w&f
Ingenieurbau

Tunnels

Connections for Life

Tunnels

Connection for Life

Creative engineering is our main focus. We understand design, conception and execution to be individually developed solutions in response to the tasks set by our clients.

As an internationally renowned construction company, we design environments, establish permanent connections between people and places and thus achieve perceptible improvements for both clients and users. In short: We create quality of life for the world of tomorrow.

Customer-oriented thinking and responsible actions form the basis of our business. After all, the success of each and every construction project is always closely linked to the quality of cooperation with our clients.

Wayss & Freytag Ingenieurbau AG is a member of the **Royal BAM Group**, one of the biggest European construction companies with its head office in the Netherlands. This powerful foundation enables us to take full advantage of all chances offered by international cooperation. For our clients this results in the greatest possible transparency in all phases of a project as well as availability of comprehensive know-how in conjunction with maximum regional presence.

At Wayss & Freytag Ingenieurbau AG more than 140 years of experience and the technological expertise of today converge. A lean structure ensures the optimum realization of our clients' projects. In our competence centres created just for this purpose specialist groups of our best staff work in close cooperation to find the most appropriate solution for every technological challenge.

Wayss & Freytag Ingenieurbau AG is active worldwide in the field of tunnelling. On the international market, the company carries out projects in which it distinguishes itself by its special know-how and excellent performance.

The scope of our activities ranges from mechanized and conventional tunnelling, the construction of sewage treatment plants and power plants, railway, bridge and stadium construction and industrial construction to environmental technology. Engineering consulting, location analyses, utilization concepts and feasibility studies complete our range of services.

Mechanized Tunnelling

In the past Wayss & Freytag was significantly involved in the development of mechanized tunnelling techniques. For example, they initiated the support of the tunnel face by means of a bentonite suspension and air-cushion. With the so-called "slurry shield" this technique was brought to operational maturity. Wayss & Freytag is a pioneer of this technique and has in the meantime driven more than 210 km of tunnel using slurry shields. In addition, more than 90 km of tunnel were driven using earth pressure balance shields and 30 km using hard rock TBMs. Examples of prominent projects in mechanized tunnelling are Westerschelde Tunnel (Netherlands) as well as Katzenberg Tunnel and Finne Tunnel, the longest railway tunnels built in Germany.

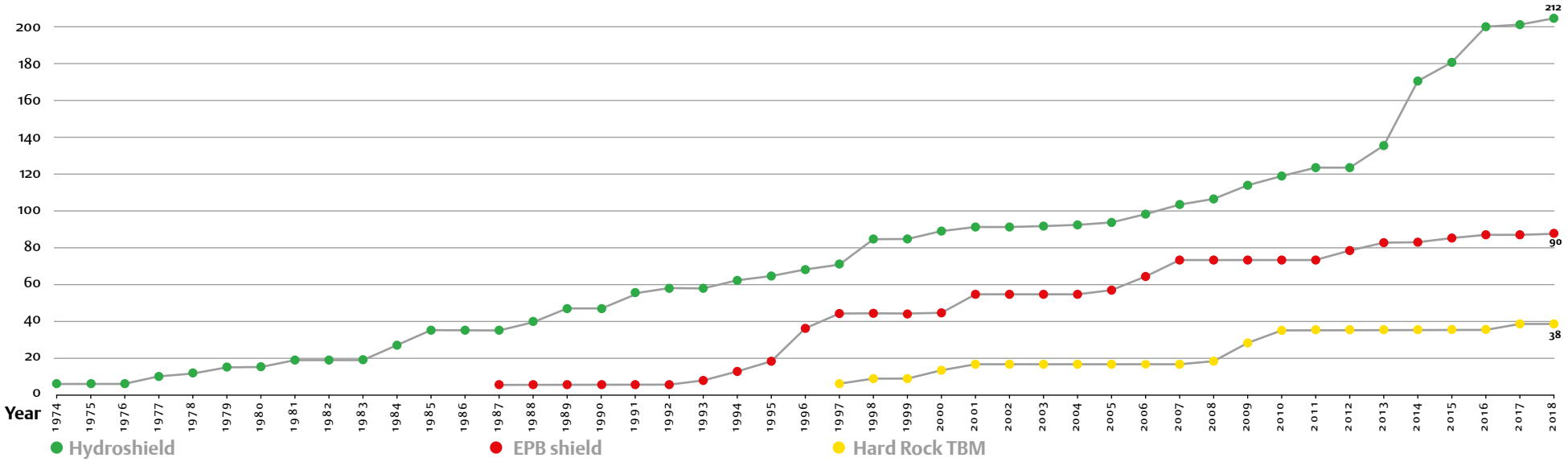
Conventional Tunnelling

The construction of tunnels using conventional construction methods has always been a challenge to every engineer. Here, the engineer's most important task is the evaluation of

the geology and the selection of the right means of securing the excavation face until final completion of the inner lining. Wayss & Freytag already rose to this challenge in 1905 when building a railway tunnel using the conventional tunnelling method in Wasserburg/Inn in gompholite (Nagelfluh) and gravel.

The range of conventional tunnelling reaches from soft rock tunnelling (e. g. a metro tunnel in Munich gravel) and tunnelling in compressed air (e. g. Ostbahnhof metro station in Munich in Tertiary formations below groundwater) to classic Drill and blast drives (e. g. Rennsteig Tunnel on the A 71 motorway, which, with a length of 8 km, is the longest motorway tunnel in Germany).

Total Driven Tunnel Length (km):



Contents

Expertise in and around tunnelling

Connections for Life

We offer you the customized solution for your tunnelling projects. From planning through work preparation, execution to operation and maintenance, we develop innovative solutions to suit the specific requirements of your projects.

The experienced teams in our **Technical Department** are at your disposal to provide optimal planning for your projects from the very beginning. Work preparation, material technology as well as individual monitoring throughout all phases of your project belong to our range of services. They comprise feasibility studies, risk analyses, design and consulting. Furthermore, we offer geotechnical evaluations, expert advice, structural analyses and much more.

The experts in our **Construction Material Technology** Department develop concrete and mortar with special characteristics for your project to meet your particular requirements. Besides this, our team supports you with concreting and concrete curing concepts as well as with quality assurance concepts.

The **W&F Tunneling Technology Department, our centre of expertise for equipment technology,** offers customized solutions for equipment concepts for all aspects of mechanized tunnelling according to your requirements. Our services are based on the experience gained on over 300 km of tunnels, driven using tunnel boring machines (TBMs) operated in slurry shield, earth pressure balance (EPB) and hard rock mode.

Our services range from the rental of individual items such as small machines through the development of conceptual designs to the supply and operation of complex large-scale equipment for all geological requirements. On request we can also provide you with our trained and experienced staff to maintain the equipment during operation or with a complete tunnelling team, including the respective management staff.

For your project we can also provide you with separation plants (STP), mud treatment equipment (MTP), slurry circuits for the conveying of excavated material, batching plants, compressed air stations, container systems, booster stations and cooling water systems, tunnel ventilation, safety equipment as well as electrical plants.

With our experienced and reliable teams in **Special Foundation Works** we also offer experienced and sound competence in nearly all parts of Europe. Our range of services in the field of specialized civil engineering comprises diaphragm walls and sealing walls (excavation by crawler cranes and diaphragm wall grippers and cutters as temporary or permanent structures with adjusted joint systems), bored piles (single piles and bored pile walls, completely piped, partly piped and slurry-supported), anchors (temporary and permanent anchors, soil nails and Micro-piles), soil injections in light soils and rock, ground freezing as well as planning and execution of turnkey excavation pits.

We look forward to meeting your challenges!

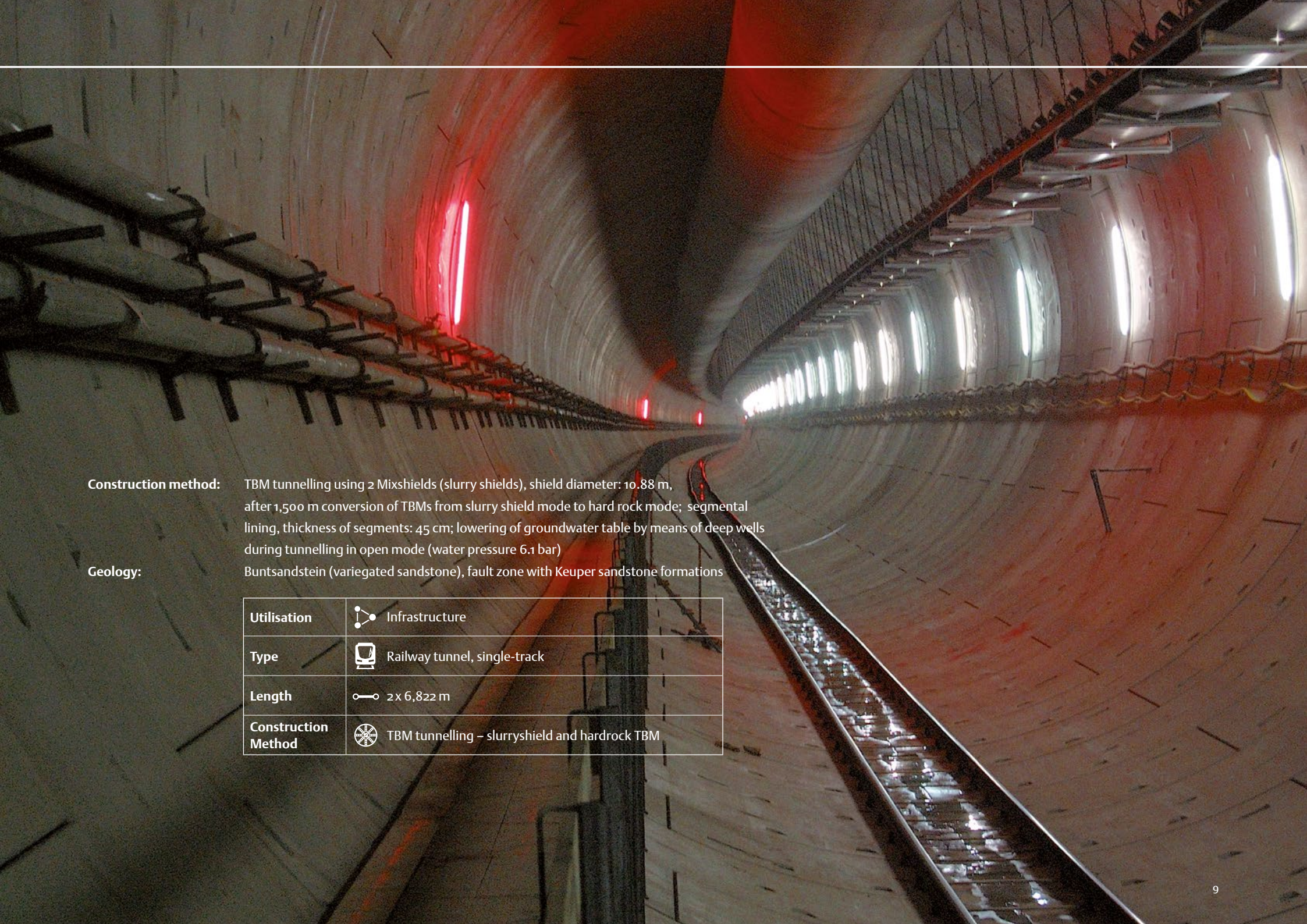
Finne Tunnel
Germany

General Data:

Project:	Finne Tunnel, part of new Erfurt-Leipzig-Halle railway line, single-track railway tunnel
Main Contractor:	DB Netz AG [German rail company], represented by DB Projekt Bau GmbH, Projektzentrum Leipzig
Client:	Wayss & Freytag Ingenieurbau AG as technical leader of a joint leader
Construction period:	December 2006 to September 2012
Net construction costs:	€ 272 million

Technical data:

Scope of work:	2 single-track railway tunnels, length: 2 x 6,822 m, internal diameter: 9.60 m; 2 cut and cover tunnel sections, each approximately 75 m long; 13 cross-passages; 2 tunnels for technical purposes; railway sections in a cutting and on an embankment, lengths: 1,000 m and 340 m; construction of sonic boom structures at all 4 tunnel portals in order to avoid the sonic boom effect, length: 75 m



Construction method: TBM tunnelling using 2 Mixshields (slurry shields), shield diameter: 10.88 m, after 1,500 m conversion of TBMs from slurry shield mode to hard rock mode; segmental lining, thickness of segments: 45 cm; lowering of groundwater table by means of deep wells during tunnelling in open mode (water pressure 6.1 bar)

Geology: Buntsandstein (variegated sandstone), fault zone with Keuper sandstone formations

Utilisation	Infrastructure
Type	Railway tunnel, single-track
Length	2 x 6,822 m
Construction Method	TBM tunnelling – slurryshield and hardrock TBM

Wallring Sewerage Tunnel, Hamburg
Germany

General Data:

Project:	Wallring Sewerage Tunnel
Main Contractor:	Hamburger Stadtentwässerung AöR
Client:	Joint Venture
	Wayss & Freytag Ingenieurbau AG (technical leadership) & Arkil
Design:	Hamburger Stadtentwässerung AöR
Construction period:	2016 to 2018
Net construction costs:	€ 12.3 million

Technical data:

Use of Tunnel:	Sewerage tunnel; tunnel length: 1,413 m (in 2 sections); Inner diameter: 1.80 m; outer diameter: 2.30 m; min. radius: 380 m; Min. cover: 6.50 m; max. cover: 25 m; 7 cross passages (lowered access shafts ; connected by cross passages)
Jacking pipes:	Type: DN 1800 reinforced concrete; number: 420 pcs.; length: 3.00 m and 4.00 m wall thickness: 0.25 m
Geology:	Geological characteristics: medium and fine sands, underlying tills, tillite (boulder clay) and silt with interstratification of sand
Max. hydrostatic pressure:	1,6 bar

Utilisation	Water / Sewerage
Type	Sewerage water tunnel
Length	1,413 m
Construction Method	Pipe Jacking

Large-scale project “Emscher” Sewerage Tunnel, BA30
Germany

General Data:

Project: Emscher Sewerage Tunnel, construction lot (BA)30 (BA 31, BA 32, BA 33) between Dortmund-Mengede and Bottrop Sewage Treatment Plant

Main Contractor: Emschergenossenschaft

Client: Wayss & Freytag Ingenieurbau AG, Central, Tunnelling & Specialized Civil Engineering/Special Foundation Engineering Divisions

Construction period: March 2012 to January 2017

Net construction costs: € 420 million

Technical data:

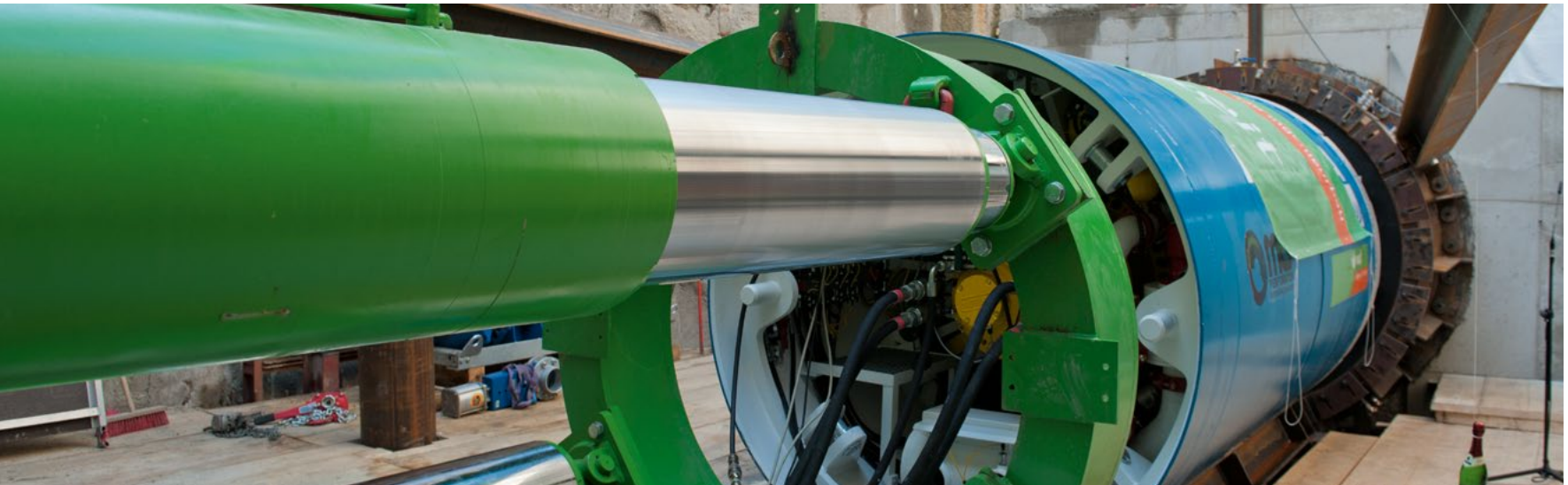
Scope of work: Construction of 130 excavation pits, 115 shaft structures and approx. 47 km of sewerage tunnel in 117 individual drives with individual lengths of < 20 m to 1.150 m

Construction method: For excavation pits the diaphragm wall and bored pile construction methods.
Pipe jacking with DN 1600, DN 1800, DN 2200, DN 2400 and DN 2800 with 9 full-face TBMs using both the EPB and slurry method

Crossing beneath waterways (Emscher Canal, Rhein-Herne- Canal), railway lines, roads, dams, buildings and pipelines.
Standard pipe length 4 m. Thickness of pipe walls between 21 cm and 39 cm.
Pipes consisting of acid-resistant concrete, some with additional special protection against corrosion.
Microtunnel DN 300 to DN 1200. maximum allowed settlement 20 mm
Construction of shaft structures with conventional climbing formwork and slipform method. Also executed in acid-resistant concrete, partly with a special PE-HD lining as special protection against corrosion.

Geology: Emscher marl, sandy and silty clays, tunnel alignment entirely below the groundwater table with a water pressure of up to 3 bar above the pipe invert level.

Utilisation	Water / Sewerage
Type	Sewerage water tunnel
Length	47,000 m
Construction Method	Pipe jacking, 9 full-face TBMs using both EPB and slurry method



Pipeline Tunnel under the Rhine River, Leverkusen
Germany

General Data:

Project:	Pipeline Tunnel under the Rhine River, Leverkusen
Main Contractor:	CURRENTA GmbH & Co.OHG Chempark, Leverkusen
Client:	Wayss & Freytag Ingenieurbau AG
Design:	MOLL-prd, Schmallenberg
Construction period:	2015 to 2017
Net construction costs:	€ 5.8 million

Technical data:

Use of Tunnel:	Accessible pipe culvert Tunnel length: 471 m Inner diameter: 2.40 m Outer diameter: 3.00 m Min. radius: 8 m (horizontal 8) Min. cover: 5 m Max. cover: 13 m
Jacking pipes:	Type: DN 2400 reinforced concrete Number: 118 pcs. Length: 4 m Wall thickness: 0.30 m
Geology:	Geological characteristics: medium to densely bedded sandy, gravelly, stony terraces
Max. hydrostatic pressure:	2 bar

Utilisation	Utility Tunnel
Type	Gas transportation
Length	471 m
Construction Method	Pipe jacking

Bad Cannstatt Tunnel
Germany

General Data:

Project: Stuttgart 21
PFA (section) 1.5, Lot 3 Long-distance route from Stuttgart Main Station to Bad Cannstatt

Main Contractor: DB Netz AG, Frankfurt/Main represented by DB Projektbau Stuttgart – Ulm GmbH

Client: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: 2012 – 2021

Net construction costs: approx. € 285 million

Utilisation	Infrastructure
Art	Railway tunnel
Length	5,050 m, 1,050 m
Construction Method	Drill and blast method and tunnel excavator

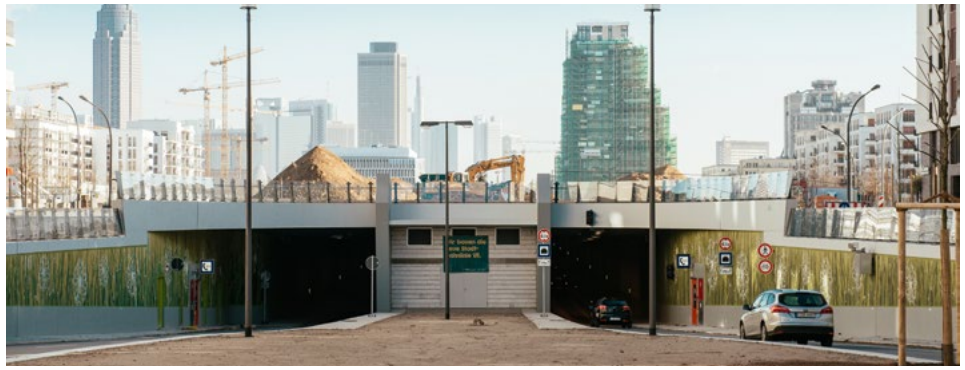
Technical data:

Scope of work: 5050 m single-track and 1050m double-track long-distance railway tunnel; A = 70-220 m², 345m single-track and 575m double-track suburban railway tunnel, A = 50-100 m²
790m rescue tunnel; A = 20 – 40m² , approx. 60m deep smoke extraction structure, 1 rescue shaft depth = 20m

Construction method: Drill and blast method and tunnel excavator, reinforced inner lining partly with foil sealing Bored pile lining, shotcrete shafts, elevation grouting

Geology: Leached and non-leached gypsum Keuper, partly containing anhydrite

Tunnel Europagarten, Frankfurt am Main
Germany



General Data:

Project:	Tunnel Europagarten, Frankfurt am Main
Main Contractor:	aurelis Asset GmbH represented by aurelis Real Estate GmbH & Co.KG, Eschborn
Client:	Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture
Construction period:	January 2015 – August 2016
Gross construction costs:	approx. € 29 million

Technical data:

Scope of work:	Length 533 m, 395 m covered over section using the cut and cover method Three tubes: outer tube for motor traffic inner tube for tram Ramps with clear width 6.50/ 7.90/6.50 m and clear height of 5.71 m Two pump buildings including operational building and road works, operational and traffic installations
Construction method:	Temporary excavation support system consisting of sheet piles with grouted anchors, underwater concrete base slab. Tunnel tube by cut and cover

Utilisation	Infrastructure
Type	Road tunnel
Length	533 m
Construction Method	Cut and cover

Darmsheim Tunnel
Germany

General Data:

Project: Darmsheim Northern Bypass, L1182 Darmsheim Tunnel
Main Contractor: Federal Land of Baden –Württemberg represented by RP Stuttgart
Client: Wayss & Freytag Ingenieurbau AG
Construction period: 2015 to 2017
Net construction costs: € 13.5 million

Technical data:

Scope of work: Two-lane road tunnel; length 460 m; A = 95 – 120m²
Escape and safety tunnels, l = 228 m, A = 13.5 – 18.3 m²
Construction method: Drill and blast
Geology: Upper shell limestone

Utilisation	Infrastructure
Type	Road tunnel, two-lane
Length	460 m
Construction Method	Drill and blast

Kö-Bogen Tunnel
Germany

General Data:

Project: Kö-Bogen Tunnel
Main Contractor: Landeshauptstadt (regional federal land capital of) Düsseldorf, Amt für Verkehrsmanagement (authority for traffic management)
Client: Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture
Construction period: 2010 to 2016
Gross construction costs: € 114 million

Technical data:

Scope of work: City centre road tunnel, construction in two lots
Lot 1: approx. 300 m South-North-Tunnel with 85 m ramp and western junction
Lot 2: approx. 675 m North-South-Tunnel with three ramps, approx. 85 m; connection to various subterranean garages, ground levels 7 m to 14 m; 36,000 m³ concrete; 120,000 m³ excavation

Construction method: Excavation supported by diaphragm walls or bored pile walls, underwater concrete with tie-back anchorage system, in some areas top-down method, sewer under existing metro tunnel, monitoring programme to protect surrounding property

Utilisation	Infrastructure
Type	Road tunnel
Length	300 m + 675 m
Construction Method	Cavern with diaphragm walls or bored pile walls

Tunnel Luise-Kiesselbach-Platz
Germany

General Data:

Project:	Mittlerer Ring Süd-West (MRSW)(Middle Ring South-West) Tunnel – Luise-Kiesselbach-Platz
Main Contractor:	Landeshauptstadt München Baureferat (Building Authority of Federal Land Capital of Munich) Abteilungen (Division) J12, T1B, MSE
Client:	Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture
Construction period:	Aug 2009 – Dec 2015, opening for traffic in July 2015
Gross construction costs:	€ 398 million

Technical data:

Scope of work:

The MRSW– Luise-Kiesselbach-Platz Tunnel Project is the third section of an infrastructure project at the Middle Ring in Munich ratified by a public referendum in 1996.

The project comprises the construction of an approx. 2800 m long inner-city tunnel, in bored pile top-down method and cut and cover construction method as well as canal and road works.

All works had to be carried out during ongoing traffic on the surface at all times (approx. 150.000 cars/day) as well as for all utilities in operation and thus required many traffic diversions and numerous construction sections.

The heart of the tunnel is considered to be the 2-storey construction of the intersection between motorway connection A95 and Middle Ring to the East and North.

Construction method: Bored pile top-down method approx. 2.000 m, cut and cover construction method approx.800 m

Geology: Quaternary gravel

Utilisation	Infrastructure
Type	City Centre road tunnel
Length	2,800 m
Construction Method	Bored pile top-down method, cut and cover construction method

Widderstall Tunnel
Germany

General Data:

Project: NBS (new construction) Stuttgart-Augsburg, Section Wendlingen-Ulm; PFA (section) 2.3 Albhöhe; VE 230-1 Widderstall Tunnel
Main Contractor: DB Project Stuttgart–Ulm GmbH
Client: Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture
Construction period: 2013 to 2016
Gross construction costs: approx. € 43.7 million

Construction method: Cut and cover construction method in arch cross-section
Geology: Lower massive limestone

Utilisation	Infrastructure
Type	Railway tunnel, double-track
Length	962 m
Construction Method	Cut and cover construction method in arch cross-section

Technical data:

Scope of work: 962 m long double-track railway tunnel; 440,000 m³ excavated material with tunnel lining (shotcrete and netting); geophysical and direct soil investigation of the karst-prone rock, material processing and backfilling; rain retention and reservoir; construction of a new parking and toilet facility at “Albhöhe”


Bahnsteig
5
Heinrich-Heine-Allee

Wehrhahnlinie (Wehrhahn Line) Lot 2
Germany

General Data:

Project: Wehrhahnlinie, Lot 2

Main Contractor: Landeshauptstadt (regional federal land capital of) Düsseldorf, Amt für Verkehrsmanagement (authority for traffic management)

Client: Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture

Construction period: 2007 to 2016

Gross construction costs: € 74 million

Technical data:

Scope of work: Total length 120 m, approx. 75 m drive under historical Kaufhof-Building
Connection to station Heinrich-Heine-Allee , tunnel with segmental lining Lot 1

Construction method: Start- and reception cavern with diaphragm walls, navigated horizontal drilling R = 350 m for ground freezing, excavation with tunnel excavator in two segments with shortcrete

Utilisation	Infrastructure
Type	Metro tunnel
Length	460 m
Construction Method	Tunnel excavator

Construction of the new “Sylvensteinspeicher” Seepage Water Tunnel
Germany

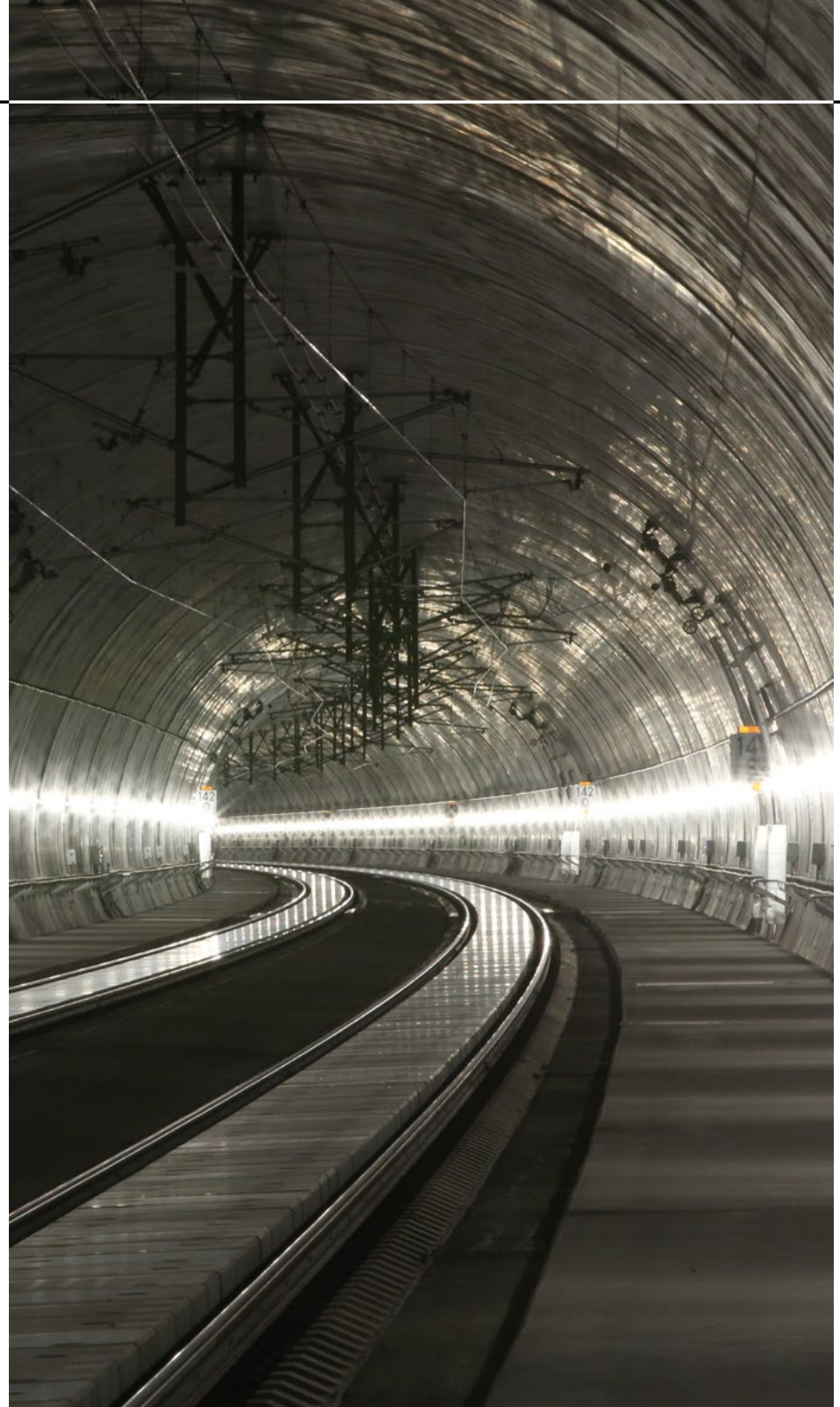
General Data:

Project: Sylvenstein Dam BA (construction lot) 3, construction of a new seepage water tunnel, Lots 1-3
Main Contractor: Wasserwirtschaftsamt (water authority) Weilheim for the Free State of Bavaria
Client: Wayss & Freytag Ingenieurbau AG
Construction period: March 2013 to July 2014
Gross construction costs: approx. € 5.6 million

Technical data:

Scope of work: Lot 1: Driving of access tunnel I: approx. 90 m and start cavern V = approx. 1,000 m³, construction of 2 pressure partitions(walls), extension of access tunnel incl. tunnel portal, infrastructure provisions
Construction method: Drill and blast, SCL inner lining
Geology: Main Dolomite formation
Scope of work: Lot 2: driving of target shaft 7 m diameter, d: approx. 40 m and target cavern, L approx. 15 m
Construction method: Drill and blast, SCL inner lining
Geology: mainly dolomite
Scope of work: Lot 3: TBM driven seepage water tunnel, diameter = 3.0 m, L approx. 160 m
Construction method: Pipe jacking with reinforced concrete pipes, L = 2.8 m, installation of two soft gel seals respectively in the transition area between rock and dam fill

Utilisation	Water / Sewerage as inspection tunnel
Type	Seepage water tunnel
Length	160 m
Construction Method	Pipe jacking



Silberberg Tunnel
Germany

General Data:

Project: German Unity Transport Project VDE8, Upgraded and New Railway Line between Nuremberg and Berlin (Nuremberg-Ebensfeld-Erfurt-Leipzig/Halle-Berlin railway line), Silberberg Tunnel

Main Contractor: DB Netz AG [German rail company]

Client: Wayss & Freytag Ingenieurbau AG as commercial leader of a joint venture

Construction period: 2009 to 2012

Net construction costs: approx. € 222 million

Technical data:

Scope of work: 7,391 m long double-track railway tunnel, excavated area: 120 m² – 150 m²; 2 intermediate tunnels serving as points of attack; inclined and parallel tunnels, length: 4,395 m, excavated area: 30 m²; rescue shaft, depth: 21 m

Construction method: Drill and blast method and tunnel excavator, waterproofing and inner lining

Geology: Thuringian slate mountains, clay/silt rock

Utilisation	Infrastructure
Type	Railway tunnel, double-track
Length	7,391 m
Construction Method	Drill and blast method and tunnel excavator

Gateway Gardens
Germany

General Data:

Project: Tunnel Gateway Gardens, Lot 2
Main Contractor: Deutsche Bahn AG
Client: ARGE Tunnel Gateway Gardens, Los 2,
Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture
Construction period: February 2016 – December 2019
Net construction costs: 120 Mio.€

Technical data:

Scope of work: Construction of light railway station Gateway Gardens including 2.2 km light railway tunnel
Construction method: Cut and cover method
Geology: Soft rock sections, Quartenary sedimentary rocks, cohesive Tertiary layers

Utilisation	Infrastructure
Type	Railway tunnel, double-track
Length	2,200 m
Construction Method	Cut and cover method

Cologne North-South Light Railway, Southern Section
Germany

General Data:

Project: Cologne North-South Light Railway, Southern Section, single-track metro tunnel

Main Contractor: Kölner Verkehrs-Betriebe AG, Cologne

Client: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: November 2003 to May 2015

Net construction costs: € 550 million

Technical data:

Scope of work: 3,260 m of light railway line with 2 single-track tunnels, total length: 5,400 m, internal diameter: 7.30 m; 7 stations; 1 crossover; 1 weaving section, tunnelling underneath buildings and traffic facilities with shallow cover ≤ 1 D

Construction method: TBM tunnelling using 2 Mixshields (slurry shields), shield diameter: 8.39 m, segmental lining; use of complex special construction methods, e.g. ground freezing, soil stabilisation (jet grouting and compaction grouting), groundwater lowering, compressed air tunnelling using ground freezing methods and pipe umbrella support systems

Geology: Quaternary sands/gravels

Utilisation	Infrastructure
Type	Metro tunnel, single-track
Length	5,400 m
Construction Method	Mixshield

Brandkopf/Lohmeberg Tunnel
Germany

General Data:

Project: German Unity Transport Project VDE 8, Upgraded and New Railway Lines between Nuremberg and Berlin (Nuremberg-Ebensfeld-Erfurt-Leipzig/Halle-Berlin railway line), Brandkopf Tunnel – Lohmeberg Tunnel

Main Contractor: DB Netz AG, Erfurt [German railway company]

Client: Wayss & Freytag Ingenieurbau AG as commercial leader of a joint venture

Construction period: August 2009 to March 2012

Net construction costs: € 67.8 million

Technical data:

Scope of work: 2 tunnels, lengths: 1,493 m and 688 m, excavated area: 120 m² – 150 m²;
2 reinforced concrete railway bridges, spanning: 150 m and 87 m respectively

Construction method: Drill and blast method and tunnel excavator, water proofing and inner lining

Geology: Lower Rotliegend, volcanic rock, clay, siltstone and sandstone

Utilisation	Infrastructure
Type	Railway tunnel, double-track
Length	2 x 1,493 m
Construction Method	Drill and blast method and tunnel excavator

New Central Services Tunnel for Brunsbüttel Lock
Germany

General Data:

Project: New central services tunnel for Brunsbüttel lock, tunnel for service lines

Main Contractor: Wasser- und Schifffahrtsamt Brunsbüttel [Water and Shipping Authority]

Client: Wayss & Freytag Ingenieurbau AG

Construction period: March 2009 to September 2011

Net construction costs: € 24 million

Technical data:

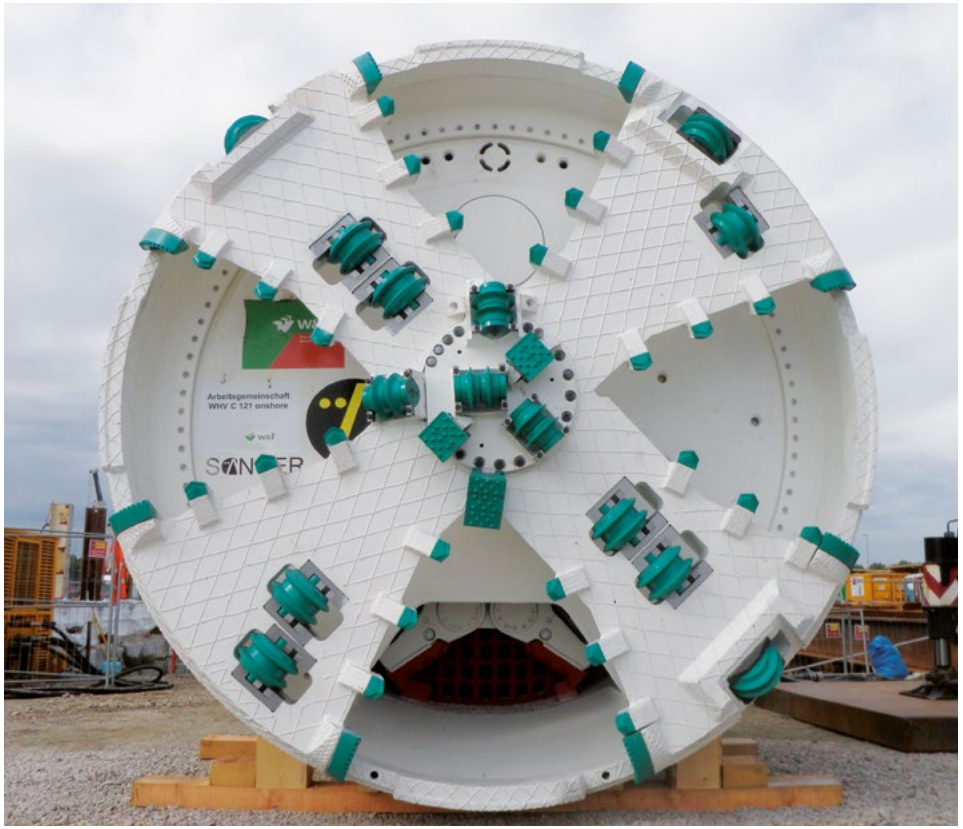
Scope of work: Construction of a services tunnel (called “Mitteldüker”) under the existing double locks at the western end of the Kiel Canal without disrupting lock operations, length: approx. 450 m, clear internal diameter: 2.20 m, tunnel invert approx. 35 m below ground level

Construction method: Pipe jacking using an AVN 2000 machine, construction of shafts using the diaphragm wall method

Geology: Gravelly sand with stones

Utilisation	Logistics
Type	Utility tunnel
Length	450 m
Construction Method	Pipe jacking

New Coal-Fired Power Plant in Wilhelmshaven,
Cooling Water Pipelines, Lot C121, Germany



General Data:

Project: New coal-fired power plant in Wilhelmshaven, cooling water pipelines, Lot C121

Main Contractor: GDF SUEZ Energie Deutschland AG

Client: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: December 2009 – August 2011

Gross construction costs: € 36 million

Technical data:

Scope of work: 4 cooling water pipelines DN 3400 with a length of 300 m each;
1 fish return pipeline DN 1200 with a length of 300 m;
start shaft: 30 m x 25 m x 15 m, diaphragm walls with anchored underwater concrete slab;
target shaft: 45 m x 11 m x 15 m, steel girder shoring with underwater concrete slab and pre-installed lean concrete block;
dyke crossing structure: 5 circular cells of secant bored piles (internal diameter approx. 7 m), a tunnel drive through each circular cell

Construction method: Pipe jacking using 2 slurry-supported tunnel boring machines, external diameter: 4.1 m
Jacking pipes:
Composite pipes DN 3400, consisting of a reinforced concrete pipe with an integrated HDPE pipe liner

Geology: Silty sand with bands of clay

Utilisation	Water / Sewerage
Type	Cooling water tunnel
Length	4 x 300 m
Construction Method	Pipe jacking

Katzenberg Tunnel
Germany

General Data:

Project: Katzenberg Tunnel,
part of the new/upgraded Karlsruhe-Basel railway line,
single-track railway tunnel

Main Contractor: DB Netz AG [German rail company],
represented by DB Projektbau GmbH,
Projektzentrum Karlsruhe

Client: Wayss & Freytag Ingenieurbau AG
as commercial leader of a joint venture

Construction period: August 2003 to March 2011

Net construction costs: € 348 million

Utilisation	Infrastructure
Type	Railway tunnel, single-track
Length	2 x 9,400 m
Construction Method	TBM tunnelling using two EPB shields

Technical data:

Scope of work: Twin-bore railway tunnel, each tube 9.4 km long, of which 8,984 m were driven using a TBM, internal diameter: 9.60 m; 2 cut and cover sections, lengths: 286 m and 115 m; 19 cross-passages (18 cross-passages constructed using mining techniques, 1 cross-passage within the sonic boom structures); 2 ventilation shafts, 67 m deep; water pressure up to 9.2 bar; construction of sonic boom structures at all portals to avoid the sonic boom effect

Construction method: TBM tunnelling using 2 EPB shields,
shield diameter 11.12 m,
operated both in open and in closed mode,
segmental lining, 60 cm thick

Geology: Tertiary claystone, marlstone, limestone and sandstone

Munich Metro, Line 3 North, Section 2
Germany

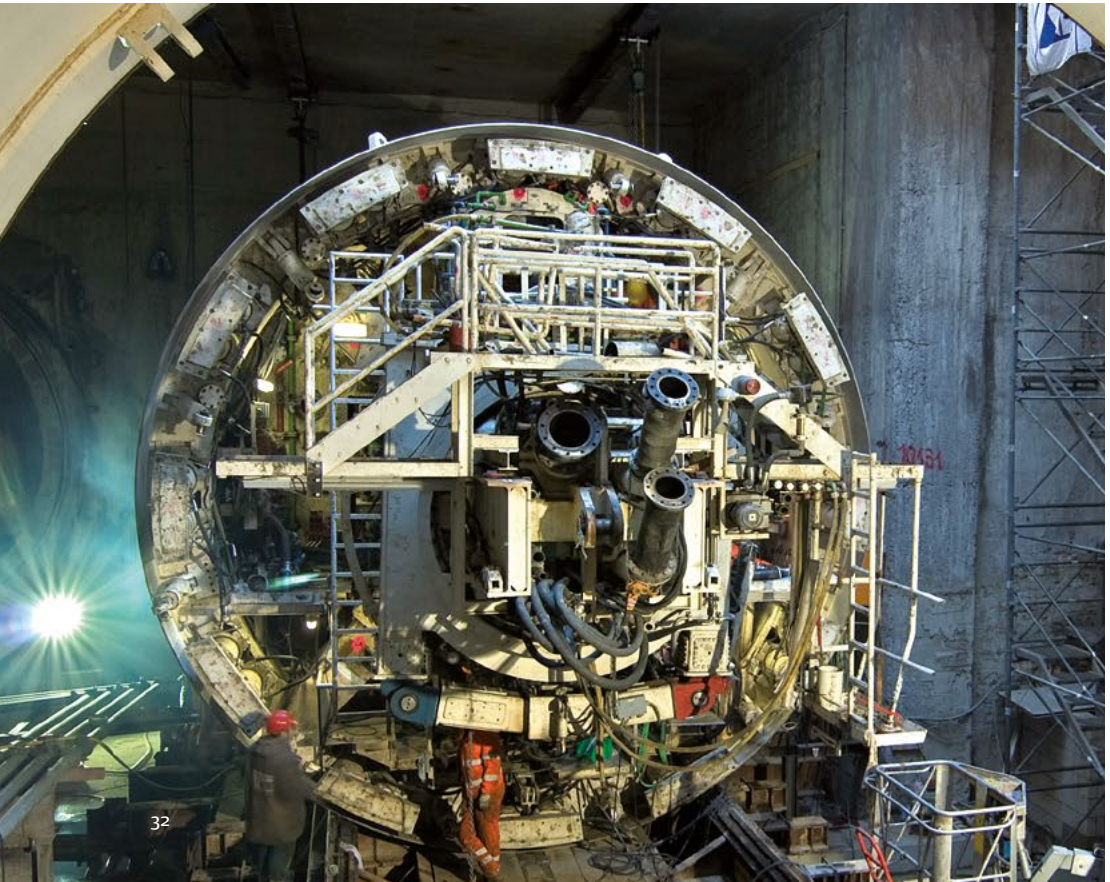
General Data:

Project:	Munich Metro, Line 3 North, Section 2, single-track metro
Main Contractor:	Landeshauptstadt München, Baureferat U-Bahn [State Capital of Munich, Building Division – Underground Railway]
Client:	Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture
Construction period:	September 2004 to February 2010
Net construction costs:	€ 81 million

Technical data:

Scope of work:	2 single-track metro tunnels, total length: 2,410 m, internal diameter: 6.30 m; construction of Moosach and Moosacher St.-Martins-Platz Stations
Construction method:	TBM tunnelling using a Hydroshield (slurry shield), shield diameter: 7.34 m, segmental lining, construction of metro stations using the top-down method
Geology:	Gravel, clay, silt

Utilisation	Infrastructure
Type	Railway tunnel, single-track
Length	2,410 m
Construction Method	TBM tunnelling with slurry shield



Stuttgart Metro, Line U6 Fasanenhof
Germany

General Data:

Project:	U6 metro link to Fasanenhof, double-track tunnel
Main Contractor:	Stuttgarter Straßenbahnen AG
Client:	Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture
Construction period:	2007 to 2010
Gross construction costs:	€ 30 million

Technical data:

Scope of work:	Double-track mined tunnel, length: 380 m, excavated cross-section: 90 m²; 852 m constructed using the cut and cover method
Construction method:	Sprayed concrete lining (SCL) method with tunnel excavator; tunnelling under a high rise building protected by a pipe umbrella support system, under a four-lane federal road and an industrial building with a shallow overburden
Geology:	Sandstone of varying strength

Utilisation	Infrastructure
Type	Metro tunnel, double-track
Length	2 x 380 m
Construction Method	Sprayed concrete lining (SCL) method with tunnel excavator

Pipe Jacking under Leipzig Main Station
Germany

General Data:

Project:	Pipe jacking under Leipzig Main Station
Main Contractor:	City Tunnel Leipzig Joint Venture, consisting of Wayss & Freytag Ingenieurbau AG and and Strabag AG
Client:	Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture
Construction period:	October 2006 to July 2007
Net construction costs:	€ 2.8 million

Technical data:

Scope of work:	Construction of two pilot tunnels in the course of the construction of Leipzig City Tunnel, Section C, length: 110 m and 145 m, internal diameter: 2.40 m
Construction method:	Pipe jacking with a slurry-supported tunnel face; AVN 2000 tunnelling machine, external diameter: 2,400 mm; enlarged to 3,000 mm; wall thickness of jacking pipes: 30 cm, standard length: 3 m; max. settlement 3 mm
Geology:	Sand, gravel

Utilisation	Infrastructure
Type	Pilot tunnel for ground freezing
Length	110 und 145 m
Construction Method	Pipe jacking

Dortmund Ostentor Light Railway
Germany

General Data:

Project: Dortmund Ostentor Light Railway Line III, Contract Section S10.1, 2nd Stage

Main Contractor: Stadt Dortmund, Stadtbahnbauamt [City of Dortmund, Light Rail Construction Authority]

Client: Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture

Construction period: March 2002 to December 2005

Gross construction costs: € 40 million

Construction method: Sprayed concrete lining (SCL) method with tunnel excavator, partly with pipe umbrella support system;
cut and cover method:
western and eastern railhead of the stations with accesses;
100 m closed ramp as a double-track rectangular cross-section;
120 m open ramp as a retained cut

Geology: Marlstone, weathering zone of sandy, gravelly and silty clays

Technical data:

Scope of work:

Start shaft	diameter: 15 m, depth: 22 m
600 m single-track cross-section	excavated area = 36 m²
200 m double-track cross-section	excavated area = 70 m²
70 m enlargement section	excavated area = 36 m² - 60 m²
30 m branch-off section, three-bay	excavated area = 185 m²
100 m station tubes	excavated area = 62 m²
80 m station section, three-bay	excavated area = 138 m²

Utilisation	Infrastructure
Type	Metro tunnel
Length	1,230 m
Construction Method	SCL method with tunnel excavator, cut and cover method

Rennsteig Tunnel
Germany

General Data:

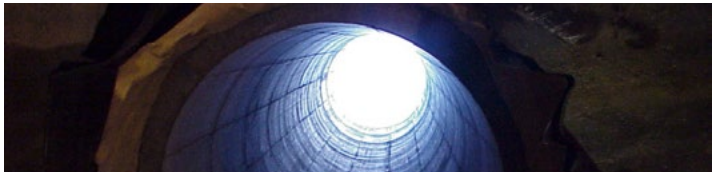
Project: Rennsteig Tunnel, twin-tube, two-lane motorway tunnel on the BAB A 71
Main Contractor: DEGES Deutsche Einheit Fernstraßenplanungs- und -bau GmbH, Berlin
Client: Wayss & Freytag Ingenieurbau AG as commercial leader of a joint venture
Construction period: 1998 – 2003
Gross construction costs: € 192 million

Construction method: Drill and blast method, sprayed concrete lining (SCL) method
Geology: Porphyry, conglomerates

Utilisation	Infrastructure
Type	Road tunnel, two lanes
Length	2 x 7,900 m
Construction Method	Drill and blast, SCL method

Technical data:

Scope of work: 2 x 7.9 km, standard cross-section: 80 m², emergency lay-bys: 120 m²;
23 cross-passages, 2 central ventilation stations with exhaust shaft;
2 air supply adits;
tunnelling under a 100-year old railway tunnel with a small clearance between the tunnels



Reconstruction of suburban train station under Dortmund Main Station
Germany

General Data:

Project: Stadtbahn Dortmund, Suburban railway line I, Lot 20 – reconstruction and extension of suburban railway Dortmund Main Station

Main Contractor: Stadt (Municipality) Dortmund (Tiefbauamt – Building authority for civil engineering)

Client: Wayss & Freytag Ingenieurbau AG

Construction period: 2014 to 2017

Net construction costs: € 10.2 million

Technical data:

Scope of work: Conversion and extension of the suburban railway station at main station, enlargement of the platforms across the DB (German Railway) track field, tunnel ceiling cover 2.5 m
Replacement of bored pile walls and outer walls of the existing structure by a beam-column system connected monolithically to the existing structure as well as to the inner lining of the platform extension.

Construction method: Mining technique (conventional method) protected by a pipe umbrella, length 46 m, manned pipe jacking with forward shield; diameter 1,600 mm, two start shafts
Inner lining of watertight reinforced concrete
Enlargement using conventional methods in two partial cross-sections (roof section and then base) with SCL lining, max. depth of advance 1.0 m, jet underpinning approx. every 7.0 m

Geology: Coarse clay with peat inclusions, marl, area with high probability of explosive ordnance

Utilisation	Infrastructure
Type	Reconstruction and extension of suburban railway
Length	2,410 m
Construction Method	Mining technique and pipe jacking

Port Said Tunnel
Egypt

General Data:

Project: Port Said Tunnels

Main Contractor: Port Said Road Tunnels under the Suez Canal, Egypt
Republic of Egypt, Ministry of Defence (Ultimate Client)
Arab Contractors – Orascom Construction JV

Client: Wayss & Freytag Ingenieurbau AG
(Service Agreement for Consultancy and Operation of 2 TBMs)

Construction period: August 2015 – February 2018

Net construction costs: appr. 20 mio. €

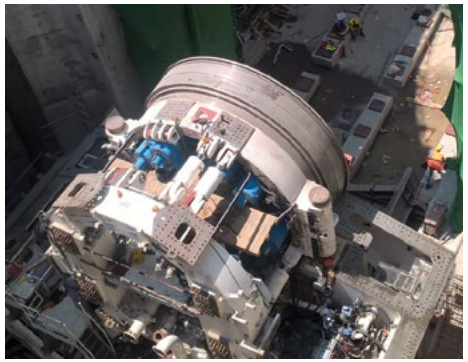
Technical data:

Scope of work: Construction of 2 parallel road tunnels, length 2.85 km each, inner diameter 11.80 m with 2 cross passages and internal road deck, connecting Sinai Peninsula with African mainland

Construction method: Construction of tunnels with 2 nos. Slurry TBM (Herrenknecht Mixshields) shield diameter 13.02 m (max. hydrostatic pressure of 6.5 bar under the Suez Canal)

Geology: Soft clay at both ends of the tunnel
Hard clay / sand in the center part

Utilisation	Infrastructure
Type	Road tunnel, two-lane
Length	2 x 2,850 m
Construction Method	TBM tunneling, Hydroshield



Liefkenshoek Rail Link
Antwerp, Belgium

General Data:

Project: Liefkenshoek Rail Link, double-track railway tunnel
Main Contractor: Infrabel
Client: Wayss & Freytag Ingenieurbau AG as a member of Locobouw Joint Venture
Construction period: November 2008 to July 2013
Net construction costs: € 693 million

Technical data:

Scope of work: Construction of a double-track railway line, length: 16.2 km; construction of 4.8 km of embankment fills, 4.2 km of tunnel constructed by the cut and cover method and the top-down method using diaphragm walls; 13 cross-passages constructed using ground freezing; 2 x 5,792 m of TBM tunnel; 1 evacuation shaft built using ground freezing; 7 evacuation shafts with sealing block

Construction method: TBM tunnelling using 2 Hydroshields (slurry shields), shield diameter: 8.32 m, internal diameter of tunnel: 7.30 m, segmental lining, 40 cm thick, Refurbishment of 1.2 km Beveren Tunnel

Geology: Quaternary and Tertiary sand / Boom Clay

Utilisation	Infrastructure
Type	Railway tunnel, 2 tubes
Length	16,200 m (TBM: 2 x 5.792 m)
Construction Method	TBM tunnelling using 2 Hydroshields (slurry shields)

Schuman-Josaphat Tunnel
Belgium

General Data:

Project: Schuman-Josaphat Tunnel,
double-track railway tunnel

Main Contractor: Departement Mobiliteit en Vervoer
[Belgian Department of Transport]

Client: Wayss & Freytag Ingenieurbau AG
as a member of Locobouw Joint Venture

Construction period: October 2008 to June 2015

Net construction costs: € 255 million

Technical data:

Scope of work: Structural modification of Schuman train and metro station; construction of double-track Schuman-Josaphat Tunnel, box section, length: 1,400 m, width: approx. 10.85 m, height: 6.86 m; pipe jacking to build a pipe umbrella support system, lengths of pipe jacking:
760 m with an internal diameter of 3.00 m
1,200 m with an internal diameter of 2.10 m

Construction method: Mining techniques for most of the tunnel, partly under the protection of manually constructed underpinnings, partly by a pipe umbrella support system constructed using the pipe jacking method; pipe jacking using an AVN 1800 machine

Geology: Sand with beds of sandstone

Utilisation	Infrastructure
Type	Railway tunnel, double-track
Length	1,400 m
Construction Method	Mining techniques

Oosterweel Pipe Jacking
Belgium

General Data:

Project: Voorbereidende werken Oosterweelverbinding – Schijnpoort
Main Contractor: Beheersmaatschappij Antwerpen Mobiel (BAM NV)
Client: W&F Ingenieurbau, Antwerp
Construction period: April to July 2017
Net construction costs: € 5.8 million

Technical data:

Scope of work: Pipes DN 3500, wall thickness 30 cm, outer diameter 4.10 m, "plaatstale kern" design, individual length 3.00 m, individual weight 27 tons
Pipe jacking machine AVND 3500 Herrenknecht
2 x 233 m drive below Antwerp motorway ring road as well as below 2 operating tunnel tubes of Pre-Metro

Construction method: Drive with slurry supported tunnel face, depth approx. 30 m, supporting pressure 3 bar

Geology: Fine sand containing glauconite

Utilisation	Water / Sewerage
Type	Sewerage water tunnel
Length	2 x 233 m
Construction Method	Pipe jacking

Diabolo-Project
Belgium

General Data:

Project:	Diabolo Project, single-track railway tunnel
Main Contractor:	Northern Diabolo nv (PPP company for the railway tunnel)
	Via-Zaventem nv (PPP company for the road construction part)
Client:	Wayss & Freytag Ingenieurbau AG in a joint venture
Construction period:	October 2007 to February 2012
Net construction costs:	€ 333 million

Technical data:

Scope of work:

Conversion of the dead-end station at Zaventem Airport, Brussels, into a through station;
connection of the station to the new high-speed railway line from Brussels to Antwerp by means of approx. 5,600 m of tunnel:
2 TBM-driven tunnels, length: approx. 1.1 km each,
internal diameter 7.30 m,
approx. 1.1 km of tunnel built using the top-down method,
approx. 2.3 km of cut and cover tunnel,
1 emergency exit and 2 cross-passages using ground freezing techniques;
construction of additional accesses and exits for the E19 motorway;
refurbishment of an existing motorway bridge and addition of a new bridge for cyclists; construction of a fly-over

Construction method:

TBM tunnelling using a Mixshield (slurry shield),
shield diameter: 8.27 m, segmental lining, 35 cm thick;
top-down method; cut and cover method

Geology:

Sand with beds of sandstone in the rock area

Utilisation	Infrastructure
Type	Railway tunnel, single-track
Length	2 x 5,600 m (TBM: 1,100 m)
Construction Method	TBM tunnelling using a Mixshield (slurry shield)

Antwerp North-South Link (ASDAM)
Belgium

General Data:

Project: Antwerp North-South Link (ASDAM), single-track railway tunnel

Main Contractor: NMBS CCE Strategie Ontwikkeling (Belgian Railway) represented by TUC RAIL NV, Brussels, Belgium

Client: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: May 2001 to March 2005

Net construction costs: € 81 million

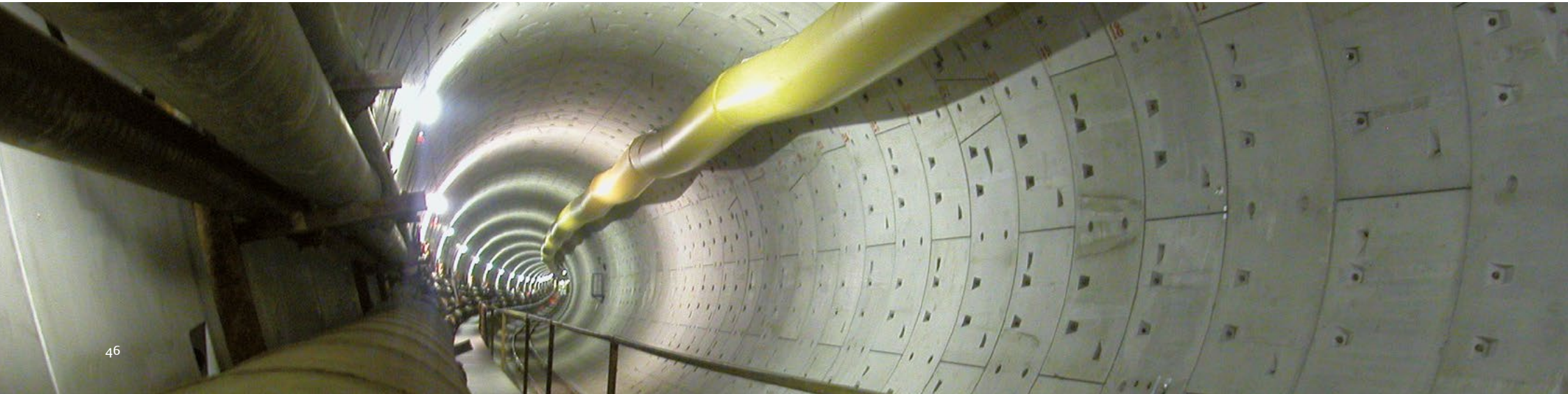
Technical data:

Scope of work: Construction of two tunnels, length: 2,456 m (2 x 1,228 m), internal diameter: 7.30 m; structural modification of the existing accesses; construction of a passageway under the main railway station; 3 emergency exits and 2 cross-passages using groundwater control techniques;

Construction method: TBM tunnelling using a Mixshield (slurry shield), shield diameter: 8.27 m; segmental lining, 35 cm thick;

Geology: Sand

Utilisation	Infrastructure
Type	Railway tunnel, single-track
Length	2,456 m (2 x 1,228 m)
Construction Method	TBM tunnelling using a Mixshield (slurry shield)



Glendoe Recovery Project
United Kingdom

General Data:

Project: Glendoe Recovery Project – construction of a bypass tunnel around a collapse area, an access tunnel to the headrace tunnel, repair works in the headrace and tailrace tunnel

Main Contractor: Scottish Southern Energy (SSE)

Client: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: January 2010 to March 2012

Net construction costs: € 134 million

Utilisation	Supply
Type	Bypass tunnel
Length	605 m
Construction Method	Drill and blast method in combination with tunnel excavator

Technical data:

Scope of work: Bypass tunnel, 605 m, excavated cross-section: 28 m², as a D-shaped profile with a gradient of 12%, access via existing headrace tunnel (length: 2 km, 19 m² circular cross-section, 12% gradient);
access tunnel, 550 m, excavated cross-section 28 m², as a D-shaped profile;
exploration borings from above ground to detect cavities in the rock;
shotcrete inner linings in the bypass tunnel and in places in the headrace tunnel;
partial removal of the flushed out collapse material from the headrace tunnel;
closing of the collapse area and the access tunnel by means of a concrete seal

Construction method: Mining techniques: drill and blast method in combination with tunnel excavator and sprayed concrete lining (SCL), classification of tunnelling operations according to the Q-System, advance per round: 1.5 m – 4 m

Geology: Quarzite with slate inclusions, uniaxial strength approx. 80 MPa – 120 MPa, Eilrig Shear Zone with highly destabilized zones (the collapse of the TBM tunnel took place in this zone).

Crossrail Western Tunnels including Bond Street and Tottenham Court Road and Farringdon Stations, London
United Kingdom

General Data:

Project: Crossrail Western Tunnels including Bond Street and Tottenham Court Road and Farringdon Stations,
Main Contractor: Crossrail Limited, London, UK
Client: Wayss & Freytag Ingenieurbau AG in a joint venture
Construction period: February 2011 to August 2018
Net construction costs: € 1,520 million

Utilisation	Infrastructure
Type	Railway tunnel, single-track
Length	2 x 6,500 m
Construction Method	TBM tunnelling using EPB shields

Technical data:

Scope of work:
Contract C300: Construction of 2 parallel, single-track railway tunnels, length: 6.5 km each, internal diameter: 6.20 m; 6 cross-passages; construction of Fisher Street Shaft and Crossover
Contract C410: Construction of Bond Street and Tottenham Court Stations
Contract C435: Construction of Farringdon Station
Construction method: Construction of the tunnels using 2 EPB shields, shield diameter: 7.10 m; segmental lining, 30 cm thick; construction of the stations using the sprayed concrete lining (SCL) method; construction of Fisher Street Shaft and Crossover using NATM techniques with a sprayed concrete inner lining
Geology: Mainly London Clay


Crossrail

Channel Tunnel Rail Link
United Kingdom

General Data:

Project:	Channel Tunnel Rail Link, Contract C250, single-track railway tunnel
Main Contractor:	Union Railways (North) Ltd., London, UK
Client:	Wayss & Freytag Ingenieurbau AG in a joint venture
Construction period:	February 2001 to September 2004
Net construction costs:	€ 217 million

Technical data:

Scope of work:	2 parallel railway tunnels, length: 5.3 km each, internal diameter: 7.15 m; 7 cross-passages; 1 ventilation shaft
Construction method:	TBM tunnelling using 2 EPB shields, shield diameter: 8.15 m; steel fibre reinforced segmental lining; both tunnels driven simultaneously from a retained cut structure
Geology:	Sand, London Clay, silt, gravel

Utilisation	Infrastructure
Type	Railway tunnel, single-track
Length	2 x 5,300 m
Construction Method	TBM tunnelling using EPB shields

Corrib Pipeline Tunnel
Ireland

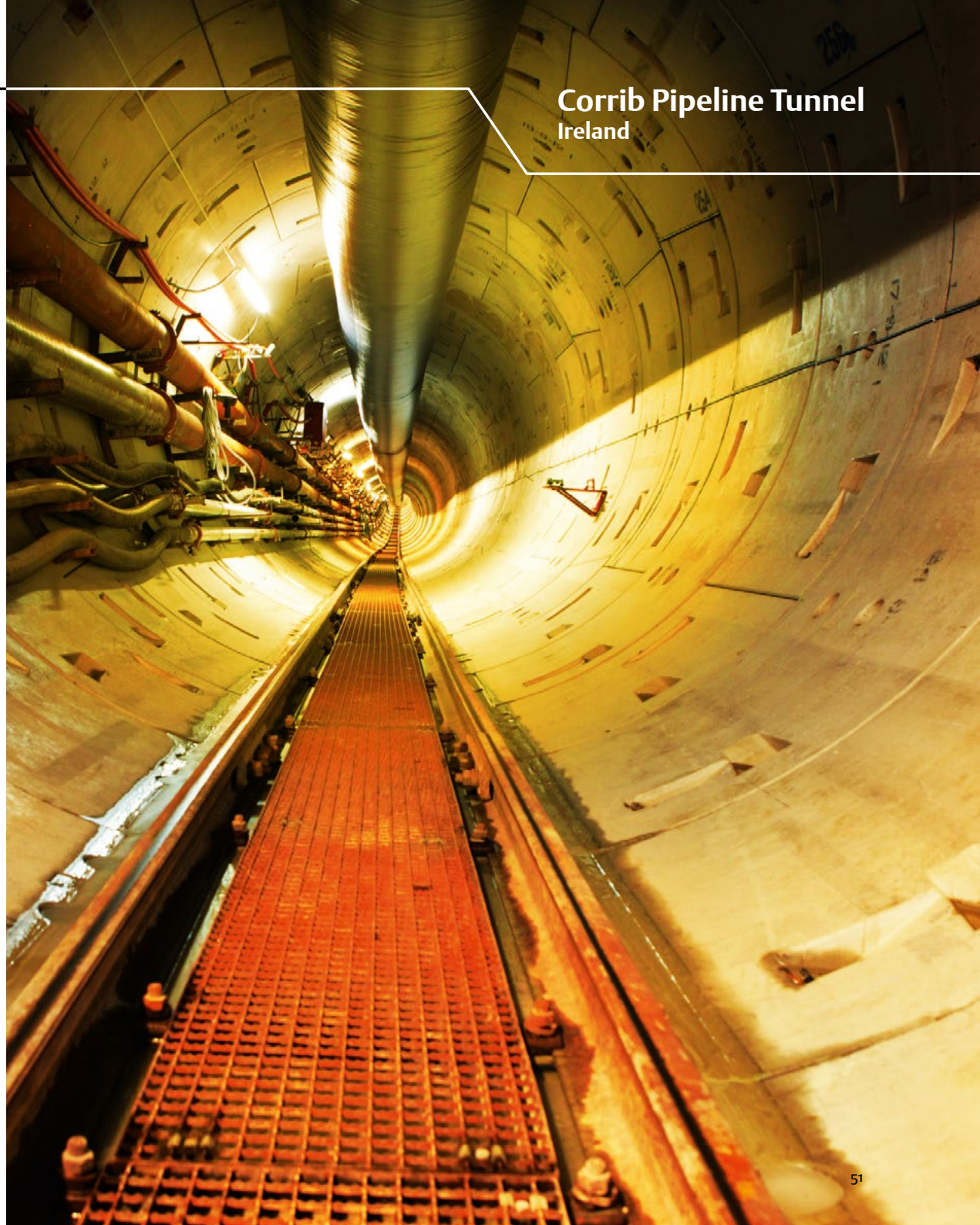
General Data:

Project:	Corrib Pipeline Tunnel, utility tunnel for a gas pipeline
Main Contractor:	Shell E&P Ireland Limited, Dublin, Ireland
Client:	Wayss & Freytag Ingenieurbau AG in a joint venture
Construction period:	November 2010 to February 2015
Net construction costs:	€ 126 million

Technical data:

Scope of work:	Tunnel for a gas pipeline, length: 4,900 m, internal diameter: 3.50 m; installation of the gas pipeline (diameter 50 cm), 2 water pipelines (diameter 25 cm) and several control cables into the tunnel; complete grout backfilling of the tunnel after installation of the pipelines and cables
Construction method:	TBM tunnelling using a Hydroshield (slurry shield), shield diameter: 4.24 m; steel fibre reinforced segmental lining, wall thickness 25 cm
Geology:	Quaternary sands, gravels, gneiss

Utilisation	Media / Supply
Type	Pipeline tunnel
Length	4,900 m
Construction Method	TBM tunnelling using a Hydroshield (slurry method)



Stafelter Tunnel
Luxembourg

General Data:

Project: Stafelter Berg Tunnel
twin-tube, two-lane motorway tunnel

Main Contractor: Grand-Duché de Luxembourg – Ministère des Travaux Publics
[Grand Duchy of Luxembourg – Ministry of Public Works]
represented by Administration des Ponts et Chaussées, Luxembourg
[Bridge and Road Department]

Client: Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture

Construction period: September 2008 to August 2012

Gross construction costs: € 100 million

Technical data:

Scope of work: 2 double-lane motorway tunnels, each with a length of 1,850 m (excavated area: 74 m² – 114 m²), of which 1,650 m were constructed using mining techniques and 200 m using the cut and cover method

Construction method: Drill and blast method in combination with tunnel excavator, construction of a pipe umbrella support system in some areas with shallow soil cover

Geology: Luxembourg Sandstone

Utilisation	Infrastructure
Type	Road tunnel, two-lane
Length	2 x 1,850 m
Construction Method	Drill and blast method in combination with tunnel excavator

Tunnel Grouft
Luxembourg

General Data:

Project: Grouft Tunnel, Luxembourg; twin-tube, two-lane motorway tunnel

Main Contractor: Grand-Duché de Luxembourg – Ministère des Travaux Publics [Grand Duchy of Luxembourg – Ministry of Public Works] represented by Administration des Ponts et Chaussées, Luxembourg [Bridge and Road Department]

Client: Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture

Construction period: February 2005 to August 2009

Gross construction costs: € 171 million

Construction method: Drill and blast method in combination with tunnel excavator, sprayed concrete lining (SCL) method

Geology: Marl, sandstone, Keuper

Utilisation	Infrastructure
Type	Road tunnel, double lane
Length	3,000 m
Construction Method	Drill and blast method in combination with tunnel excavator

Technical data:

Scope of work:
1 double-lane tunnel, 3 km, excavated cross-section: 96 m²;
1 triple-lane tunnel, 2.9 km, excavated cross-section: 174 m²;
1 cavern with ventilation shaft;
10 cross-passages, of which 4 are accessible by vehicles;
1 rescue tunnel, length: 40 m

SMART Tunnel
Malaysia

General Data:

Project: Stormwater Management and Road Tunnel (SMART) Project, flood relief and road tunnel in the city centre of Kuala Lumpur

Main Contractor: MMC Eng. Group Bhd./Gamuda Eng. Sdn. Joint Venture, Kuala Lumpur, Malaysia

Client: Wayss & Freytag Ingenieurbau AG

Construction period: January 2003 to January 2006

Net construction costs: € 83 million

Technical data:

Scope of work: Combined flood relief and road tunnel, length: 5,230 m, internal diameter: 11.83 m

Construction method: TBM tunnelling using a Mixshield (slurry shield), shield diameter: 13.21 m, segmental lining

Geology: Sand, gravel, limestone

Utilisation	Infrastructure
Art	Flood relief and road tunnel
Length	5,230 m
Construction Method	TBM tunnelling using a Mixshield (slurry method)

Rotterdamsebaan
The Netherlands

General Data:

Project: Rotterdamsebaan Den Haag, Victory Boogie Woogie Tunnel, double tube road tunnel passing under the City of The Hague

Main Contractor: City of The Hague, represented by the project organisation Rotterdamsebaan

Client: Combinatie Rotterdamsebaan, consisting of BAM Infra and Wayss & Freytag Ingenieurbau AG. The construction JV consists of BAM Infra, Wayss & Freytag Ingenieurbau and Volker Wessels.

Construction period: December 2015 to July 2020

Net construction costs: € 301 million incl. 15 years maintenance

Technical data:

Scope of work: 2 parallel tunnel tubes with a length of 1.645 km each, inner diameter 10.15 m; 6 cross passages driven under the protection of ground freezing; 2 access ramps, which at the same time function as start and target shafts, Passing under A4/A13 motorways incl. connection to existing infrastructure

Construction method: Single segmental lining, driven by slurry shield, shield diameter: 11.32; reinforced concrete segments with a thickness of 40cm

Geology: Quaternary fills of sands and coarse clays, interstratifications of peat and clay, Tertiary sands

Utilisation	Infrastructure
Type	Road Tunnel, double-track
Length	1,645 m
Construction Method	TBM tunnelling with Hydroshield

Sluiskil Canal Crossing
The Netherlands

General Data:

Project: Sluiskil Canal Crossing, twin-bore road tunnel under the Ghent-Terneuzen Canal

Main Contractor: Province of Zeeland [Provincie Zeeland], represented by BV Kanaal-kruising Sluiskil

Client: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: October 2010 to May 2015

Gross construction costs: € 234 million incl. 2 years maintenance

Technical data:

Scope of work: 2 parallel tunnel tubes, length: 1.15 km each, internal diameter: 10.10 m;
4 cross-passages built using ground freezing;
2 ramp structures serving as start and/or target shafts;
2 intersections - East and West - consisting of bridge structures with 2 roundabouts each

Construction method: TBM tunnelling using a Hydroshield, Mixshield (slurry shields), shield diameter: 11.32 m and 11.37 m, reinforced concrete segmental lining, wall thickness: 45 cm

Geology: Sand, silt, Boom Clay, sand containing glauconite

Utilisation	Infrastructure
Type	Road tunnel
Length	2 x 1,150 m
Construction Method	TBM tunnelling with Hydroshield and Mixshield

Ems-Dollard Crossing
The Netherlands

General Data:

Project: Ems-Dollard Crossing between Germany and the Netherlands, tunnel for a gas pipeline

Main Contractor: Nederlandse Gasunie

Client: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: June 2008 to September 2010

Net construction costs: € 45.7 million

Technical data:

Scope of work: Tunnel for a gas pipeline, length: approx. 4,050 m,
internal diameter: 3.0 m;
start and target shaft;
installation of the gas pipeline in the tunnel using the floating method and subsequent backfill grouting of the tunnel; extensive soil investigation

Construction method: TBM tunnelling using a Hydroshield (slurry shield),
shield diameter: 3.78 m;
steel fibre reinforced segmental lining, wall thickness 25 cm

Geology: Potklei (local type of clay), sands, clays

Utilisation	Supply
Type	Cable tunnel
Length	4.050 m
Construction Method	TBM tunnelling using a Hydroshield (slurry method)

Hubertus Tunnel
The Netherlands

General Data:

Project: Hubertus Tunnel,
road tunnel

Main Contractor: emeente Den Haag [Municipality of The Hague],
the Netherlands

Client: Wayss & Freytag Ingenieurbau AG
in a joint venture

Construction period: September 2004 to September 2008

Net construction costs: € 109 million

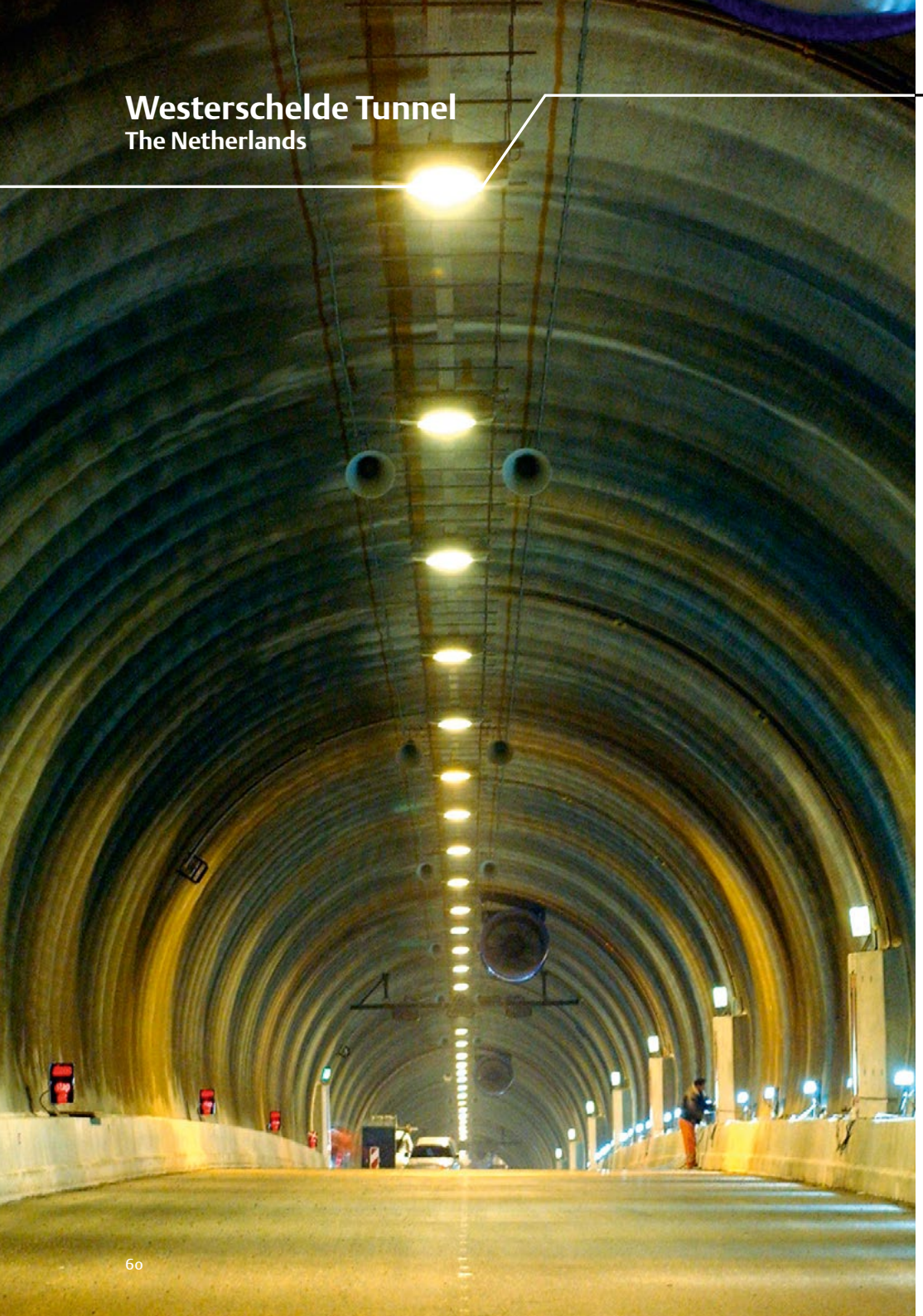
Technical data:

Scope of work: 2 double-lane tunnels, each 1,490 m long, internal diameter: 9.40 m;
2 ramp structures;
5 cross-passages built using ground freezing;

Construction method: TBM tunnelling using a Mixshield (slurry shield),
external diameter of TBM: 10.50 m;
reinforced concrete segmental lining, 40 cm thick

Geology: Silty fine sands to medium dense beach sands

Utilisation	Infrastructure
Type	Road tunnel, double-lane
Length	2 x 1,490 m
Construction Method	TBM tunnelling using a Mixshield



Westerschelde Tunnel
The Netherlands

General Data:

Project:	Westerschelde Tunnel, road tunnel
Main Contractor:	Ministerie van Verkeer en Waterstaat, Directoraat-Generaal Rijskwaterstaat [Dutch Ministry of Transport, Public Works and Water Management]
Client:	Wayss & Freytag Ingenieurbau AG in a joint venture
Construction period:	January 1997 to March 2003
Net construction costs:	€ 690 million

Technical data:

Scope of work:	2 parallel tunnel tubes, Length: 2 x 6,600 m, Internal diameter: 10.10 m 26 cross passages built using ground freezing; Ramp structures, toll stations and road connections including various civil engineering structures
Construction method:	TBM tunnelling using 2 Mixshields (slurry shields), shield diameter: 11.34 m, segmental lining, 45 cm thick
Geology:	Sand, Boom Clay

Utilisation	Infrastructure
Type	Road tunnel
Length	2 x 6,600 m
Construction Method	TBM tunnelling using 2 Mixshields (slurry method)

Koralm Tunnel, KAT 1
Austria

General Data:

Project: Koralm Railway Line between Graz and Klagenfurt
Koralm Tunnel, Contract Section
KAT 1 – km 37+700 – km 43-150 – B 1961

Main Contractor: ÖBB Infrastructure Bau AG, Graz [National railway of Austria]

Client: Wayss & Freytag Ingenieurbau AGas technical leader of a joint venture

Construction period: 2009 to 2013

Net construction costs: 90 million

Technical data:

Scope of work: Two single-track railway tunnels, each 1,961 m long, excavated area: 65 m² – 80 m²; 5 cross-passages; 280 m of double-track tunnel tubes with a partition wall constructed by the cut and cover method; approx. 3 km-long open-cut railway line including earthworks and civil engineering works (flyovers, wildlife bridges, noise barriers); technical building including an emergency basin and retaining walls at the tunnel portal

Construction method: Drill and blast method and tunnel excavator

Geology: Neogene (Miocene to Quaternary), sediments (loose rock – silt – sand) overlying poorly consolidated rock (siltstone and sandstone)

Utilisation	Infrastructure
Type	Railway tunnel, single-track
Length	2 x 2,280 m
Construction Method	Drill and blast method in combination with tunnel excavator

Hengsberg Tunnel
Austria

General Data:

Project:	Koralmbahn (railway) Graz–Klagenfurt B 1581 Lot 3 – Hengsberg Tunnel
Main Contractor:	ÖBB-Infrastructure Bau AG
Client:	Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture
Construction period:	2007 to 2010
Net construction costs:	€ 76.8 million

Technical data:

Scope of work:	Double-track railway tunnel, L=1,695 m, closed construction method L = 1035 m, A = 110-125 m², cut and cover method, L = 400m; top-down method L = 210 m; 3 emergency exits Open land section, L = 5,898 m, earthworks, drainage works, noise protection, accompanying paths, retention areas Objects: 1 underpass structure, 1 stormwater bridge
Construction method:	Closed construction method: combination of tunnel excavator and Drill and blast, cut and cover and top-down method with separate bored pile sheeting
Geology:	Quaternary: Sand, gravel; Neogene: sandstone, silt- / clay-/ marl- stone, silt

Utilisation	Infrastructure
Type	Railway tunnel, double-track
Length	2,730 m
Construction Method	Drill and blast method in combination with tunnel excavator

Roppen Tunnel
Austria

General Data:

Project:	Roppen Tunnel, Second Tube, two-lane motorway tunnel and adaptation of first tube
Main Contractor:	ASFINAG Baumanagement GmbH, Vienna
Client:	Wayss & Freytag Ingenieurbau AG in a joint venture
Construction period:	2006 to 2010
Net construction costs:	€ 80 million

Technical data:

Scope of work:	Length: 5.1 km, excavated cross-section: 80 m² – 95 m²; 7 emergency lay-bys, 23 cross-passages
Construction method:	Sprayed concrete lining (SCL) method with drill and blast excavation
Geology:	Dolomite (dolomia principale)

Utilisation	Infrastructure
Type	Road tunnel, double-lane
Length	5.10 km
Construction Method	Sprayed concrete lining (SCL) method with drill and blast excavation

Lilienberg Tunnel
Austria

General Data:

Project:	Völkermarkt Bypass, two-lane road tunnel
Main Contractor:	Land Kärnten, Abteilung 17 – Brücken und Tunnels [State of Carinthia, Division 17 – Bridges and Tunnels]
Client:	Wayss & Freytag Ingenieurbau AG in a joint venture
Construction period:	2007 to 2009
Net construction costs:	€ 23 million

Technical data:

Scope of work:	Two-lane road tunnel, main tunnel, L = 1,300 m, A = 85 m², 1 breakdown bay, 2 escape tunnels, L = 600 m, A = 25 m²
Construction method:	combination of tunnel excavator and drill and blast
Geology:	Phyllite

Utilisation	Infrastructure
Type	Road tunnel, double-lane
Length	1,300 m + 600 m
Construction Method	Drill and blast method in combination with tunnel excavator

Henndorf Bypass
Austria

General Data:

Project: B 1 Federal Road Wiener Straße, Henndorf Bypass, two-lane road tunnel

Main Contractor: Land Salzburg, Landesbaudirektion [State of Salzburg, State Building Authority]

Client: Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture

Construction period: 2006 to 2009

Net construction costs: € 38 million

Technical data:

Scope of work: Length: 2.2 km, excavated cross-section: 80 m² – 100 m²;
2 parking bays, area: 125 m²;
6 cross-passages to an existing exploration tunnel;
ventilation shaft, diameter: 4m, depth: 38 m;
service buildings and emergency exit shafts

Construction method: Drill and blast method in combination with tunnel excavator, length: 1.4 km;
length: 1.4 km;
cut and cover method: 732 m

Geology: Ground moraine and Flysch sedimentary rock

Utilisation	Infrastructure
Type	Road tunnel, double-lane
Length	2,200 m
Construction Method	Drill and blast method in combination with tunnel excavator

Vienna Metro - U2/2 Taborstrasse
Austria

General Data:

Project:	Metro line 2, Section 2, Taborstrasse
Main Contractor:	Wiener Linien GmbH & Co KG
Client:	Wayss & Freytag Ingenieurbau AG in a joint venture
Construction period:	2002 to 2007
Gross construction costs:	€ 110 million

Technical data:

Scope of work:	Length: 2 x 1.1 km, excavated cross-section: 39 m² – 44 m²; 2 station tubes, excavated cross-section: 65 m²; access and supply shafts
Construction method:	Tunnel excavator: advance under the protection of jet-grouted canopies and jet-grouted bulkheads Dewatering: 270 wells up to a depth of 40 m, electronic monitoring and control system, maximum output 285 l/s, total output 25 million cubic metres of groundwater
Geology:	Tertiary silts and sands, groundwater

Utilisation	Infrastructure
Type	Metro Tunnel
Length	2 x 1,100 m
Construction Method	Tunnel excavator

Klaus Tunnel String, 2nd Tubes, Lots 4+5
Austria

General Data:

Project: A9 Pyhrn Motorway full extension of 2nd tube
Lot 5 “Spering” and “Falkenstein” Tunnels,
Lot 4 “Klauser” and “Traunfried” Tunnels

Main Contractor: ASFINAG Baumanagement GmbH

Client: Wayss & Freytag Ingenieurbau AG
as commercial leader of a Joint venture

Construction period: 2014 to 2017

Net construction costs: € 34.99 million + 31.29 million

Technical data:

Scope of work: Double-lane motorway tunnel Lot 5 “Spering” Tunnel, L = 2,894 m, enlargement to full cross-section, bench/invert, A = 30 – 60 m², 10 cross-passages, 2 breakdown bays, Falkenstein Tunnel, L = 752 m, A = 70 – 80 m² 2 cross-passages
Lot 4 Klauser Tunnel, 2,166 m of which 1,900m to be enlarged to full cross-section, bench/invert
A = 30 – 60 m², L = 160 m complete, excavation A = 75 – 85 m², 8 cross-passages, 2 breakdown bays, Traunfried Tunnel, L = 462m, A = 75 – 85 m²;
2 service buildings and water tank for firefighting purposes

Construction method: Drill and blast method and tunnel excavator

Geology: Firm to slightly weathered main dolomite, tectonically strongly stressed limestone with all grades of weathering, slightly weathered to bedded Wetterstein dolomite, loose soil layers (unconsolidated colluvium)

Utilisation	Infrastructure
Type	Motorway tunnel, two-lane
Length	6,274 m
Construction Method	Drill and blast method in combination with tunnel excavator

Gleinalm Tunnel 2nd tube
Austria

General Data:

Project: Pyhrn motorway, full extension, 2nd tube “Gleinalm” Tunnel
Main Contractor: ASFINAG Baumanagement GmbH
Client: Wayss & Freytag Ingenieurbau AG of a joint venture
Construction period: 2013 to 2017
Net construction costs: € 99.4 million

Technical data:

Scope of work: Double-lane motorway tunnel, L = 8,047 m, A = 80 – 90 m², 34 cross-passages, L = 840 m, A = 15 – 45 m², 8 breakdown and 7 ventilation bays, A = 110+ 120 m², 2 portal galleries and ventilation towers
Construction method: Drill and blast
Geology: Gneiss, amphibolite as well as slate in massive, plate-like to slate-like form

Utilisation	Infrastructure
Type	Motorway tunnel, two lanes
Length	8,887 m
Construction Method	Drill and blast method

Koralm Tunnel, Paierdorf Ventilation Structure
Austria

General Data:

Project: Koralmbahn (railway) Graz–Klagenfurt,
Koralm Tunnel, Lot Paierdorf Ventilation Structure – B 11968

Main Contractor: ÖBB-Infrastructure Bau AG

Client: Wayss & Freytag Ingenieurbau AG

Construction period: 2012 to 2013

Net construction costs: € 7.4 million

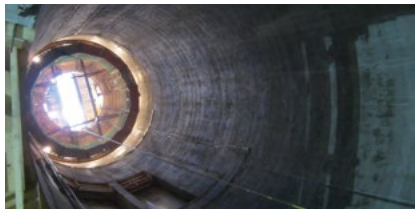
Technical data:

Scope of work: Construction of a ventilation building consisting of North tube access cavern, L = 18 m, A = 120 m² and enlargement area L = 90m, A = 114 m², ventilation tunnel North, L = 93 m, gradient 14°, A = 36 m², Enlargement of south tube from existing tube to complete cross-section, L = 250 m, Ventilation shaft interior construction H = 117 m, Maintenance of exploration structure during the construction period.

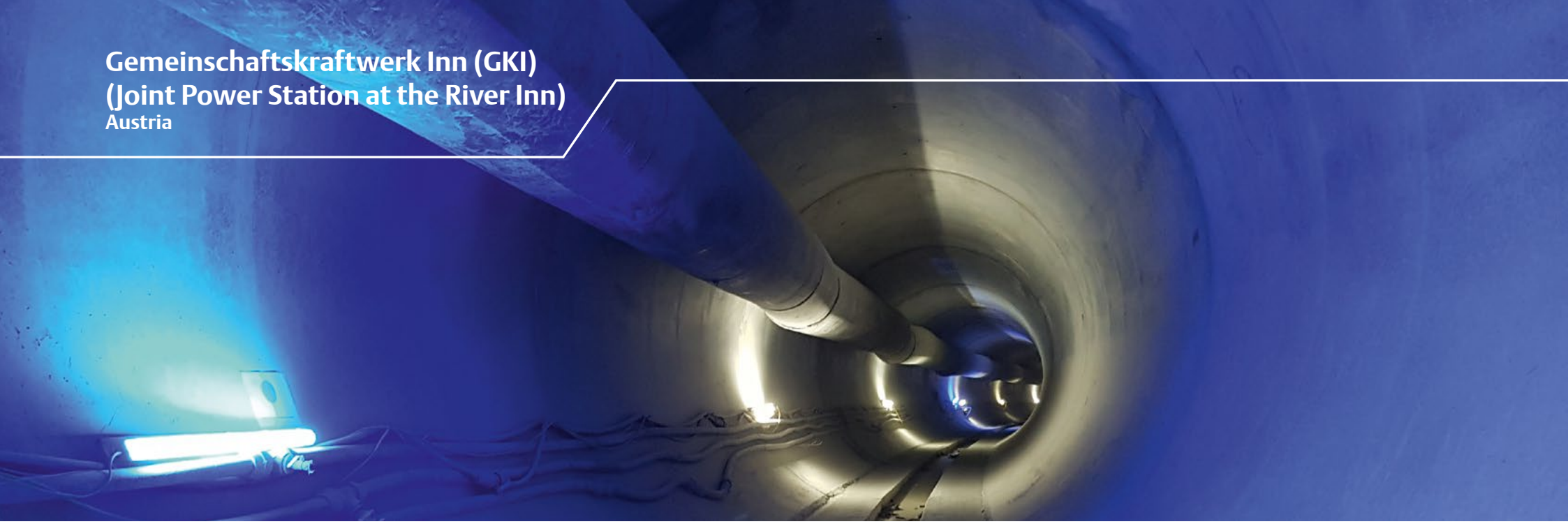
Construction method: Drill and blast method and tunnel excavator, SCL inner lining, slip-form construction

Geology: Neogene (Miocene) consisting of coarse clay (clayey, sandy), sand (silty)

Utilisation	Infrastructure
Type	Railway tunnel, single-track
Length	533 m
Construction Method	Drill and blast method in combination with tunnel excavator



Gemeinschaftskraftwerk Inn (GKI) (Joint Power Station at the River Inn)
Austria



General Data:

Project: Gemeinschaftskraftwerk Inn (GKI), Prutz/Ried
Main Contractor: Tiroler Wasserkraft (Tirolean Hydropower)/EKW-OEE/Verbund
Client: Wayss & Freytag Ingenieurbau AG, in a joint venture
Construction period: 2014 to 2018
Net construction costs: € 56 million

Technical data:

Scope of work: Penstock, inclined shaft, approx. 400 m; gradient less than 31 %,
Surge chamber plumb shaft
Excavation and securing works, D=100 m, Ø 15 m
Concrete works vertical shaft, inner Ø 14 m
Return Drive (in opposite direction) approx. 1,000 m
Concrete works return drive, inner lining, bottom and roof, access tunnel, caverns
Construction method: Drill and blast method and tunnel excavator
Geology: Dark limestone phyllite

Utilisation	Water / Sewerage
Type	Supply tunel
Length	400 m + approx. 1,000 m
Construction Method	Drill and blast method and tunnel excavator

Eppenberg Tunnel
Switzerland

General Data:

Project:	Eppenberg Tunnel Project, Part 1 “Tunnel in mining technique” Railway tunnel, double track
Main Contractor:	SBB Infrastructure
Client:	Wayss & Freytag Ingenieurbau AG in a joint venture
Construction period:	July 2015 to July 2019
Net construction costs:	€ 90 million

Technical data:

Scope of work: 1 double-track railway tunnel, total length 2,613 m,
of which a first part of approx. 80 m is driven in mining technique,
1,820 m in hard rock with TBM and 713 m in soft rock with TBM
Inner diameter tunnel 11.19 m, drilling diameter 12,79 m
3 rescue and escape tunnels with the respective shafts
As well as 5 bays for technical purposes in the tunnel

Construction method: TBM-tunnel driven with convertible TBM in hard rock as well as in soft rock (slurry mode), shield diameter 12.75 m – double lining with tunnel segments as outer lining and in-situ concrete lining with external sealing as inner lining each with a thickness of 30 cm. The rescue tunnels are constructed in mining technique.

Geology: Effingen beds (claystone partly cemented), lower freshwater Molassegravel in soft rock sections

Utilisation	Infrastructure
Type	Railway tunnel, double-track
Length	2,613 m
Construction Method	TBM tunneling with Hard Rock TBM and Hydroshield

Weinberg Tunnel, Sections 3.1 and 3.2
Switzerland

General Data:

Project: Weinberg Tunnel, Sections 3.1 and 3.2, Zurich, as part of the Zurich Main Station-Altstetten-Oerlikon Diameter Line

Main Contractor: Schweizerische Bundesbahnen SBB [Swiss Federal Railways] represented by Infrastructure – Projekt Management Durchmesserlinie

Client: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: September 2007 to May 2014

Net construction costs: € 246 million

Technical data:

Scope of work:

Lot 3.1: Tunnelling under the southern part of Zurich Main Station and construction of a shaft in front of the southern part, 220 running metres of longitudinal tunnels (excavated area: approx. 36 m²) and 390 running metres of transverse tunnels (excavated area: 14 m² - 17 m²) as auxiliary tunnels for construction work using the top-down method under the southern part

Lot 3.2: Double-track railway tunnel (main tunnel) and parallel escape and rescue tunnel, total length of main tunnel: 4,537 m, of which 4,382 m are shield-driven, internal diameter: 9.74 m, length of escape and rescue tunnel: 4,460 m, internal diameter: 4.35 m; 8 cross-passages; 2 emergency exits; 105 m of conventional tunnelling between the TBM launching chamber and the cut and cover tunnel in Oerlikon; Brunnenhof start shaft (diameter: approx. 23 m, depth approx. 37 m); 8 recesses for technical equipment inside the tunnel

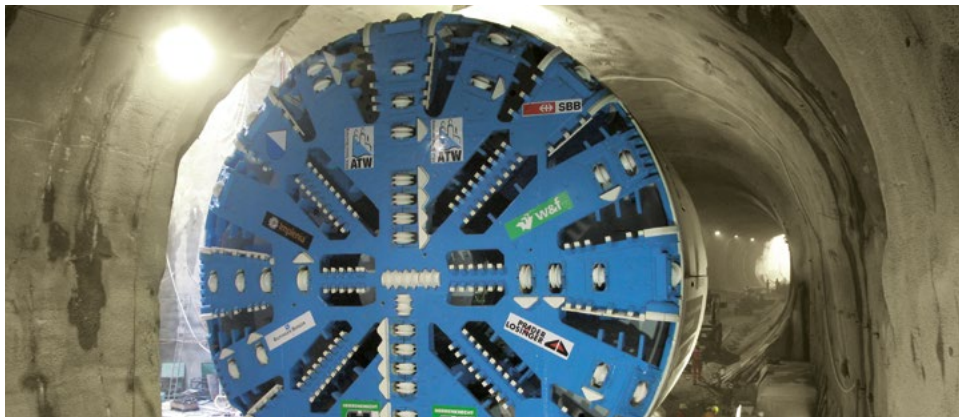
Construction method:

Los 3.1: Auxiliary tunnels: tunnel excavator with pipe and spile canopy support systems

Los 3.2: Main tunnel: TBM tunnelling using a convertible TBM, operated both in hard rock mode (4,105 m) and in slurry mode (277 m), shield diameter: 11,23 m; double lining: segmental lining with in-situ concrete inner lining with external water proofing; Escape and rescue tunnel: 4,390 m constructed by a Gripper-TBM and 70 m using a roadheader, TBM diameter: 4.75 m, lining: shotcrete with wire mesh reinforcement and anchors

Geology: Los 3.1: Ground moraine (glacial gravels)
Los 3.2: Rock (molasse) and loose rock (gravel, lake sediments)

Utilisation	Infrastructure
Type	Railway tunnel, double-track
Length	4,537 m
Construction Method	TBM tunnelling using a convertible TBM



Limmern Access Tunnel I
Switzerland

General Data:

Project: Limmern Access Tunnel I, Section A1,
transportation tunnel to the machine cavern of the new extension to Limmern Pumped Storage Power Plant

Main Contractor: Kraftwerke Linth-Limmern AG (KLL)

Client: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: October 2009 to May 2013

Net construction costs: € 89 million

Utilisation	Logistics
Type	Access tunnel
Length	3,762 m
Construction Method	TBM tunnelling using Gripper TBM as well as drill and blast method

Technical data:

Scope of work: Length of access tunnel (inclined tunnel): 3,762 m,
gradient: 24 %, internal diameter: min. 7.30 m;
Portal structure / cut and cover tunnel, length: 18 m;
horizontal access tunnel to valley station, length: 219 m,
excavated cross-section: approx. 68 m²
cavern of valley station, length: 35 m,
excavation volume: 9,600 m³

Construction method: Inclined tunnel: tunnelling using a Gripper-TBM,
bore diameter of TBM: 8.03 m,
lining: anchors, wire mesh reinforcement and
2 layers of shotcrete;
access tunnel to valley station: drill and blast method
with sprayed concrete support;
cavern of valley station: drill and blast method

Geology: Quintner limestone with karstic features

Tridel Tunnel
Switzerland

General Data:

Project: Tridel Tunnel in Lausanne, Switzerland, single-track railway tunnel
Main Contractor: Tridel SA Lausanne, Switzerland
Client: Wayss & Freytag Ingenieurbau AG in a joint venture
Construction period: 2004 to 2006
Gross construction costs: € 35 million

Technical data:

Scope of work: Length: 3.6 km, excavated area: 40 m²
Construction method: Excavation using a roadheader with pneumatic-tired material transport;
single-pass lining, with anchored shotcrete, partly with arches
Geology: Molasse, partly eroded

Utilisation	Infrastructure
Type	Railway tunnel, single-track
Length	3,600 m
Construction Method	Excavation using a roadheader with pneumatic-tired material transport

Uetliberg Tunnel
Switzerland

General Data:

Project: Uetliberg Motorway Tunnel,
two parallel tunnels, each for three lanes

Main Contractor: Baudirekton Kanton Zürich
[Building Authority of the Canton of Zurich]

Client: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: 2000 to 2007

Gross construction costs: € 340 million

Technical data:

Scope of work: 2 tunnels, each 4.4 km long, excavated area: 160 m²

Construction method: Soft ground tunnelling: approx. 1.6 km in 7 sections;
Drill and blast tunnelling: approx. 1.2 km in 3 sections;
Pilot TBM (5 m diameter): 5.6 km;
Tunnel bore extender TBE (14.40 m diameter): 5.6 km;
Cut and cover method: approx. 0.4 km

Geology: Molasse (partly eroded at the end of the tunnels) and moraine

Utilisation	Infrastructure
Type	Road Tunnel
Length	2 x 4,400 m
Construction Method	TBM tunneling and drill and blast method

Oenzberg Tunnel
Switzerland

General Data:

Project: Oenzbergtunnel
double-track railway tunnel,
new railway line between Zurich and Bern (200 km/h)

Main Contractor: SBB Project Group “Neubaustrecke Mattstetten – Rothrist”
[Swiss Federal Railways]

Client: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: 1999 to 2003

Gross construction costs: € 150 million

Technical data:

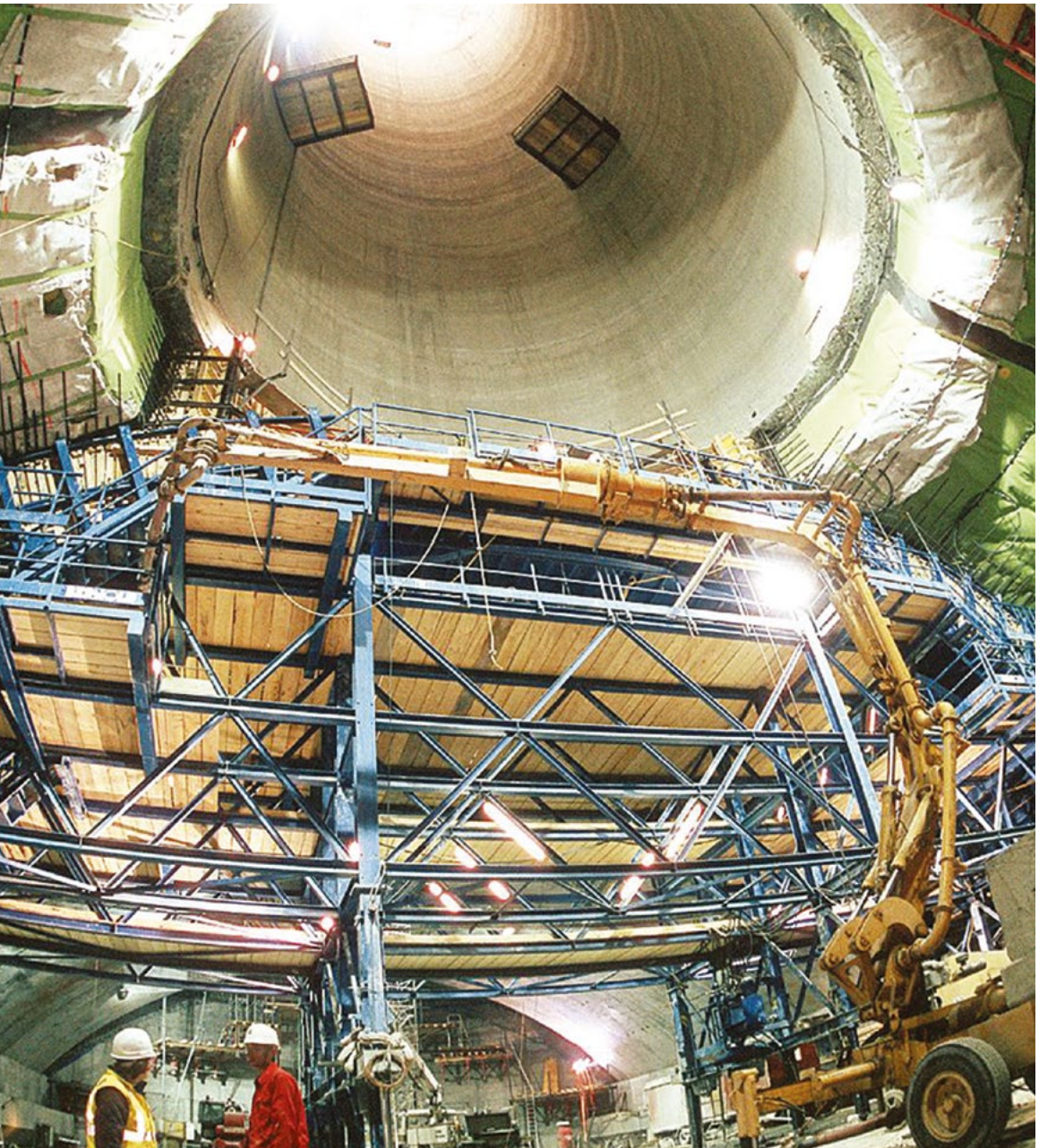
Scope of work: 1 double-track railway tunnel (Oenzberg Tunnel), total length: 3,161 m, of which 2,265 m were driven
using a TBM, internal diameter: 10.84 m;
2 single-track branch-off tunnels (Wolfacher Tunnels),
lengths: 314 m and 440 m, excavated cross-section: 80 m²

Construction method: Oenzberg Tunnel: TBM-tunnelling using a convertible TBM: 1,925 m in hard rock mode, 340 m in slurry shield mode, shield diameter: 12.33 m, double lining consisting of reinforced concrete segments and an in-situ concrete inner lining with external water proofing;
branch-off tunnels (Wolfacher Tunnels): roadheader tunnelling: 900 m, sprayed concrete
lining (SCL) method;
cut and cover method = 0.1 km

Geology: Molasse, moraine

Utilisation	Infrastructure
Type	Railway tunnel, double-track
Length	3,161 m
Construction Method	TBM tunnelling using a convertible TBM

CERN Nuclear Research Centre, Geneva
Switzerland



General Data:

Project: Complete remodelling of the particle accelerator
Main Contractor: CERN – European Organization for Nuclear Research
Client: Wayss & Freytag Ingenieurbau AG
in a joint venture
Construction period: 1998 to 2003
Gross construction costs: € 70 million

Technical data:

Scope of work: 3 shafts, depth: 100 m, max. diameter: 25 m;
2 caverns with a volume of 70,000 m³ and
100,000 m³ respectively; various smaller tunnels
Construction method: Sprayed concrete lining method with excavator and chisel, in-situ concrete inner lining
Geology: Molasse

Utilisation	Infrastructure
Type	Logistics tunnel
Length	3,600 m
Construction Method	Sprayed concrete lining (SCL) method with excavator and chisel

Singapore Metro, North-East Line, Contract C704
Singapore

General Data:

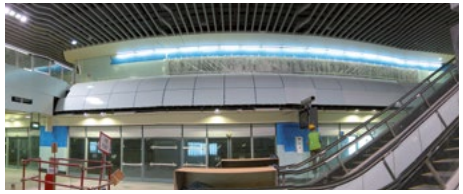
Project:	Singapore Metro, North East Line, Contract C704, single-track metro tunnel
Main Contractor:	Land Transport Authority of Singapore (LTA)
Client:	Wayss & Freytag AG as technical and commercial leader of a joint venture
Construction period:	1997 to 2002
Gross construction costs:	€ 177 million

Technical data:

Scope of work:

2 tunnel tubes,
length: 2,550 m each, internal diameter: 5.80 m,
6 cross-passages at intervals of 250 m,
2 stations:
Serangoon Station, 205 m long, Woodleigh Station, 210 m long, built in an open excavation supported by shoring (soldier piles and timber lagging), designed as civil defence shelters, turn-key

1 viaduct with 2 separate superstructures with 2 x 3 lanes, length:



1,750 m, width: 2 x 11.40 m, using overhead launching system and the free cantilever method for large-span areas,
contiguous bored pile walls for Braddell Bartley Underpass, approx. 1 km long, and soldier piles and timber lagging for the excavation of the Upper Paya Lebar Underpass box structure,
extensive roadworks,
3 pedestrian bridges,
1 switching substation

Construction method: TBM tunnelling using 2 EPB shields, shield diameter: 6.56 m, cross-passages built using NATM techniques with an in-situ concrete inner lining

Geology: Sand, clay, granite

Utilisation	Infrastructure
ype	Metro tunnel, single-track
Length	2 x 2,550 m
Construction Method	TBM tunnelling using an EPB shield

Tunnel Rastatt
Germany

Tunneling Technology

General Data:

Project: JV Rastatt Tunnel
Main Contractor: Ed. Züblin AG, Hochtief Solutions
Client: DB Netz AG (German Railway) represented by DB Projekt Bau GmbH
Contractor: Wayss & Freytag Ingenieurbau AG, Tunnelling Division, Tunneling Technology Department
Construction period: August 2015 to February 2018

Technical data:

Scope of work: Design, calculation, verification, procurement, installation, putting into operation, dismantling and maintenance of the following components:
System for the separation of excavated material: 1 x separation plant 2,450 m³/h , 1 x separation plant 2,500 m³/h
Belt conveying system for the separation plant with separation of fine and coarse grains
Mud dewatering system with polymer conditioning: combination of 3 x filter presses + 1 x centrifuge
Container system for fresh and waste bentonite slurry suspension with ancillary equipment 7 x individual containers with a total effective volume of 7,075 m³
Internal pipe and feeding system
Bentonite batching system and silos: 45-150 m³/h and 180 m³ storage capacity
System for the generation of compressed air: compressed air station with compressed-air reservoir
Booster system: booster station + cooling tower
Provision of staff for installation, putting into operation, operation + dismantling
Construction method: Slurry shield drive with segmental lining
Geology: Tertiary, gravel, sandy clay, alluvial clay, drive below groundwater table with pressing groundwater

Utilisation	Infrastructure
Type	Railway tunnel, single-track
Length	4,000 m
Construction Method	TBM tunnelling with slurry shield

Eppenberg Tunnel
Switzerland

Tunneling Technology

General Data:

Project: JV Eppenberg Tunnel (Switzerland)
Main Contractor: SBB Infrastructure
Client: JV Marti Tunnelbau AG, Wayss & Freytag Ingenieurbau AG
Construction period: April 2017 – March 2018

Technical data:

Scope of work:

1. Design, calculation, verification, procurement, installation, putting into operation, dismantling and maintenance of the following components:
1.1. System for the separation of excavated material: 1 x separation plant 2.400 m³/h
1.2. Belt conveying system for the separation plant with separation of fine and coarse grains
1.3. Mud dewatering system with polymer conditioning: 4 x filter presses
1.4. Container system for fresh and waste bentonite slurry suspension with ancillary equipment 6 x individual containers with a total effective volume of 5,700 m³
1.5. Internal pipe and feeding system
1.6. Bentonite batching system and silos: 2 x 30-60 m³/h und 2 x 80 m³ storage capacity
1.7. Slurry circuit system: 2 x feeding pumps and 2 x slurry pumps
2. Provision of staff for installation, putting into operation, dismantling

Construction method: Slurry shield drive with segmental lining
Geology: Molasse, gravel, sand

Utilisation	Infrastructure
Type	Railway tunnel, double-track
Length	2,613 m
Construction Method	TBM tunnelling with slurry shield

General Data:

Project: Combinatie Rotterdamsebaan

Main Contractor: Gemeente Den Haag, Projectorganisatie Rotterdamsebaan, Netherlands

Client: JV BAM Infra, BAM Infra Verkeerstechniek, Wayss & Freytag Ingenieurbau AG, KWS Infra, Van Hattum en Blankevoort, Vialis

Construction period: August 2017 – March 2019

Technical data:

Scope of work:

1. Supervision of refurbishment and modification of TBM from Sluiskil project (cons. No. 9), boring diameter 11.38m
2. Design, calculation, verification, procurement, installation, putting into operation, dismantling and maintenance of the following components:

2.1. System for the separation of excavated material: 1 x separation plant 2.500 m³/h

2.2. Belt conveying system for the separation plant with separation of fine and coarse grains

2.3. Bentonite batching system and silos: 30-100 m³/h and 2 x 50 m³ storage capacity

2.4. Mud dewatering system with polymer conditioning: 2 x centrifuges and 1 x binder plant

2.5. Container system for fresh and waste bentonite slurry suspension with ancillary equipment: 6 x individual containers with a total effective volume of 7,535 m³

2.6. Internal pipe and feeding system

2.7. Slurry circuit system: 1 x feeding pump and 1 x slurry pump

2.8. Booster system: booster station + cooling tower

2.9. System for the generation of compressed air: compressed air station with compressed-air reservoir

2.10. System for decomposition of solids in filtrate water: filtrate water treatment plant

3. Provision of staff for installation, putting into operation, operation and dismantling

Construction method: Slurry shield drive with segmental lining

Geology: Quaternary fills of sands and coarse clays, interstratifications of peat and clay, tertiary sands

Utilisation	Infrastructure
Type	Road tunnel, double-lane
Length	2 x 1.645 m
Construction Method	TBM tunnelling with slurry shield

References

CONSTRUCTION PERIOD	PROJECT AND CLIENT	SCOPE OF WORKS	CONSTRUCTION METHOD
2017	Oosterweelverbinding, Antwerp, Belgium. THV Schijnpoort Joint Venture, Borgerhout (Antwerp), Belgium	Construction of a pipeline tunnel using the pipe jacking method. 2 x 230 m = 460 m	Hydroshield
2016/2019	Tunnel Gateway Gardens, Frankfurt am Main (Germany); Deutsche Bahn AG	Light Rail tunnel with station; length: 2,200 m	Open construction method
2016/2018	Wallring Sewer, Hamburg, Germany. Hamburger Stadt-entwässerung (wastewater department of the City of Hamburg), Germany	Construction of a new sewer as part of Hamburg's inner-city sewage relief scheme. Scope of work: construction of a sewer in two drives using the pipe jacking method, length of drives: 600 m and 800 m; construction of a launching shaft for two TBM launches and a target shaft using bored piles; construction of 7 caisson shafts including connection to the pipe-jacked sewer under compressed air as well as construction of shaft lining using cast-in-place concrete. Length: 1,400 m	AVND machine and Hydroshield
2015/2021	Thames Tideway West, London, UK. Bazalgette Tunnel Ltd. ("Tideway"), London, UK	Design and construction of the western section of the Thames Tideway Tunnel (super sewer). The scope of work comprises - the 7 km long western section of the main sewer (driven using an EPB TBM), - a 1.1 km long connection tunnel (Frogmore Tunnel), - 7 shafts which are to take in sewage from discharge points and feed it into the main sewer, including technical equipment as well as final landscaping. The contract also includes the complex approval and coordination procedures with the authorities and stakeholders under the new Development Consent Order (DCO) system. Main tunnel: 6,950 m length; Connection tunnel: 1,100 m	Main tunnel: EPB TBM
2015/2020	Victory Boogie Woogie Tunnel (for the Rotterdamsebaan artery road), The Hague, Netherlands. Gemeente Den Haag (Municipality of The Hague), Projectorganisatie Rotterdamsebaan, Netherlands	Construction of 2 road tunnels in the central area of The Hague. Length of each tunnel: 1,876 m, of which 1,654 m will be driven by TBM and lined with precast concrete segments. The project also includes the construction of two ramp structures: Binckhorst-laan ramp (approx. 420 m long) and Vlietzone ramp (approx. 376 m long) and 6 cross-passages, which will be built using ground freezing techniques, as well tunnelling under the existing A5/A13 motorway interchange at Ypenburg. In addition, the contract includes a 15-year maintenance contract for the tunnel. Length: 6,290 m	Hydroshield
2015/2019	Eppenbergtunnel, Part 1, (Switzerland); SBB Infrastruktur	Double-track railway tunnel; length: 2,613 m, shield driven, shield diameter 12.75 m, 3 rescue and escape tunnels with associated shafts, 5 niches for technical installations in the tunnel; double-shell lining consisting of segments and cast in-situ concrete inner lining, each 30 cm thick.	Hard Rock TBM and Hydroshield
2015/2018	Port Said Tunnels, Service Agreement, Egypt. Civil Joint Venture Arab Contractors and Orascom Construction, Cairo, Egypt	Provision of consultancy services and specialists for the work preparation and the construction of TBM-driven 2 road tunnels under the Suez Canal connecting the African continent with the Sinai Peninsula. Length of tunnels: 2 x 3,900 m = 7,800 m, length of TBM-driven section: 2 x 2,850 m = 5,600 m. Construction of 6 cross-passages, of which 4 are to be built using the ground freezing technique.	Mixshield
2015/2017	Darmsheim Northern Bypass, L1182 Darmsheim Tunnel (D); Federal State of Baden-Württemberg, represented by Regierungspräsidium Stuttgart	Double-lane road tunnel, length 460 m	Drill and blast method

CONSTRUCTION PERIOD	PROJECT AND CLIENT	SCOPE OF WORKS	CONSTRUCTION METHOD
2015/2016	Europagarten Tunnel, Frankfurt am Main (Germany); Aurelis Asset GmbH, represented by Aurelis Real Estate GmbH & Co. KG, Eschborn	Road tunnel with three tubes, length 533 m, of which 395 m are a covered over section constructed using theopen construction method	Open construction method
2015	Replacement Pipeline Tunnel under the River Rhine in Leverkusen, Germany. Currenta GmbH & Co. OHG, Leverkusen, Germany	Construction of a walkable tunnel under the Rhine river that is to accommodate various pipelines for the transport of chemicals; the tunnel will be driven using the pipe jacking method. Construction of excavation pits with bored pile walls and underwater concrete base slab below the groundwater table. Internal fit out of two shafts. Installation of a racking system to carry the pipelines and construction of an inspection aisle. Length: 470 m	AVND machine and Hydroshield
2014/2018	Gemeinschaftskraftwerk Inn hydroelectric power plant (Austria); Tiroler Wasserkraft/EKW-OEE/Verbund	Headrace, inclined shaft, approx. 400 m, incline less than 31%, excavation and support work, d = 100 m, tunnel drive from the opposite direction approx. 1,000 m access tunnel, caverns	Drill and blast method and tunnel excavator
2014/2017	Renovation of light railway system under Dortmund Central Station, Section 20 (D); Stadt Dortmund (Tiefbauamt)	Renovation and extension of light railway system under central railway station, construction of mined tunnel by means of a pipe roof support system, manned pipe jacking using an open hooded shield, diameter 1,600 mm	Tunnel excavator and pipe jacking
2014/2017	A 9 Pyhrn Motorway, Construction of Second Tubes, Section 5 Spering and Falkenstein Tunnels, Section 4 Klauser and Traunfried Tunnels (Austria); ASFINAG Baumanagement GmbH	Double-lane motorways tunnels: Spering Tunnel: L = 2,894 m, 10 cross-passages, 2 emergency lay-bys; Falkenstein Tunnel: L = 752 m, 2 cross-passages; Klauser Tunnel: L = 2,166m, 8 cross-passages, 2 emergency lay-bys; Traunfried Tunnel: L = 462 m; 2 operational buildings and fire water tanks	Drill and blast method and tunnel excavator
2013/2017	A 9 Pyhrn Motorway, Construction of Second Tube for Gleinalm Tunnel (Austria); ASFINAG Baumanagement GmbH	Double-lane motorway tunnel, L = 8,047 m, 34 cross passages, L = 840 m, 8 emergency lay-bys and 7 ventilation bays, area = 110 + 120 m²; 2 portal galleries and ventilation towers	Drill and blast method
2013/2016	Widderstall Tunnel, New Stuttgart-Augsburg Railway Line, Wendlingen-Ulm-Section, PFA Albhöhe, VE: 230-1 (D); DB Projekt Stuttgart-Ulm GmbH	Double-track railway tunnel, length 962 m	Cut and cover method
2013/2014	Seepage Water Tunnel at Sylvenstein Reservoir near Lenggries, Germany; Wasserwirtschaftsamt Weilheim for Freestate Bavaria	Lot 1: length 80 m, access shaft and start cavern 1,000 m³, 2 pressure bulkheads; Lot 2: Drive reception shaft, D = 7 m and launching cavern, L = 15 m; Lot 3: water seepage tunnel, D = 3,0 m, L = approx. 160 m	Drill and blast method TBM
2013	Sylvenstein Reservoir - Dam Retrofit, Sections 1-3, near Lenggries, Germany Wasserwirtschaftsamt Weilheim, Germany	Construction of a tunnel system to collect, control and monitor water seepage, consisting of the following elements: access tunnel, launching chamber, seepage tunnel and reception chamber with reception shaft. The 86 m long access tunnel, the launching chamber, the 21 m long reception chamber and the 43 m deep reception shaft were constructed using the Drill and blast method. The approx. 160 m long seepage water tunnel was driven through an existing dam using the pipe jacking method. Length: 160 m	AVND machine and Hydroshield

EPB shield
Hard Rock TBM
Mixshield / Hydroshield
Drill and blast method
Open construction / Cut and cover method
Top-down method
Gripper-TBM
Tunnel excavator
Road header
Pipe jacking

References

CONSTRUCTION PERIOD	PROJECT AND CLIENT	SCOPE OF WORKS	CONSTRUCTION METHOD
2012/2018	Stuttgart 21, PFA 1,5, Lot 3 railway connection from Stuttgart Main Station to Bad Cannstatt (Germany); DB Netz AG, represented by DB Projektbau Stuttgart-Ulm GmbH	Railway Tunnel, single track: length: 5,050 m and double track length: 1,050 m, A = 70-220 m²; metro tunnel, 345 m single track and 575 double-track, A = 50-100 m²; 790 m rescue tunnel, A = 20-40 m²	Drill and blast method and tunnel excavator
2012/2017	Large-Scale Emscher Sewerage Tunnel Project, Section 30 between Dortmund Mengede and Sewerage Plant Bottrop (Germany), Emschergenossenschaft	Length 47,000 m, construction of 130 excavation pits, 115 shafts, sewerage tunnel in 117 individual drives varying in length from under 20 m to 1,150 m	Pipe jacking EPB Shield Hydroshield
2012/2013	Koralmbahn Graz-Klagenfurt, Koralmtunnel, Lot Ventilation Building Paierdorf B 11968 (Austria); ÖBB - Infrastruktur Bau AG	Ventilation building northern tube, entrance cavern, length: 18 m, A = 120 m²; ventilation tunnel North, lenght: 93 m, A 36 m², gradient 14°, southern tube widening to full diameter; length: 250 m, ventilation shaft finishing, H = 117 m, maintaining exploration building during construction period	Drill and blast method and tunnel excavator
2011/2018	Crossrail Western Tunnels incl. Bond Street and Tottenham Court Road and Farringdon Stations, London, Contracts C300, C410 and C435 (United Kingdom); Crossrail Limited	2 parallel, single-track railway tunnels; length: 5.9 km each; shield diameter: 7.10 m; internal diameter: 6.20 m; segmental lining;	EPB shield
2011/2015	Corrib Pipeline Tunnel (County Mayo, Ireland); Shell E&P Ireland Ltd.	Utility tunnel for a gas pipeline; length: 4,900 m; shield diameter:4.24 m; internal diameter: 3.50 m; steel fibre reinforced segmental lining; installation of gas pipeline by floating method	Hydroshield
2010/2016	Tunnel Kö-Bogen, Duesseldorf (Germany); Landeshauptstadt Duesseldorf, Amt f. Verkehrsmanagement	Inner City Road Tunnel and ramps in open construction, length: 1,603 m; Bored Piles and diaphragm walls, cover	Excavator and top-down method
2010/2015	Sluiskil Canal Crossing,Terneuzen/Sluiskil (Netherlands); Province of Zeeland represented by BV Kanaalkruising Sluiskil	Twin-bore road tunnel; length: 1.15 km each; shield diameter: 11.32 m; internal diameter: 10.10 m; reinforced concrete segmental lining	Hydroschild
2010/2012	Glendoe Recovery Project (Scotland, United Kingdom); Scottish Southern Energy	Construction of a bypass tunnel (length: 605 m, A = 28 m²) around a collapse area and an access tunnel (length: 550 m, A = 28 m²) to the headrace tunnel; repair works in the headrace and tailrace tunnel	Drill and blast method
2009/2015	Tunnel Luise-Kiesselbach-Platz, Munich (Germany); City of Munich	Inner City Road Tunnel, length: 2,800 m, bored piles, top-down method 2,000 m; cut and cover method approx. 800 m	Bored piles, top-down method, cut and cover method
2009/2013	Limmern Access Tunnel I (Switzerland); Kraftwerke Linth-Limmern AG	Access tunnel (inclined tunnel); length: 3,762 m; shield diameter: 8.03 m; internal diameter: min. 7.30 m; lining: anchors, wire mesh reinforcement and 2 layers of shotcrete	Gripper-TBM
2009/2013	Koralm Railway Line between Graz and Klagenfurt, B1961 Koralm Tunnel, Contract Section KAT 1 (Austria); ÖBB Infrastruktur Bau AG	Two single-track drill and blast railway tunnels; length: 1,961 m each; 280 m of double-track tunnel using the cut and cover method	Drill and blast method and tunnel excavator
2009/2012	Central Services Tunnel for the Large Lock of the Kiel Canal locks, Brunsbüttel, Germany. Wasser- und Schifffahrtsverwaltung des Bundes, Wasser- und Schifffahrtsamt Brunsbüttel (Waterways and Shipping Administration of the Federal Government, Brunsbüttel Water and Shipping Authority Germany	Construction of a new services tunnel under the double locks at the western end of the Kiel Canal. The tunnel was driven using the pipe jacking technique, depth: approx. 35 m below ground surface. Construction of 5 shafts, average depth: 35 m, mostly using diaphragm wall techniques. Length: 450 m	AVN 2000 machine

CONSTRUCTION PERIOD	PROJECT AND CLIENT	SCOPE OF WORKS	CONSTRUCTION METHOD
2009/2012	GSED - Coal-Fired Power Plant Wilhelmshaven, Unit 1: Cooling Water System - Onshore (Lot C121), Germany. GDF SUEZ Energie Deutschland AG, Berlin, Germany	Cooling water system for a new coal-fired power plant, Utility tunnel consisting of 4 cooling water pipelines DN 3400, each approx. 300 m long, and a fish return pipeline DN 1200, length: 300 m. Construction of start shaft (35 m x 25 m x 15 m) and reception shaft (45 m x 11 m x 15 m). Pipe jacking using 2 slurry-supported TBMs, external diameter: 4.1 m; composite pipes, consisting of a reinforced concrete pipe with an integrated HDPE pipe liner. Length: 1,200 m	Hydroshield + AVN 2000 machine Pipe jacking, Slurry Mode
2009/2012	German Unity Transport Project VDE 8, Upgraded and New Railway Lines between Nuremberg and Berlin (Germany); Brandkopf Tunnel and Lohmeberg Tunnel, DB Netz AG	2 NATM tunnels; lengths: 1,493 m and 688 m	Drill and blast method and tunnel excavator
2009/2012	German Unity Transport Project VDE 8, Upgraded and New Railway Lines between Nuremberg and Berlin (Germany); Silberberg Tunnel, DB Netz AG	Double-track railway tunnel; length: 7,391 m	Drill and blast method and tunnel excavator
2008/2015	Schuman-Josaphat Tunnel (Belgium); Department Mobiliteit en Vervoer	Double-track railway tunnel; length: 1,400 m; Structural modification of Schuman train and metro station; construction of double-track Schuman-Josaphat-Tunnel, length: 1,400 m, excavation partly, below a pipe umbrella support systen constructed using the pipe jacking method	Pipe jacking, Open Mode, Top-down Method
2008/2013	Liefkenshoek Rail Link, Antwerp (Belgium); Infrabel	Double-track railway tunnel; length: 12 km; shield diameter: 8.39 m; internal diameter: 7.30 m; segmental lining	Hydroshield
2008/2010	Ems-Dollard Crossing (between Germany and the Netherlands); Nederlandse Gasunie	Utility tunnel for a gas pipeline; length: 4,050 m; shield diameter: 3.6 m; internal diameter: 3.0 m; steel fibre reinforced segmental lining	Hydroshield
2008/2012	Stafelter Tunnel (Luxembourg); Grand-Duché de Luxembourg, Ministère des Travaux Publics, represented by Administration des Ponts et Chaussées	2 double-lane motorway tunnels; length: 1,850 m each; excavated area = 74 - 114 m²; 1,650 m are constructed using mining techniques and 200 m using the cut and cover method	Drill and blast method and tunnel excavator
2007/2014	Weinberg Tunnel, Sections 3.1 and 3.2, Zurich, as part of the Zurich Main Station-Altstetten-Oerlikon Diameter Line (Switzerland); SBB AG represented by Infrastruktur - Projekt Management Durchmesserlinie	Section 3.1: 220 running metres of longitudinal tunnels (excavated area: approx. 36 m²) and 390 running metres of transverse tunnels (excavated area: 14 m² - 17 m²). Section 3.2: Double-track railway tunnel; total length: 4,537 m, of which 4,382 m are driven by convertible TBM (hard rock mode: 4,105 m, slurry mode: 277 m); TBM diameter: 11.23 m; internal diameter: 9.74 m; double lining: segmental lining with in-situ concrete inner lining with external water proofing. Escape and rescue tunnel; length 4,460 m; excavated by Gripper-TBM (4,390 m) and road header (70 m); shield diameter 4.75 m; internal diameter: 4.35 m; lining with shotcrete with wire mesh reinforcement and anchors	Hard Rock TBM and Hydroshield Gripper-TBM
2007/2013	Wehrhahn Linie Lot 2, Germany; City of Duesseldorf	Metro tunnel with connecting platform to Station Heinrich-Heine Allee, drive length: 75 m, ground freezing	Drill and blast method, ground freezing

EPB shield
Hard Rock TBM
Mixshield / Hydroshield
Drill and blast method
Open construction / Cut and cover method
Top-down method
Gripper-TBM
Tunnel excavator
Road header
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2007/2012	Diabolo Project, Brussels Airport (Belgium); Northern Diabolo nv (PPP company for the railway tunnel) and Via-Zaventem nv (PPP company for the road construction part)	2 TBM-driven single-track railway tunnels, length: approx. 1,100 m each, shield diameter: 8.27 m, internal diameter: 7.30 m, segmental lining; approx. 1,100 m of tunnel built using the top-down method; approx. 2,300 m of cut and cover tunnel	Mixshield, top-down method, cut and cover method
2007/2010	Koralm Railway Line between Graz and Klagenfurt, B1581 Contract Section 3 - Hengsberg Tunnel (Austria); ÖBB Infrastruktur Bau AG	Double-track railway tunnel, length: 1,700 m; 1,035 m mined tunnel; 450 m driven using the cut and cover method; 250 m built using the top-down method	Drill and blast method and tunnel excavator
2007/2010	U6 Metro Link to Fasanenhof 26th section (Germany); Stuttgarter Straßenbahnen AG	Double-track metro tunnel; cut and cover tunnel, length: 852 m; mined tunnel, length: 380 m, excavated cross-section: 90 m²; sprayed concrete lining (SCL)	Tunnel excavator and cut and cover method
2007/2009	Völkermarkt Bypass Lilienberg Tunnel; Section 2 (Austria); Land Kärnten	Two-lane road tunnel; length: 1,090 m	Drill and blast method and tunnel excavator
2007	Pipe jacking under Leipzig Main Station, Germany. Joint Venture City Tunnel Leipzig, Los C, Germany	Construction of two pilot tunnels using the pipe jacking method in the course of the construction of Leipzig City Tunnel, Section C. Length: 110 m + 145 m	AVN 2000 machine and Hydroshield
2006/2012	Finne Tunnel (Germany); DB Netz AG, represented by DB Projekt Bau GmbH, Projektzentrum Leipzig	Single-track railway tunnel; length: 13,644 m; shield diameter: 10.88 m; internal diameter: 9.60 m; segmental lining	Hydroshield Hard Rock TBM
2006/2010	Roppen Tunnel, Second Tube (Austria); ASFINAG Baumanagement GmbH	Double-lane motorway tunnel; length: 5.095 m; sprayed concrete lining (SCL)	Drill and blast method and tunnel excavator
2006/2009	B 1 Federal Road Wiener Straße, Henndorf Bypass (Austria); Land Salzburg, Landesbaudirektion	Double-lane road tunnel; total length: 2,150 m; 1.4 km by drill and blast method in combination with tunnel excavator; 732 m by cut and cover method	Drill and blast method, tunnel excavator and cut and cover
2004/2010	Munich Metro, Line 3 North, Section 2, (Germany); Landeshauptstadt München, Baureferat U-Bahn	Single-track metro tunnel; length: 2,410 m; shield diameter: 7.34 m; internal diameter: 6.30 m; segmental lining	Hydroshield
2004/2009	Grouft Tunnel (Luxembourg); Administration des Ponts et des Chaussées	Twin-tube, double- and triple-lane motorway tunnels; length: 3,000 m each; A = 96 m² and 174 m² respectively; sprayed concrete lining	Drill and blast method and tunnel excavator
2004/2008	Hubertus Tunnel, The Hague (Netherlands); Gemeente Den Haag	Road tunnel; length 2,980 m; shield diameter: 10.50 m; internal diameter: 9.40 m; segmental lining	Mixshield
2003/2014	Cologne North-South Light Railway, Southern Section (Germany); KVB Kölner Verkehrs-Betriebe AG	Single-track metro tunnel; length: 5,400 m; shield diameter: 8.39 m; internal diameter: 7.30 m; segmental lining	Mixshield
2003/2011	Katzenberg Tunnel (Germany); DB Netz AG, represented by DB Projektbau GmbH, Projektzentrum Karlsruhe	Single-track railway tunnel; length: 17,968 m; shield diameter 11.12 m, internal diameter 9.60 m, segmental lining	EPB shield
2003/2006	Tridel Tunnel, Lausanne (Switzerland); Tridel SA	Single-track railway tunnel; length: 3,600 m; A = 40 m²; single-pass lining with anchored shotcrete	Road header

CONSTRUCTION PERIOD	PROJECT AND CLIENT	SCOPE OF WORKS	CONSTRUCTION METHOD
2003/2006	SMART Tunnel, Kuala Lumpur (Malaysia); MMC Eng. Group Bhd. / Gamuda Eng. Sdn. Joint Venture	Flood relief and road tunnel; length 5,230 m; shield diameter: 13.21 m; internal diameter: 11.83 m; segmental lining	Mixshield
2002/2007	Vienna Metro, Line 2, Section 2, Taborstrasse (Austria); Wiener Linien GmbH & Co. KG	Single-track metro tunnel; length: 2,200 m; A = 39-44 m²; sprayed concrete lining (SCL)	Tunnel excavator
2002/2005	Dortmund Ostentor Light Railway Line III, Contract Section S10.1, 2nd Stage; (Germany); Stadt Dortmund, Stadtbahnbauamt	1,100 m NATM tunnel; 100 m closed ramp as a double-track rectangular cross-section; 120 m open ramp as a retained cut	Tunnel excavator and cut and cover method
2001/2005	Antwerp North-South Link (ASDAM), (Belgium); NMBS CCE Strategie Ontwikkeling	Single-track railway tunnel; length 2,456 m; shield diameter: 8.27 m; internal diameter: 7.30 m; segmental lining	Mixshield
2001/2004	Channel Tunnel Rail Link, Contract C250, London (United Kingdom); Union Railways (North) Ltd.	Single-track railway tunnel; length 10,600 m; shield diameter: 8.15 m; internal diameter: 7.15 m; steel fibre reinforced segmental lining	EPB shield
2000/2004	Oenzberg Tunnel (Switzerland); Schweizerische Bundesbahnen SBB, Projektgruppe Neubaustrecke Mattstetten-Rothrist	Double-track railway tunnel; total length: 3,161 m (2,265 m driven by TBM); shield diameter: 12.34 m; internal diameter: 10.84 m; double lining consisting of reinforced concrete segments and in-situ concrete inner lining with external water proofing. Branch off tunnels; lengths: 314 m and 440 m (A = 80 m²); excavated by road header	Hard Rock TBM and Hydroshield Road header
2000/2003	Athens Metro, Line 2 Extension, Sepolia-Thivon Tunnel (Greece); Attiko Metro A.E.	Double-track metro tunnel; length: 2,700 m; shield diameter: 9.50 m; internal diameter: 8.48 m; segmental lining	Open Mode
2000/2001	Passenger Transport System at Zurich Airport (Switzerland); Flughafen Immobiliengesellschaft (FIG)	Passenger transport tunnel; length 1,800 m; shield diameter: 6.28 m; internal diameter: 5.40 m; segmental lining	Mixshield
1999/2008	Uetliberg Tunnel (Switzerland); Baudirektion Kanton Zürich	Two parallel triple-lane motorway tunnels, length: 2 x 4.4 km; excavated area: 160 m²; soft ground tunnelling: 1.6 km in 7 sections; drill and blast tunnelling: 1.2 km in 3 sections; Pilot TBM, diameter: 5 m: 5.6 km (extended to 14.4 m diameter:); cut and cover: 0.4 km	TBM and TBE drill and blast method and tunnel excavator
1999/2003	Rennsteig Tunnel on BAB A71 Erfurt-Schweinfurt (Germany); DEGES Deutsche Einheit Berlin Fernstraßenplanungs- und bau GmbH	Two-lane motorway tunnel; twin-tube; length: 2 x 7.9 km (A= 80 m²); sprayed concrete lining (SCL)	Drill and blast method
1999/2002	Velbert-Langenberg Tunnel (Germany); Landschaftsverband Rheinland/ Essen	Double-lane road tunnel; length 486 m (A = 85 m²); sprayed concrete lining (SCL)	Drill and blast method in combination with tunnel excavator
1998/2003	CERN Nuclear Research Centre, Geneva (Switzerland); CERN - European Organization for Nuclear Research	Construction of industrial buildings on ground level and underground buildings for ATLAS-Detector; 3 shafts, max. diameter: 25 m, 100 m deep; 2 caverns of 70,000 m³ and 100,000 m³; various smaller tunnels	SCL method with tunnel excavator and chisel

EPB shield
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Mixshield / Hydroshield
Drill and blast method
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Top-down method
Gripper-TBM
Tunnel excavator
Road header
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References

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1998/2002	Botlek Tunnel (Netherlands); NS Railinfrabeheer, b.v. (Dutch Railway)	Single-track railway tunnel; length 3,670 m; shield diameter: 9.75 m; internal diameter: 8.65 m; segmental lining	EPB shield
1998/1999	New baggage system at Zurich Airport (Switzerland); Flughafen Immobiliengesellschaft Zurich (FIG)	Baggage tunnel; length 490 m; shield diameter: 6.28 m; internal diameter: 5.40 m; segmental lining	Mixshield
1997/2003	Westerschelde Tunnel (Netherlands); Ministerie van Verkeer en Waterstaat, Directoraat-Generaal Rijkswaterstaat	Road tunnel; length: 13,200 m; shield diameter: 11.34 m; internal diameter: 10.10 m; segmental lining	Mixshield
1997/2003	Zimmerberg Base Tunnel, second double-track line between Zurich Main Station and Thalwil, Section 2.01 (Switzerland); Schweizerische Bundesbahnen (SBB)	Double-track railway tunnel; length 2,619 m; shield diameter: 12.34 m; internal diameter: 10.84 m; double lining consisting of reinforced concrete lining and in-situ inner lining with external water proofing	Hard Rock TBM Hydroshield
1997/2003	Zimmerberg Base Tunnel, second double-track line between Zurich Main Station and Thalwil, Section 3.01 (Switzerland); Schweizerische Bundesbahnen (SBB)	Double-track railway tunnel; length 6,421 m; shield diameter: 12.29 m; internal diameter: 10.84 m; double lining consisting of reinforced concrete lining and in-situ inner lining with external water proofing	Hard Rock TBM
1997/2002	Singapore Metro, North East Line, Contract C704 (Singapore); Land Transport Authority of Singapore (LTA)	Single-track metro tunnel; length 5,100 m; shield diameter: 6.56 m; internal diameter: 5.80 m; segmental lining	EPB shield
1996/2001	New Cologne-Rhine/Main High-Speed Railway Line, Central Section, Lot B (Germany); Deutsche Bahn AG	Railway tunnels: Elzer Berg Tunnel (1,110 m); Himmelberg Tunnel (2,395 m); Wahnscheid Tunnel (735 m); Dickheck Tunnel (575 m); all: A = 147-164 m²; sprayed concrete lining (SCL)	Drill and blast method in combination with tunnel excavator
1996/2000	Munich Underground Railway, Line 2 East, Lot 2 Trudering (Germany); Landeshauptstadt München, U-Bahn-Referat	Metro tunnels; lengths: 3,200 m (A = 40 m²) and 300 m (A = 80m²); sprayed concrete lining (SCL)	Tunnel excavator
1996/2000	Rio Subterraneo Tunnel, Buenos Aires (Argentina); Aguas Argentinas S.A.	Water supply tunnel; length: 15,160 m; shield diameter: 4.35 m; internal diameter: 3.50 m; segmental lining	EPB shield
1996/1999	Izmir Light Rail Transit System (Turkey); City of Izmir	Double-track light rail tunnel; 1,388 m NATM tunnel (A = 64 m²); 284 m station (A = 130 - 140 m²); sprayed concrete lining (SCL); 2 parallel, single-track shield-driven tunnels; total length: 2,750 m; shield diameter: 6.54 m; internal diameter: 5.92 m; segmental lining	Road header EPB shield
1996/1998	Nuremberg Underground Railway, Line 2 North, Lot 4.1 (Germany); Stadt Nürnberg, Tiefbauamt	Ziegelstein Station and 1,540 m single-track metro tunnel (A = 38 m²); sprayed concrete lining (SCL)	Road header
1995/2003	Fourth tunnel under the river Elbe in Hamburg (Germany), Freie und Hansestadt Hamburg, Tiefbauamt, Projekte Ingenieurbau, Federal Republic of Germany	Road tunnel, total length of section: 4,403 m, tunnel section: 3,101 m, of which 2,561 m were driven by TBM, shield diameter: 14.20 m, internal diameter of tunnel: 12.35 m, segmental lining	Mixshield
1995/1999	Tweede Heinenoordtunnel (Netherlands); Directoraat-Generaal Rijkswaterstaat, Ministerie van Verkeer en Waterstaat	Road tunnel; length: 1,900 m; shield diameter: 8.55 m; internal diameter: 7.60 m; segmental lining	Mixshield

CONSTRUCTION PERIOD	PROJECT AND CLIENT	SCOPE OF WORKS	CONSTRUCTION METHOD
1995/1999	Engelberg Base Tunnel (Germany); Land Baden-Württemberg; Landesamt für Straßenwesen	Two parallel motorway tunnels; length: 2,600 m each (A = 200-330 m²); sprayed concrete lining (SCL)	Drill and blast method
1994/2001	Xiaolangdi Multipurpose Dam (China); Yellow River Water and Hydroelectric Power Development Corporation	Intake structure, tunnels, plunge pool, spillway, concrete lining, tunnel construction; sprayed concrete lining (SCL)	Drill and blast method
1993/1996	Feldmoching - Moosach Main Sewer (Germany); Landeshauptstadt München, Baureferat Kanalbau	Main sewer; length: 200 m (A = 28 m²); sprayed concrete lining (SCL)	Tunnel excavator with ground freezing
1991/1993	Vienna Underground Railway, Line U6/11 Spittelau (Austria); Stadt Wien, Stadtverwaltung Abt. 38	Sprayed concrete lining (SCL)	Tunnel excavator
1988/1991	Munich Underground Railway, Weyprechtstraße Station (Germany); Landeshauptstadt München, U-Bahn-Referat	Weyprechtstrasse Station and single-track metro tunnel; length: 1,090 m (A = 38 m²); sprayed concrete lining (SCL)	Tunnel excavator
1986/1993	Essen Light Rail, Section 32/33 (Germany); Stadt Essen, U-Bahn-Bauamt	Section 32: 200 m light rail tunnel; Section 33: approx. 160 m light rail tunnel; 334 m station tunnel; 3 nos. cross passages in NATM under compressed air; water pressure up to 1.7 bar.	EPB shield and tunnel excavator under compressed air
1985/1988	Munich Underground Railway, Line 3 South, Section 9.2 (Germany); Landeshauptstadt München, U-Bahn-Referat	Single-track tunnel between Baseler Str. Station and Fürstenried West Station; length: 1,300 m (A = 38 m²); sprayed concrete lining (SCL)	Tunnel excavator
1982/1987	Munich Underground Railway Line 5/9, Section 9.2 (Germany); Landeshauptstadt München, U-Bahn-Referat	Ostbahnhof Station and tunnels; 1,350 m single-track tunnel (A = 38 m²); 240 m double-track tunnel (A = 75-115 m²); sprayed concrete lining (SCL)	Tunnel excavator under compressed air
1982/1986	Munich Underground Railway, Section 7, (Germany); Landeshauptstadt München, U-Bahn-Referat	Lehel Station and tunnels; 2,145 m single-track tunnel (A = 38 m²); 340 m station tunnel (A = 85 m²); sprayed concrete lining (SCL)	Tunnel excavator under compressed air

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