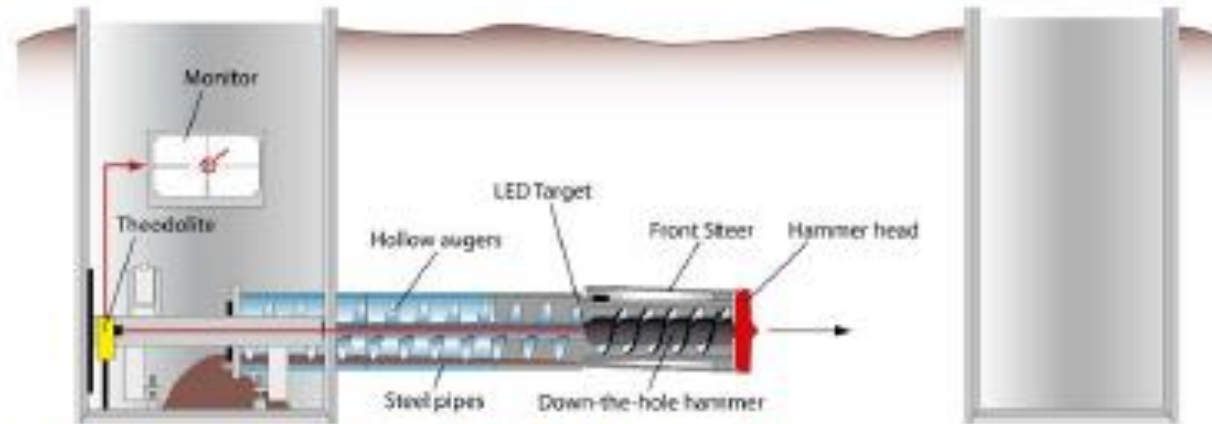
3. Expanding with extension motor and jacking of the product piping

Bohrtec technology.

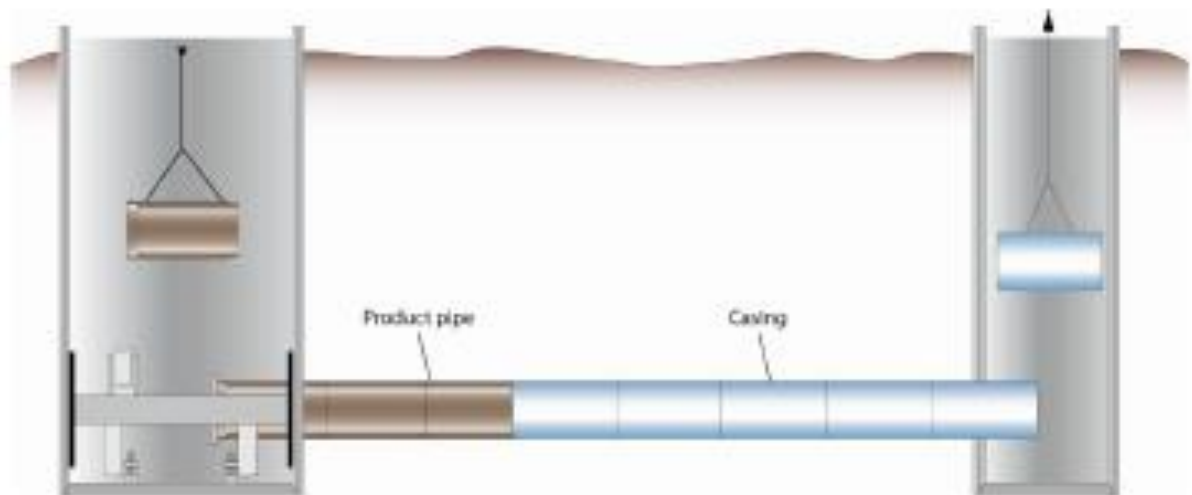
Method Statement

- ▶ **Advantages**
- ▶ Less sophisticated
- ▶ Easy to be operated
- ▶ Less maintainance
- ▶ High Efficiency
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- ▶ Universal applications

1.1. Front Steer



1. Guided drilling with Front Steer and optical guidance system



2. Jacking of the product pipes

Bohrtec technology. Application

► House connections



Large diameter Pipe Jacking ID 3000 in Singapore. Sewage Network in Eastern Jurong.

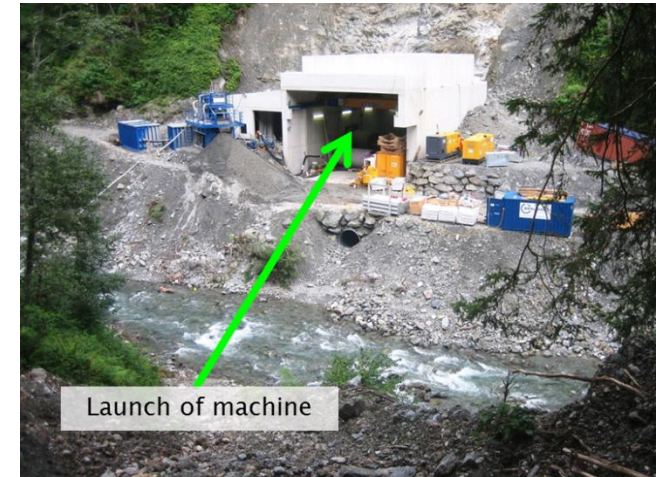
- ▶ EPB using pipes ID 3000, OD 3500
- ▶ Tunnel length: 500m + 330m
- ▶ Shaft depth: ca. 27m



AVN machine. Reference Project Hydropower. Water Pressure Tunnel Maerzenbach.

Water line
Steep drilling

- ▶ M-974M, AVN 1600 TB, OD 1970
- ▶ Location: Zillertal, Austria
- ▶ Tunnel length: 863m
- ▶ Tunnel Lining: Pipe Jacking
- ▶ Geology: rock, chist, quartzite (170MPa)
- ▶ Pipes: ID 1500, Length: 4m
- ▶ Contractor: Mauracher Bau GmbH



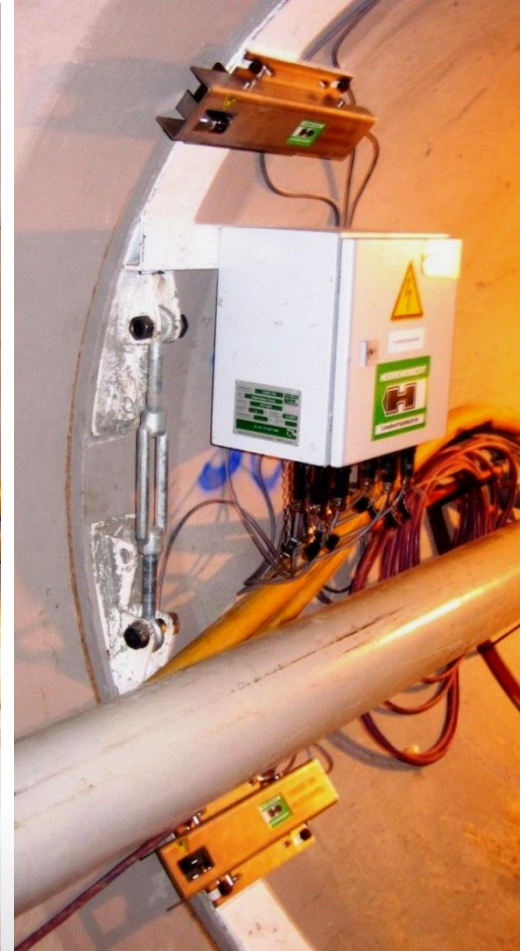
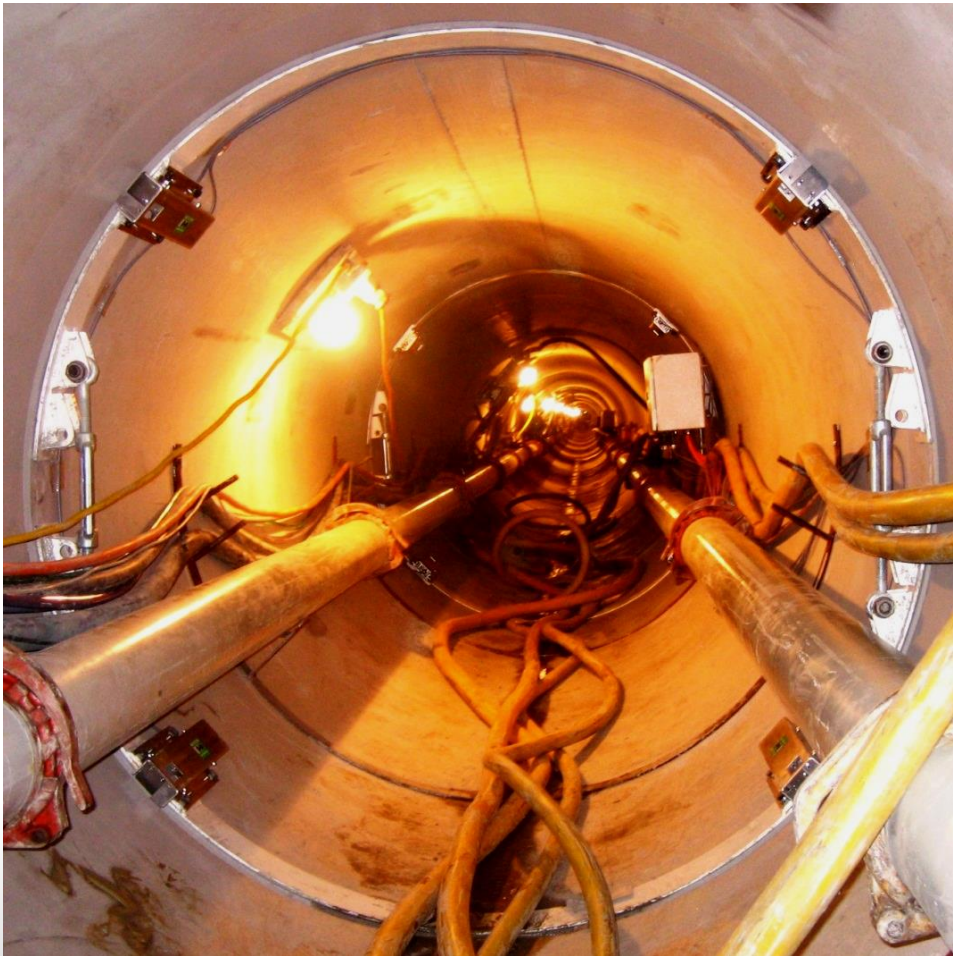
AVN machine. Reference Project Hydropower. Water Pressure Tunnel Maerzenbach.

- ▶ Altitude difference: 99.24m
- ▶ Slope: 11.6 %
- ▶ radius: 1,032m
- ▶ 5 interjacking stations installed
- ▶ OLC: Online Load Control System installed to prevent local pipe overloads, to build a high-quality tunnel



AVN machine. Reference Project Hydropower.
Water Pressure Tunnel Maerzenbach.

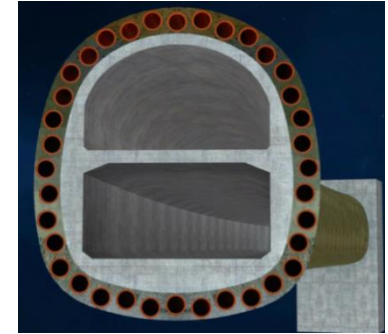
***Water line
Steep drilling***



GongBei Pipe Arch. Hong Kong - Zhuhai - Macao Bridge.

Road tunnel along the border Macao - Zhuhai.

- ▶ Connection of the 30km long bridge to the mainland
- ▶ 4 x AVN1200TC | OD 1640 + 2 x HKS 300 Separation plants
- ▶ Geology: sand, fine sand, clay
- ▶ 36 drives of 255m length each
- ▶ Curve radius = 250m



GongBei Pipe Arch. Hong Kong - Zhuhai - Macao Bridge. Road tunnel along the border Macao - Zhuhai.

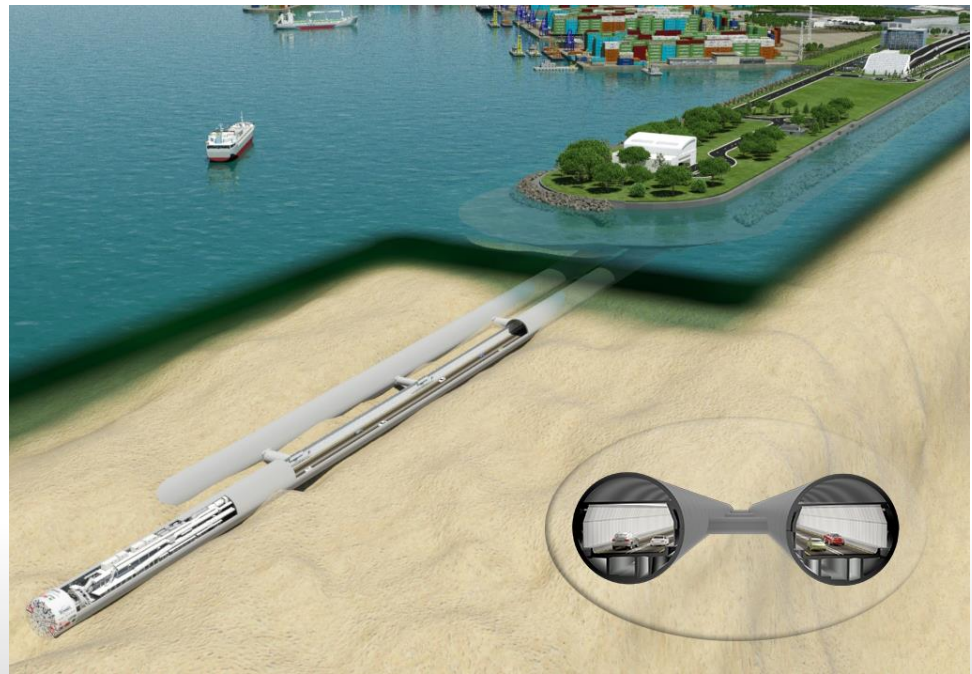
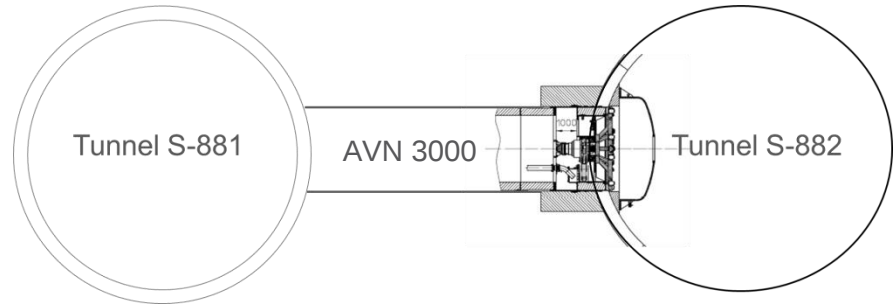
- 36 drives finished in May 2015



Tuen Mun-Chek Lap Kok Link.

Hong Kong. Cross Passages with AVN 3000.

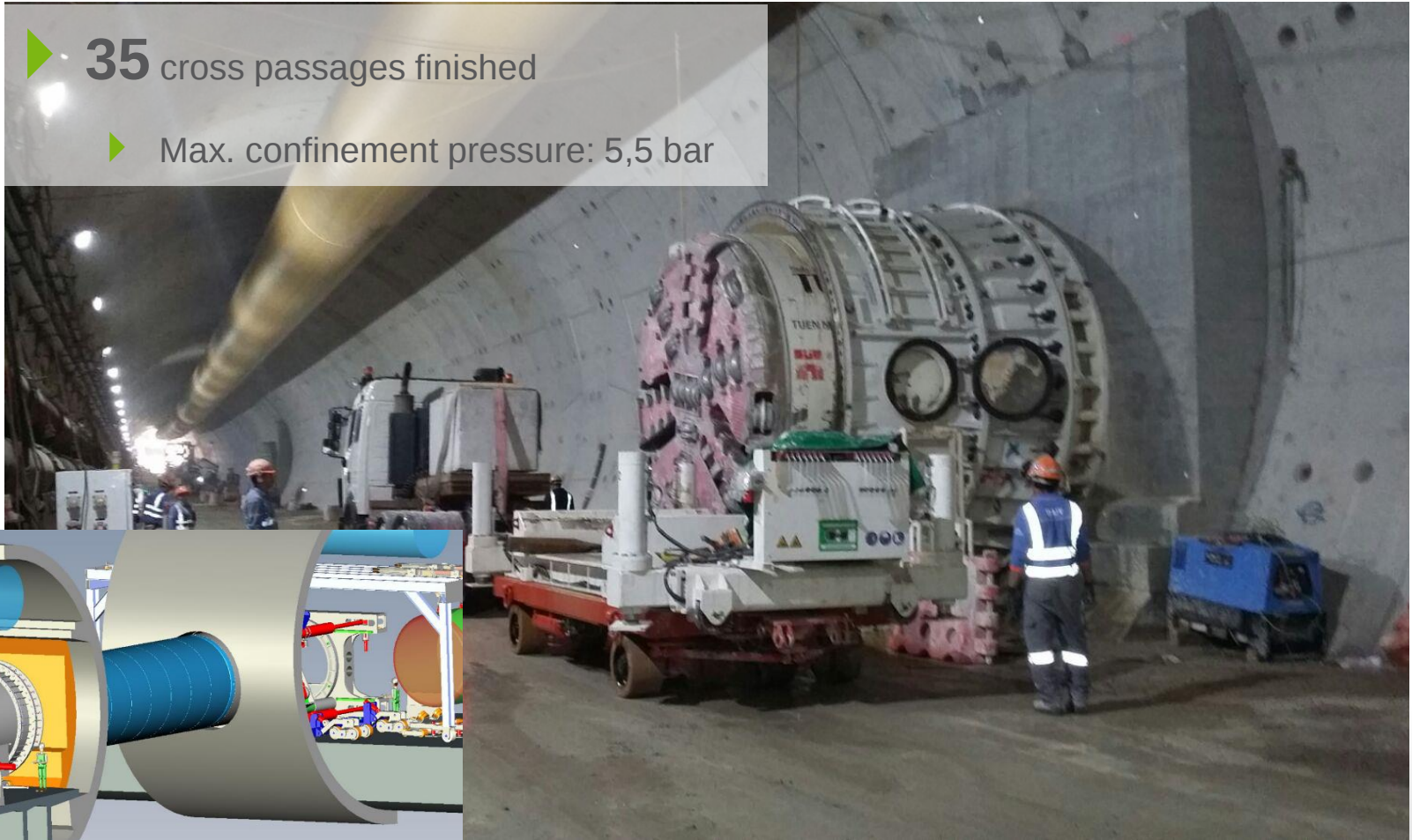
- ▶ M-2001M + M-2003M
- ▶ 2 x AVN 3000, OD 3605
- ▶ 44 Cross passages will connect the two road tunnels
- ▶ Length: ~12m each
- ▶ Geology: sand, silt, clay, gravel, granite



Tuen Mun-Chek Lap Kok Link.

Hong Kong. Cross Passages with AVN 3000.

- ▶ **35** cross passages finished
- ▶ Max. confinement pressure: 5,5 bar



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Dragages - Bouygues Joint Venture 寶嘉 - 布依格聯營



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Colector Oeste Tigre, Buenos Aires.

2 Pipe Jacking machines delivered.



- ▶ Colector Oeste Tigre
- ▶ M-1641M, EPB1500
- ▶ 4.3km Tunnel
- ▶ Contractor: Coarco S.A.



- ▶ Colector Don Torcuato
- ▶ M-1798M, AVN 800 + Ext.1100
- ▶ 4.5km Tunnel
- ▶ Contractor: Chediack - Ingenem

Main Sewage Trunk Riachuelo.

Sistema Riachuelo Lot 1 - Colector Margen Izquierda.

- ▶ M-2044M, AVN 800, OD 1060 → **1.8km**
- ▶ M-2089M, EPB3200, OD3840, Segment Lining → **9.4km**
- ▶ M-2121M, AVN1000, OD1390 → **10km**
- ▶ Location: Buenos Aires, Argentina
- ▶ Geology: sand, clay, silt
- ▶ Contractor: CCMI. | Client: Aysa – Aguas y Saniamentos Argentinas



Latin America.

More than 65 Utility machines delivered.



- ▶ Business Unit Utility Tunnelling
- ▶ Tel. +49 7824 302 0
- ▶ [mailto: utility@herrenknecht.de](mailto:utility@herrenknecht.de)
- ▶ Herrenknecht.com



Thank you !