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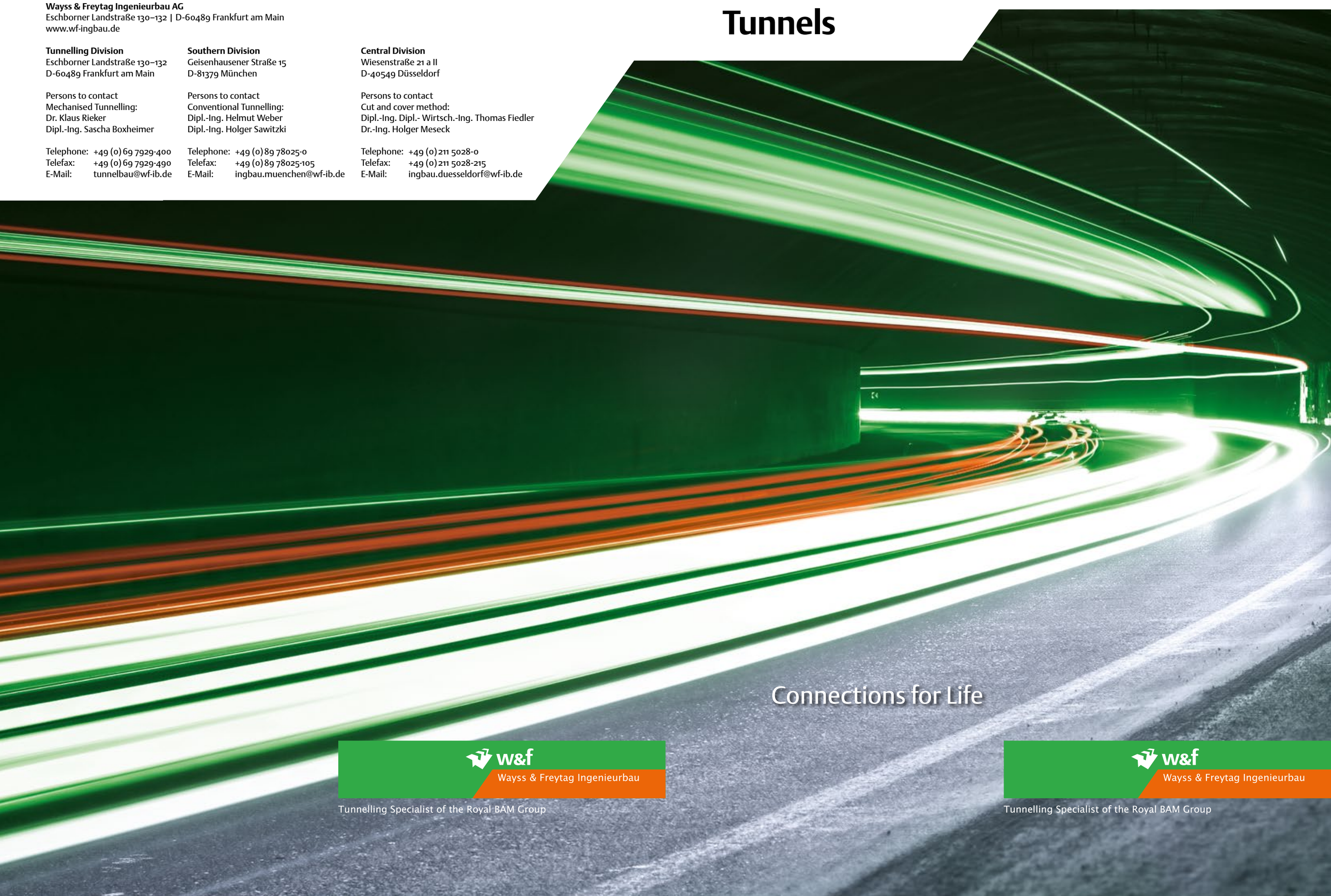
Tunnels



Connections for Life

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Tunnelling Specialist of the Royal BAM Group

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Tunnelling Specialist of the Royal BAM Group

Tunnels
Connections 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.

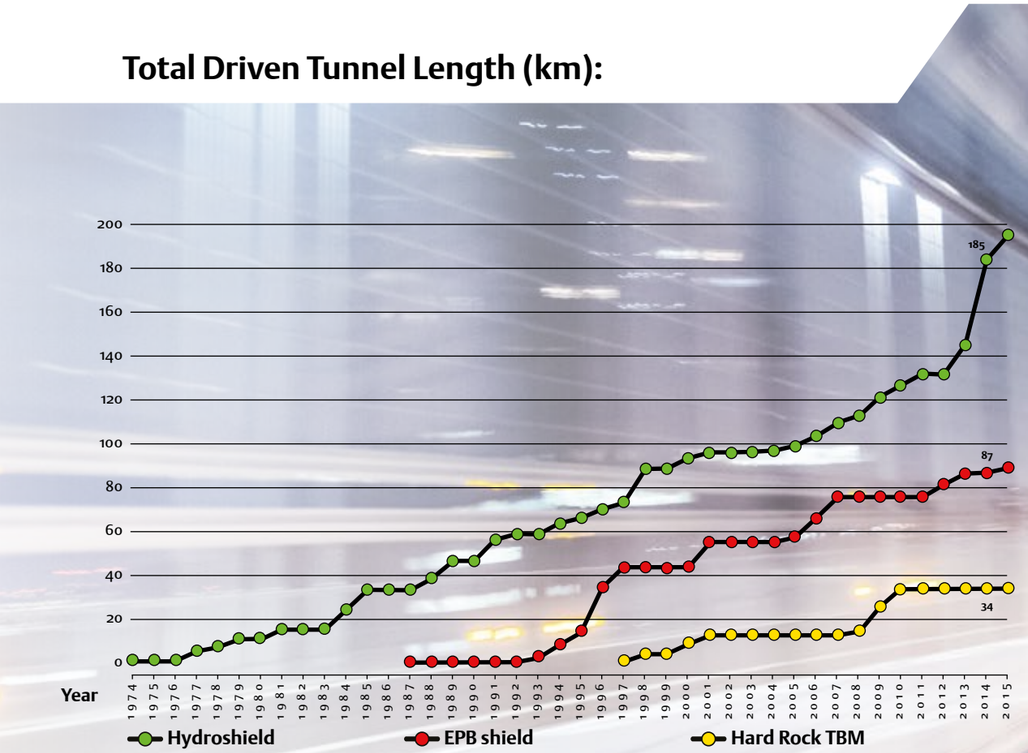
The scope of our activities ranges from mechanized and conventional tunnelling, the construction of sewage treatment plants and power plants, railway, bridge and stadium construction and industrial construction to environmental technology. Engineering consulting, location analyses, utilization concepts 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 150 km of tunnel using slurry shields. In addition, more than 80 km of tunnel were driven using earth pressure balance shields and 30 km using hard rock TBMs.

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

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 **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 Tunnel 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!

Large-scale project „Emscher“ Sewerage Tunnel, BA30 (BA = construction lot)
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

Client: Emschergenossenschaft

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

Construction period: March 2012 to January 2017

Construction costs: € 420 million

Technical Data:

Project description: 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.

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

Client: DB Netz AG, Frankfurt/Main represented by DB Projektbau Stuttgart - Ulm GmbH

Contractor: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: 2 012 – 2018

Construction costs: approx. € 285 million

Technical Data:

Project description: 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 methods: 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

Darmsheim Tunnel
Germany

General Data:

Project: Darmsheim Northern Bypass, L1182 Darmsheim Tunnel

Client: Federal Land of Baden –Württemberg represented by RP Stuttgart

Contractor: Wayss & Freytag Ingenieurbau AG

Construction period: 2015 to 2017

Construction costs: € 13.5 million

Technical Data:

Project description: Two-lane road tunnel; Length 460 m; A= 95 - 120m²
Escape and safety tunnels l = 328 m, A = 13.5 – 18.3 m²

Construction method: Drill and blast

Geology: Upper shell limestone

Europagarten Tunnel, Frankfurt
Germany

General Data:

Project: Europagarten Tunnel, Frankfurt am Main

Client: aurelis Asset GmbH represented by
aurelis Real Estate GmbH & Co.KG, Eschborn

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

Construction period: January 2015- August 2016

Construction costs: approx. € 25.2 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 width of 5.71 m
Two pump buildings including operational building and road works, operational and traffic installations

Construction method: Cavern with diaphragm walls or bored, under water concrete with rear anchoring, Top-Down method

Luise-Kiesselbach-Platz
Germany

General Data:

Project: Mittlerer Ring Süd-West (MRSW)(Middle Ring South-West)Tunnel – Luise-Kiesselbach-Platz

Client: Landeshauptstadt München Baureferat (Building Authority of F ederal Land Capital of Munich) Abteilungen (Division) J12, T1B, MSE

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

Construction period: Aug 2009 – Dec 2015, opening for traffic in July 2015

Construction costs: € 398 million

Technical Data:

Project description: 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

Widderstall Tunnel
Germany

General Data:

Project: NBS (new construction) Stuttgart-Augsburg Section Wendlingen-Ulm; PFA (section) 2.3 Albhöhe; VE 230-1 Widderstall Tunnel

Client: DB Projekt Stuttgart-Ulm GmbH

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

Construction period: 2013 to 2016

Construction costs: approx. € 43.7 million

Technical Data:

Project description: 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”

Construction method: Cut and cover construction method in arch cross-section

Geology: lower massive limestone

Wehrhahnlinie (Wehrhahn Line)Lot 2
Germany

General Data:

Project: Wehrhahnlinie Lot 2

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

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

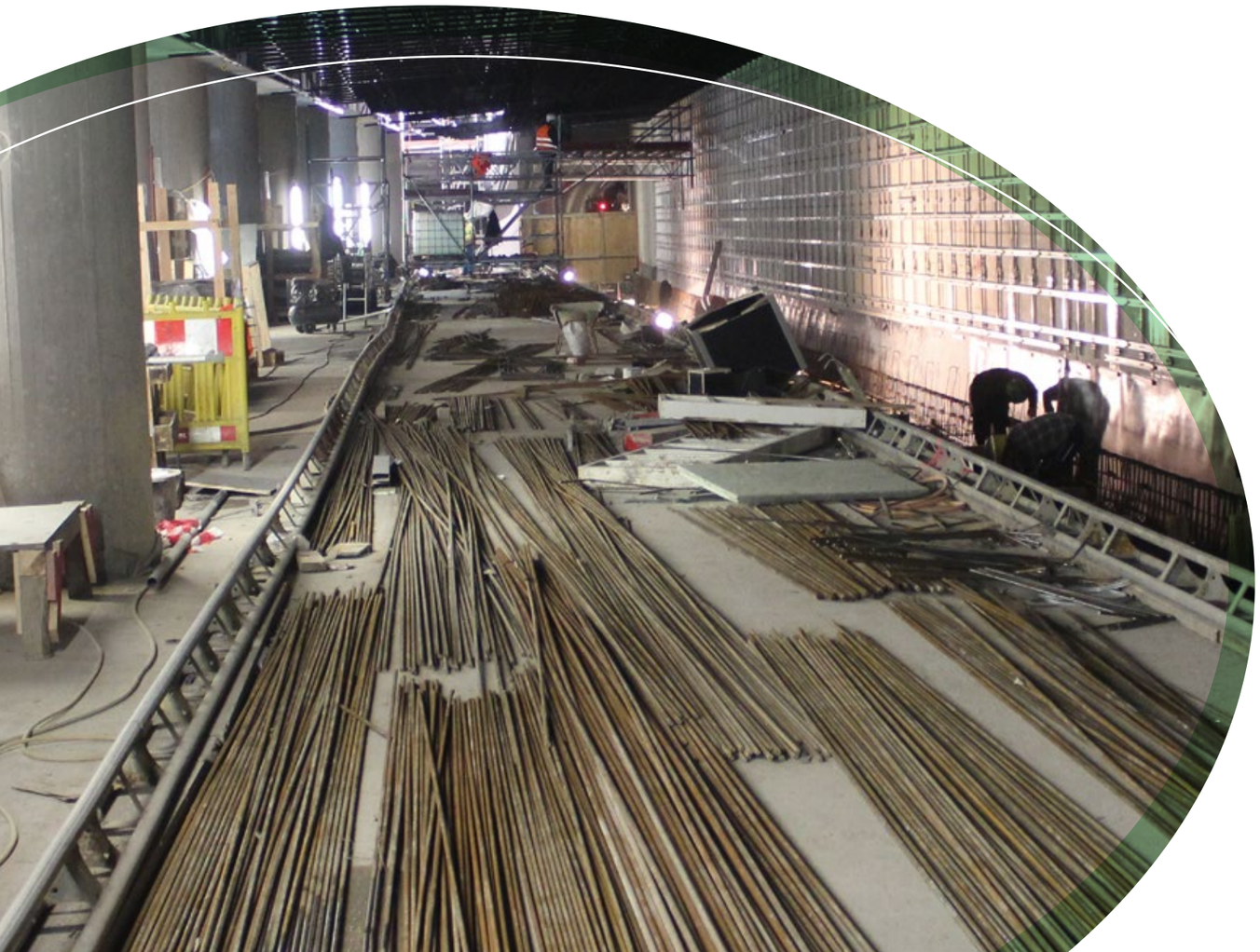
Construction period: 2007 to 2016

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 diphragm walls, navigated horizontal drilling R = 350 m for ground freezing, excavation with tunnel excavator in two segments with shortcrete



Kö-Bogen Tunnel
Deutschland

General Data:

Project: Tunnel Kö-Bogen

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

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

Construction period: 2010 to 2016

Construction costs: € 114 million

Technical Data:

Scope of work: Construction in two Lots

Lot 1: approx. 300 m South-North-Tunnel with 850 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 excavatio

Construction method: Cavern with diaphragm walls or bored, under water concrete with rear anchoring, Top-Down method

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

Client: Wasserwirtschaftsamt (water authority) Weilheim for the Free State of Bavaria

Contractor: Wayss & Freytag Ingenieurbau AG

Construction period: March 2013 to July 2014

Construction costs: approx. € 5.6 million

Technical Data:

Project description: Lot 1: Driving of access tunnel L approx. 80 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: mainly dolomite

Project description: Lot 2: driving of target shaft D= 7 m T approx. 40 m and target cavern L approx. 15 m

Construction method: drill and blast, SCL inner lining

Geology: mainly dolomite

Project description: Lot 3: TBM driven seepage water tunnel D=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

Silberberg Tunnel
Germany

General Data:

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

Client: DB Netz AG [German rail company]

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

Construction period: 2009 to 2012

Construction costs: approx. € 264 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

Finne Tunnel
Germany

General Data:

Project: Finne Tunnel, part of new Erfurt-Leipzig-Halle railway line, single-track railway tunnel

Client: DB Netz AG [German rail company], represented by DB Projekt Bau GmbH, Projektzentrum Leipzig

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

Construction period: December 2006 to September 2012

Construction costs: € 270 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

Cologne North-South Light Railway, Southern Section
Germany

General Data:

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

Client: Kölner Verkehrsbetriebe AG, Cologne

Contractor: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: November 2003 to February 2014

Construction costs: € 470 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

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

Brandkopf/Lohmeberg Tunnels
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

Client: DB Netz AG, Erfurt [German railway company]

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

Construction period: August 2009 to March 2012

Construction costs: € 80 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

New Central Services Tunnel for Brunsbüttel Lock
Germany

General Data:

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

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

Contractor: Wayss & Freytag Ingenieurbau AG

Construction period: March 2009 to September 2011

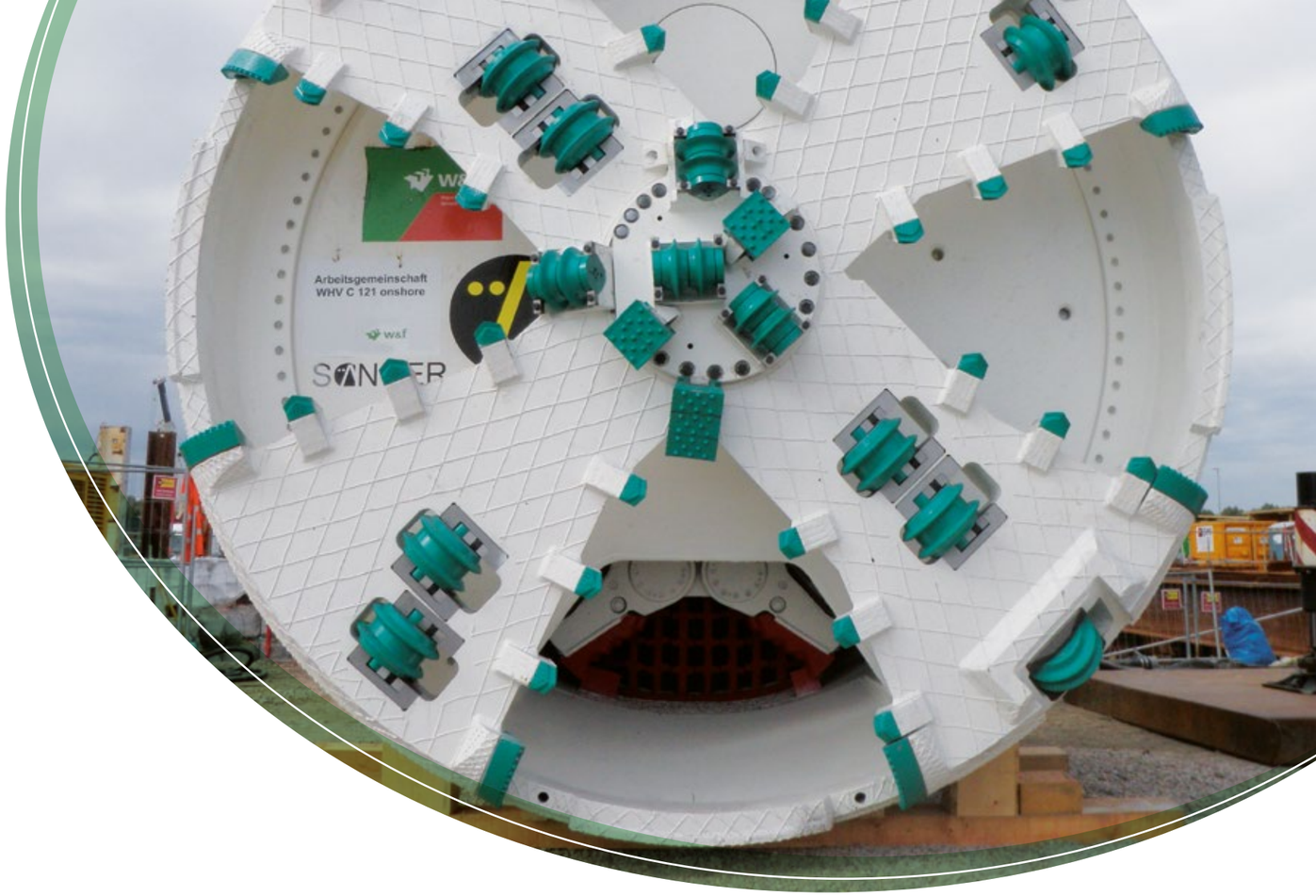
Construction costs: € 22 million

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



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

Client: GDF SUEZ Energie Deutschland AG

Contractor: Wayss & Freytag Ingenieurbau AG
in a joint venture

Construction period: December 2009 - August 2011

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

Katzenberg Tunnel
Germany

General Data:

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

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

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

Construction period: August 2003 to March 2011

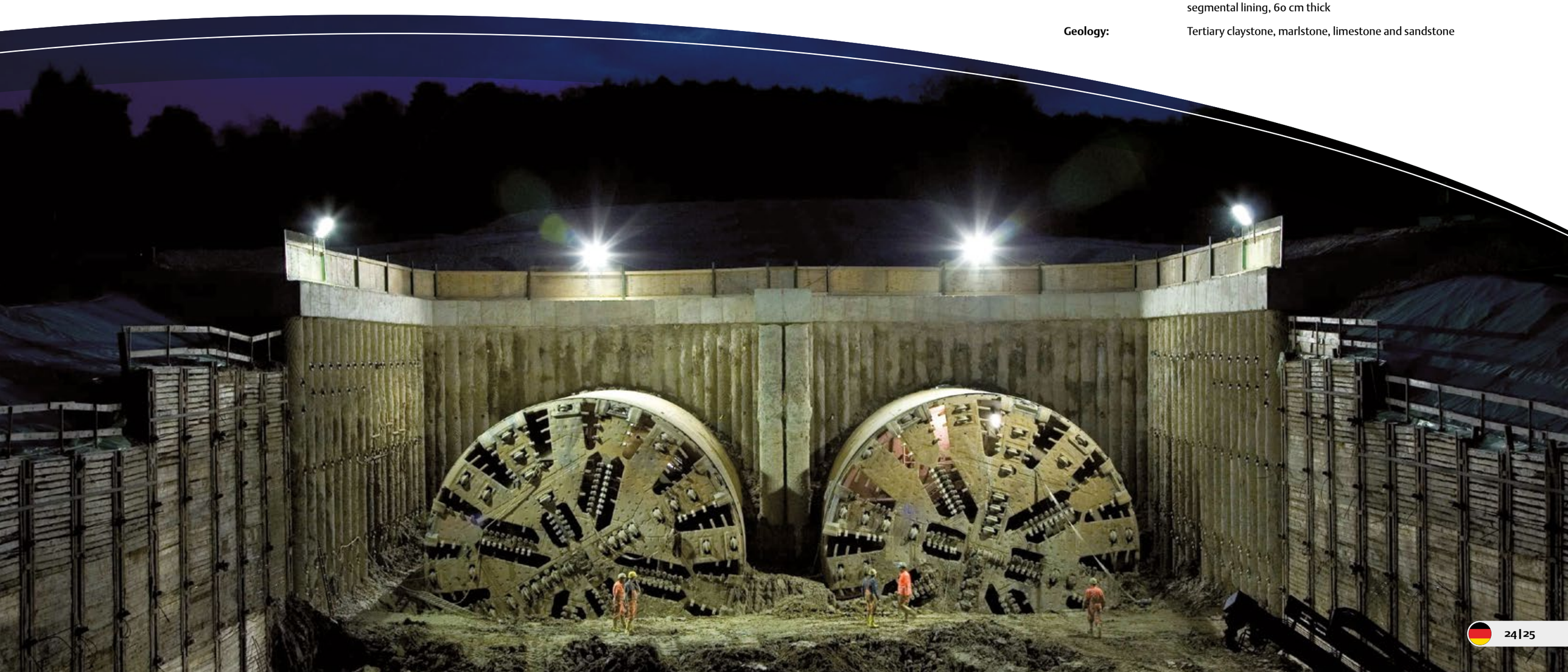
Construction costs: € 340 million

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

Client: Landeshauptstadt München, Baureferat U-Bahn
[State Capital of Munich, Building Division - Underground Railway]

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

Construction period: September 2004 to February 2010

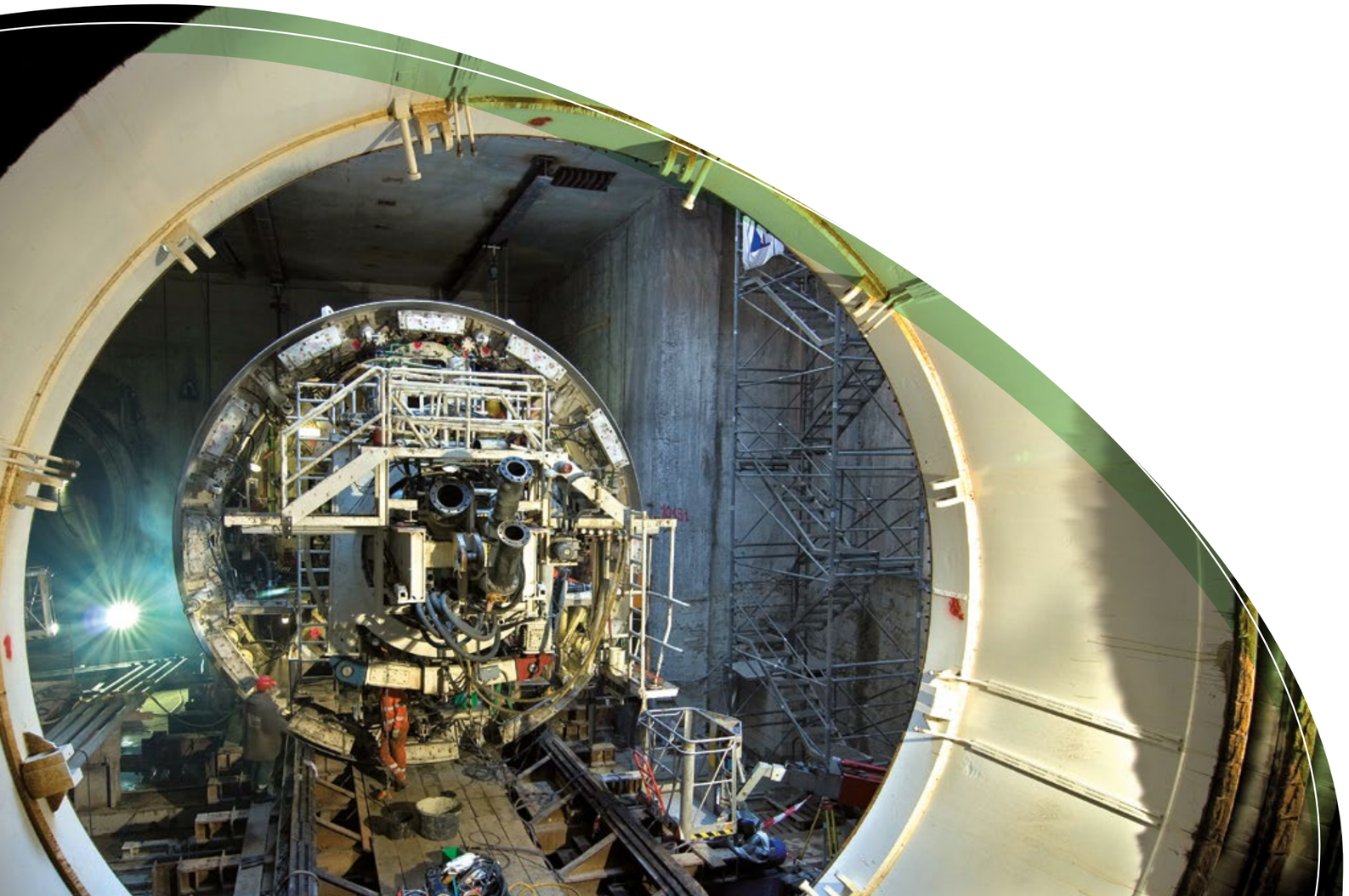
Construction costs: € 81 million

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



Stuttgart Metro, Line U6 Fasanenhof
Germany

General Data:

Project: U6 metro link to Fasanenhof, double-track tunnel

Client: Stuttgarter Straßenbahnen AG

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

Construction period: 2007 to 2010

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

Pipe Jacking under Leipzig Main Station
Germany

General Data:

Project:	Pipe jacking under Leipzig Main Station
Client:	City Tunnel Leipzig Joint Venture, consisting of Wayss & Freytag Ingenieurbau AG and Ed. Züblin AG
Contractor:	Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture
Construction period:	October 2006 to July 2007
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

Dortmund Ostentor Light Railway
Germany

General Data:

Project:	Dortmund Ostentor Light Railway Line III, Contract Section S10.1, 2nd Stage
Client:	Stadt Dortmund, Stadtbahnbauamt [City of Dortmund, Light Rail Construction Authority]
Contractor:	Wayss & Freytag Ingenieurbau AG as technical leader of a joint venture
Construction period:	March 2002 to December 2005
Construction costs:	€ 40 million

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
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:	Marl stone, weathering zone of sandy, gravelly and silty clays	

Rennsteig Tunnel
Germany

General Data:

Project: Rennsteig Tunnel, twin-tube, two-lane motorway tunnel on the BAB A 71

Client: DEGES Deutsche Einheit Fernstraßenplanungs- und -bau GmbH, Berlin

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

Construction period: 1998 - 2003

Construction costs: € 192 million

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

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

Geology: Porphyry, conglomerates

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"

Client: Stadt (Municipality) Dortmund (Tiefbauamt - Building authority for civil engineering)

Contractor: Wayss & Freytag Ingenieurbau AG

Construction period: 2014 to 2017

Net construction costs: € 10.2 million

Technical Data:

Project description: 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

Liefkenshoek Rail Link
Antwerp, Belgium

General Data:

Project: Liefkenshoek Rail Link, double-track railway tunnel

Client: Infrabel

Contractor: Wayss & Freytag Ingenieurbau AG
in a joint venture

Construction period: November 2008 to mid-2013

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 and 4.3 km of open and covered cuts;
construction of 2 single-track TBM tunnels, length: 2 x 6 km, internal diameter: 7.30 m;
refurbishment of existing Beveren-Tunnel, length: 1.2 km;
various civil engineering structures

Construction method: Tunnel: TBM tunnelling using 2 Hydroshields (slurry shields), shield diameter: 8.32 m,
segmental lining

Geology: Quaternary sand / Boom clay

Diabolo Project
Belgium

General Data:

Project: Diabolo Project, single-track railway tunnel

Client: Northern Diabolo nv (PPP company for the railway tunnel)
Via-Zaventem nv (PPP company for the road construction part)

Contractor: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: October 2007 to February 2012

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
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, 25 cm thick;
top-down method; cut and cover method

Geology: Sand with beds of sandstone in the rock area

Schuman-Josaphat Tunnel
Belgium

General Data:

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

Client: Departement Mobiliteit en Vervoer
[Belgian Department of Transport]

Contractor: Wayss & Freytag Ingenieurbau AG
in a joint venture

Construction period: October 2008 to June 2015

Construction costs: € 217 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:
703 m with an internal diameter of 3.00 m
1,700 m with an internal diameter of 1.80 m
550 m with an internal diameter of 1.40 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

Antwerp North-South Link (ASDAM)
Belgium

General Data:

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

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

Contractor: Wayss & Freytag Ingenieurbau AG
in a joint venture

Construction period: May 2001 to March 2005

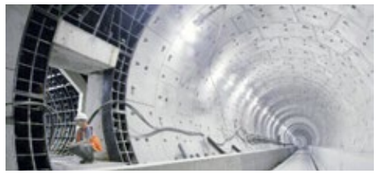
Construction costs: € 81 million

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;
2 cross-passages

Construction method: TBM tunnelling using a Mixshield (slurry shield), shield diameter: 8.27 m

Geology: Sand



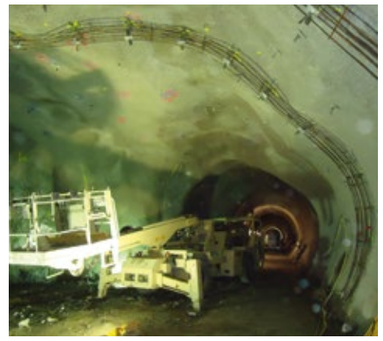
Crossrail Western Tunnels and Bond Street and Tottenham Court Road Stations, London
United Kingdom

General Data:

Project:	Crossrail Western Tunnels and Bond Street and Tottenham Court Road Stations, single-track railway
Client:	Crossrail Limited, London, UK
Contractor:	Wayss & Freytag Ingenieurbau AG in a joint venture
Construction period:	February 2011 to August 2018
Construction costs:	€ 1,191 million

Technical Data:

Scope of work:	
Contract C300:	Construction of 2 parallel, single-track railway tunnels, length: 5.9 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; construction of 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:	London Clay



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
Client:	Scottish Southern Energy (SSE)
Contractor:	Wayss & Freytag Ingenieurbau AG in a joint venture
Construction period:	January 2010 to March 2012
Construction costs:	€ 68 million

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).

Channel Tunnel Rail Link
United Kingdom

General Data:

Project: Channel Tunnel Rail Link, Contract C250,
single-track railway tunnel

Client: Union Railways (North) Ltd., London, UK

Contractor: Wayss & Freytag Ingenieurbau AG
in a joint venture

Construction period: February 2001 to September 2004

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

Corrib Pipeline Tunnel
Ireland

General Data:

Project: Corrib Pipeline Tunnel,
utility tunnel for a gas pipeline

Client: Shell E&P Ireland Limited, Dublin, Ireland

Contractor: Wayss & Freytag Ingenieurbau AG
in a joint venture

Construction period: November 2010 to February 2015

Construction costs: € 125 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 using the floating method;
complete grout backfilling of the tunnel after installation of he 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

Stafelter Tunnel
Luxembourg

General Data:

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

Client: 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]

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

Construction period: September 2008 to August 2012

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 are 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

Grouft Tunnel
Luxembourg

General Data:

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

Client: 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]

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

Construction period: February 2005 to August 2009

Construction costs: € 171 million

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

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

Geology: Marl, sandstone, Keuper

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

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

Contractor: Wayss & Freytag Ingenieurbau AG

Construction period: January 2003 to January 2006

Construction costs: € 83 million

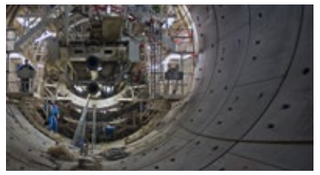
Technical Data:

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

Sluiskil Canal Crossing
The Netherlands



General Data:

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

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

Contractor: Wayss & Freytag Ingenieurbau AG
in a joint venture

Construction period: October 2010 to May 2015

Construction costs: € 233 million

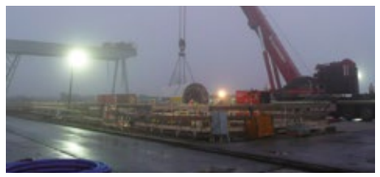
Technical Data:

Scope of work: 2 parallel tunnel tubes, length: 1.15 km each, internal diameter: 10.10 m;
4 cross-passages;
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 (slurry shield),
shield diameter: 11.32 m,
reinforced concrete segmental lining, wall thickness: 45 cm

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

Ems-Dollard Crossing
The Netherlands



General Data:

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

Client: Nederlandse Gasunie

Contractor: Wayss & Freytag Ingenieurbau AG
in a joint venture

Construction period: June 2008 to September 2010

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: 3.6 m;
steel fibre reinforced segmental lining,
wall thickness 25 cm

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

Hubertus Tunnel
The Netherlands

General Data:

Project: Hubertus Tunnel,
road tunnel

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

Contractor: Wayss & Freytag Ingenieurbau AG
in a joint venture

Construction period: September 2004 to September 2008

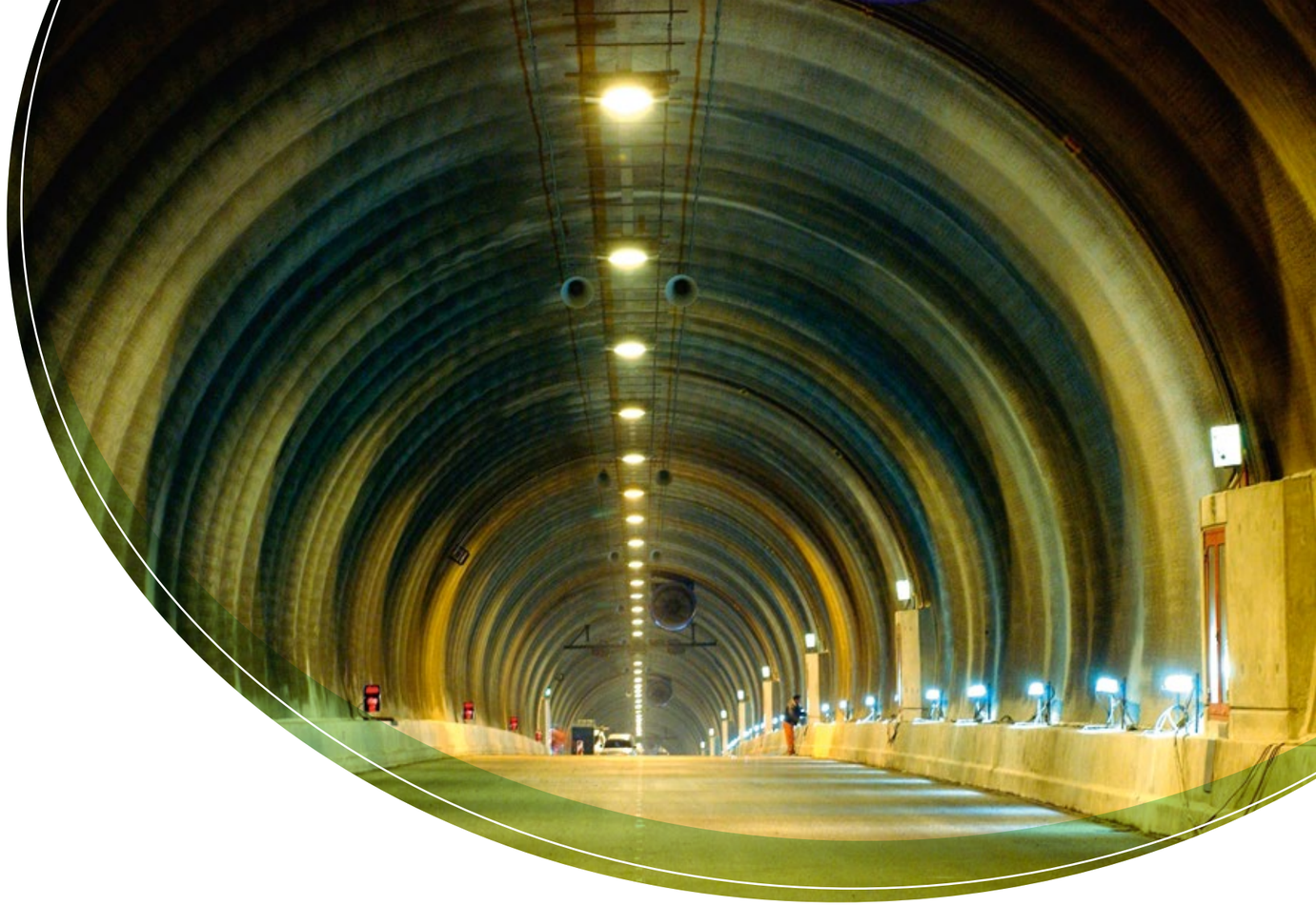
Construction costs: € 109 million

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

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

Geology: Silty fine sands to medium dense beach sands



Westerschelde Tunnel
The Netherlands

General Data:

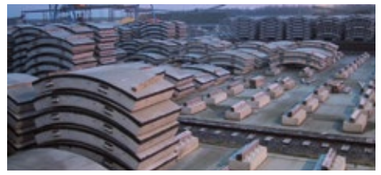
Project: Westerschelde Tunnel, road tunnel

Client: Ministerie van Verkeer en Waterstaat, Directoraat-Generaal Rijskwaterstaat
[Dutch Ministry of Transport, Public Works and Water Management]

Contractor: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: January 1997 to March 2003

Construction costs: € 690 million



Technical Data:

Scope of work: 2 parallel tunnel tubes,
Length: 2 x 6,600 m,
Internal diameter: 10.10 m

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

Geology: Sand, Boom Clay

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

Client: ÖBB Infrastruktur Bau AG, Graz
[National railway of Austria]

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

Construction period: 2009 to 2013

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; 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)

Hengsberg Tunnel
Austria

General Data:

Project: Koralmbahn (railway) Graz–Klagenfurt B 1581
Lot 3 – Hengsberg Tunnel,

Client: ÖBB Infrastruktur Bau AG

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

Construction period: 2007 to 2010

Construction costs: € 76.8 million

Technical Data:

Project description: double-track railway tunnel KL=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- rock, silt

Roppen Tunnel
Austria

General Data:

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

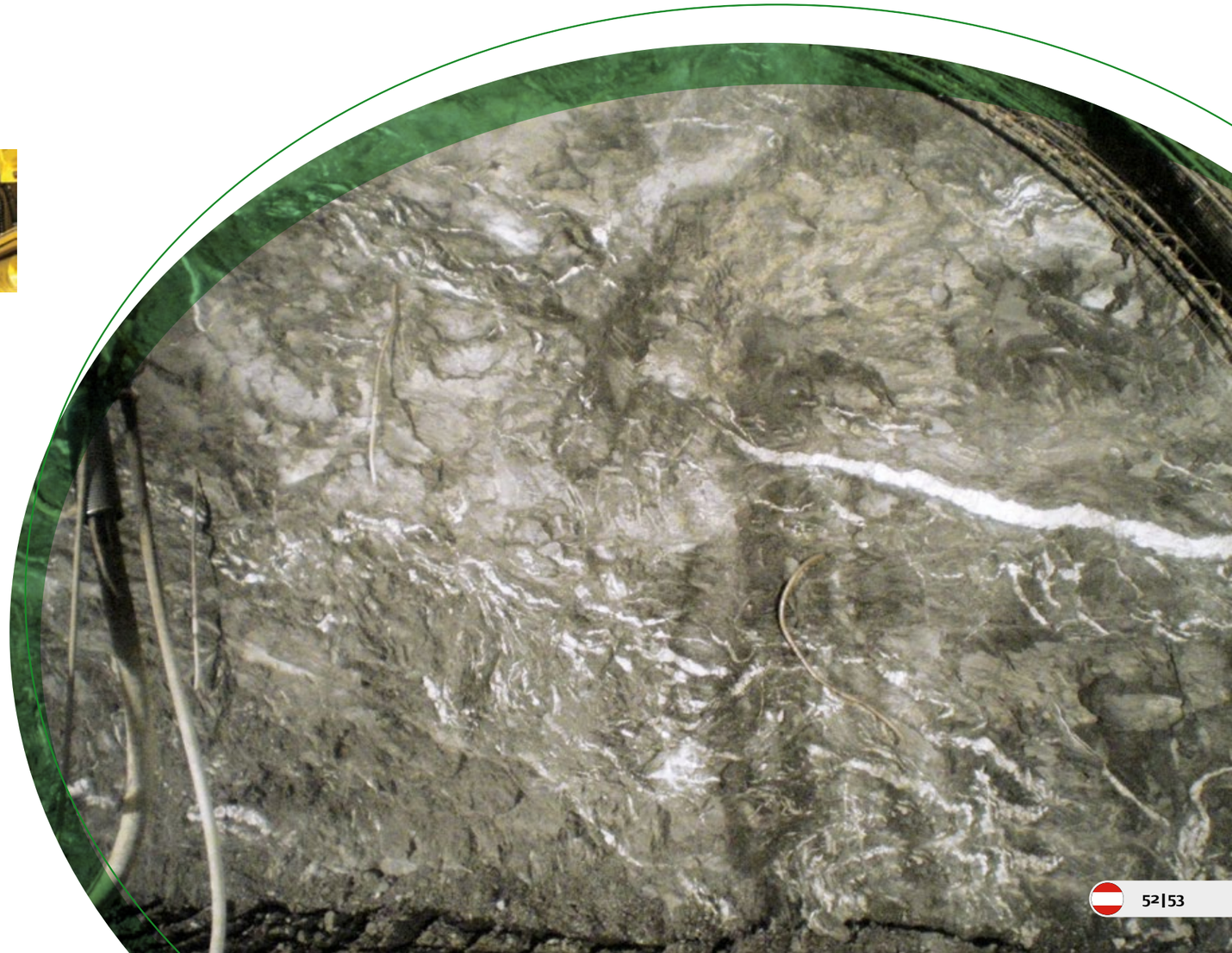
Lilienberg Tunnel
Austria

General Data:

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

Technical Data:

Project description:	two-lane road tunnel, L = 1,100 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



Henndorf Bypass
Austria

General Data:

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

Client: Land Salzburg, Landesbaudirektion [State of Salzburg, State Building Authority]

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

Construction period: 2006 to 2009

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;
cut and cover method: 732 m

Geology: Ground moraine and Flysch sedimentary rock

Vienna Metro - U2/2 Taborstrasse
Austria

General Data:

Project: Metro line 2, Section 2, Taborstrasse

Client: Wiener Linien GmbH & Co KG

Contractor: Wayss & Freytag Ingenieurbau AG
in a joint venture

Construction period: 2002 to 2007

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 ground water

Geology: Tertiary silts and sands, groundwater

Klaus Tunnel String 2nd Tubes Lots 4+5
Austria

General Data:

Project: A9 Phyrn Motorway full extension of 2nd tube
Lot 5 “Sperring” and „Falkenstein“ Tunnel,
Lot 4 „Klauser“ and „Traunfried“ Tunnel

Client: Asfinag Baumanagement GmbH

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

Construction period: 2014 to 2017

Construction costs: € 34.99+31.29 million

Technical Data:

Project description: double-lane motorway tunnel Lot 5 „Sperring“ Tunnel L=2,894 m, enlargement to full cross-section, face/floor , 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, face/floor
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: rill 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)

Gleinalm Tunnel 2nd tube
Austria

Allgemeine Daten:

Project: Phyrn motorway full extension 2nd tube “Gleinalm” Tunnel

Client: Asfinag Baumanagement GmbH

Contractor: Wayss & Freytag Ingenieurbau AG of a joint venture

Construction period: 2013 to 2017

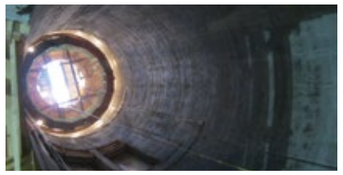
Construction costs: € 99.4 million

Technical Data:

Project description: double-lane motorway tunnel L=8,047 m, A = 80– 90 m²
34 cross-passages L=840m 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



Koralm Tunnel Paierdorf Ventilation Structure
Austria

General Data:

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

Client: ÖBB-Infrastruktur Bau AG

Contractor: Wayss & Freytag Ingenieurbau AG

Construction period: 2012 to 2013

Construction costs: € 7.4 million

Technical Data:

Project description: 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

Eppenberg Tunnel
Switzerland

General Data:

Project:	Eppenberg Tunnel Project, Part 1 „Tunnel in mining technique (conventional method)“ Railway tunnel, double track Four-track extension between Aarau and Olten
Client:	SBB Infrastruktur
Contractor:	Wayss & Freytag Ingenieurbau AG in a joint venture
Construction period:	July 2015 to July 2019
Construction costs:	€ 80.8 million

Technical Data:

Project description:	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 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-driven tunnel 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 as inner lining with external sealing with a thickness of 30 cm each. The rescue tunnels are constructed in mining technique.
Geology:	Effingen beds (claystone partly cemented) lower freshwater Molasse Gravel in soft rock sections

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

General Data:

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

Technical Data:

Project description:	Length and Cross-section: power descent, inclined shaft approx. 400 m; gradient less than 31% Surge chamber plumb vertical shaft Excavation and securing works, T=100m, 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

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

Client: Schweizerische Bundesbahnen SBB [Swiss Federal Railways] represented by Infrastruktur - Projekt Management Durchmesserlinie

Contractor: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: September 2007 to May 2014

Construction costs: € 246 million

Technical Data:

Scope of work:

Section 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

Section 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

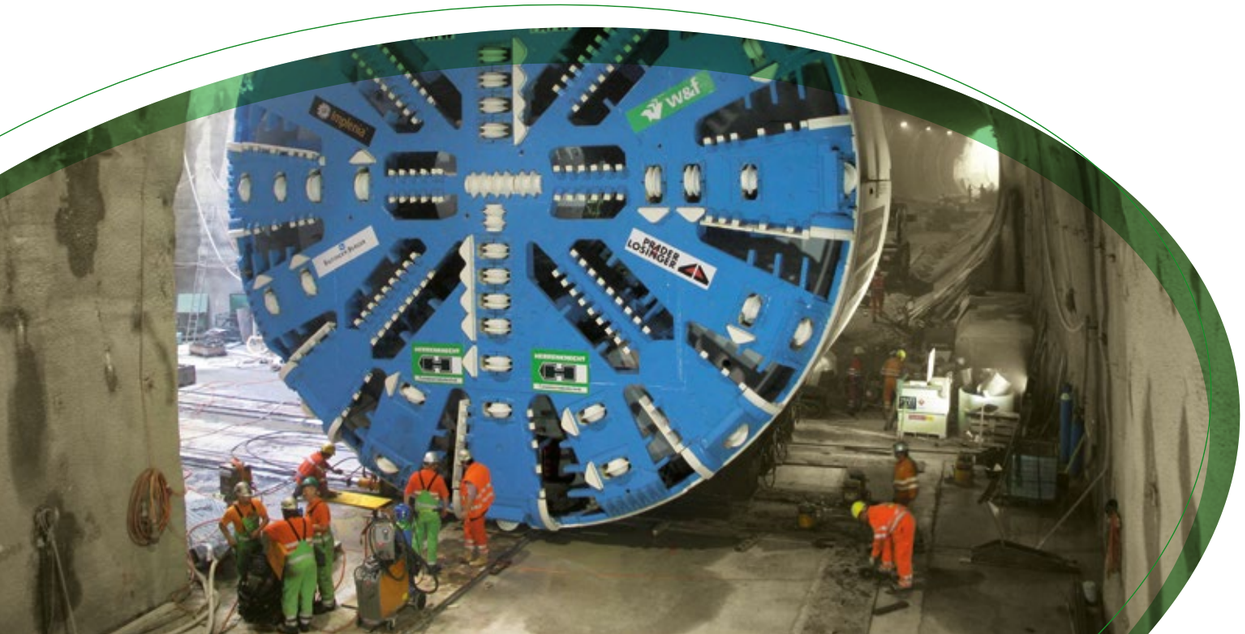
Construction method:

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

Section 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:

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



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

Client: Kraftwerke Linth-Limmern AG (KLL)

Contractor: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: October 2009 to May 2013

Construction costs: € 89 million

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. 70 m²
cavern of valley station, length: 35 m, excavation volume: 9,500 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

Client: Tridel SA, Lausanne, Switzerland

Contractor: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: 2004 to 2006

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

Uetliberg Tunnel
Switzerland

General Data:

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

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

Contractor: Wayss & Freytag Ingenieurbau AG in a joint venture

Construction period: 2000 to 2007

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

CERN Nuclear Research Centre, Geneva
Switzerland

General Data:

Project: Complete remodelling of the particle accelerator

Client: CERN - European Organization for Nuclear Research

Contractor: Wayss & Freytag Ingenieurbau AG
in a joint venture

Construction period: 1998 to 2003

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

Oenzberg Tunnel
Switzerland

General Data:

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

Client: SBB Project Group “Neubaustrecke Mattstetten - Rothrist”
[Swiss Federal Railways]

Contractor: Wayss & Freytag Ingenieurbau AG
in a joint venture

Construction period: 1999 to 2003

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: 754 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: 12.34 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

Singapore Metro, North-East Line, Contract C704
Singapore

General Data:

Project: Singapore Metro, North East Line, Contract C704, single-track metro tunnel

Client: Land Transport Authority of Singapore (LTA)

Contractor: Wayss & Freytag AG
as technical and commercial leader of a joint venture

Construction period: 1997 to 2002

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

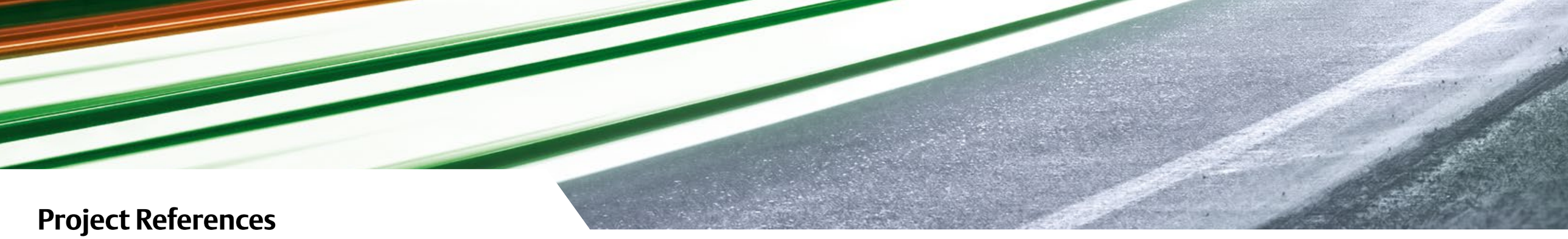
Geology: Sand, clay, granite

Project References

CONSTRUCTION PERIOD	PROJECT AND CLIENT	SCOPE OF WORKS	CONSTRUCTION METHOD
2015/2019	Eppenberg Tunnel, Subproject 1 (CH); SBB Infrastruktur	Railway tunnel, double-track, l = 2,613 m, shield-driven, shield diameter 12.75 m, 3 escape and rescue tunnels and associated shafts, 5 niches for technical installations in the tunnel, double tunnel lining: segmental lining and in-situ concrete inner lining, each 30 cm thick	Hard Rock TBM and Hydroshield
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
2015/2016	Europagarten Tunnel, Frankfurt am Main (D); 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 the cut and cover method	Cut and cover method
2014/2018	Gemeinschaftskraftwerk Inn hydroelectric power plant (A); Tiroler Wasserkraft/EKW-OEE/Verbund	Headrace, inclined shaft, approx. 400 m, incline less 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 pipe roof support system, manned pipe jacking using an open hooded shield, diameter 1,600 mm	Tunnel excavator
2014/2017	A9 Pyhrn Motorway, Construction of Second Tubes, Section 5 Spering and Falkenstein Tunnels, Section 4 Klauser and Traunfried Tunnels (A); 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	Pyhrn Motorway, Construction of Second Tube for Gleinalm Tunnel (A); 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: lenght 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
2012/2018	Stuttgart 21, PFS 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; Metrotunnel, 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 lenght 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, Enttrance cavern, length: 18 m, A = 120 m²; ventilation tunnel North, lenght: 93 m, A o 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

CONSTRUCTION PERIOD	PROJECT AND CLIENT	SCOPE OF WORKS	CONSTRUCTION METHOD
2011/2018	Crossrail Western Tunnels incl. Bond Street and Tottenham Court Road Stations, London, Contracts C300 and C410 (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
2010/2015	Sluiskil Canal Crossing,Terneuzen/Sluiskil (Netherlands); Province of Zeeland represented by BV Kanaal-kruising 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
2010/2016	Tunnel Kö-Bogen, Duesseldorf (Germany);	Inner City Road Tunnel and ramps in open construction, length: 1,603 m; Bored Piles and diaphragm walls, cover	excavator and Top-Down method
2010/2012	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; open construction 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 (Austria); ÖBB Infrastruktur Bau AG	Koralm Tunnel, Contract Section KAT 1: 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	German Unity Transport Project VDE 8, Upgraded and New Railway Lines between Nuremberg and Berlin (Germany); DB Netz AG	Brandkopf Tunnel and Lohmeberg Tunnel on the Nuremberg-Ebensfeld-Erfurt-Leipzig/Halle-Berlin railway line: 2 NATM tunnels; lengths: 1,493 m and 688 m	Drill and blast method and tunnel excavator
2009/2012	German Unity Transport Project VDE8, Upgraded and New Railway Lines between Nuremberg and Berlin (Germany); DB Netz AG	Silberberg Tunnel on the Nuremberg-Ebensfeld-Erfurt-Leipzig/Halle-Berlin railway line: double-track railway tunnel; length: 7,391 m	Drill and blast method and tunnel excavator
2009/2011	New Coal-Fired Power Plant in Wilhelmshaven (Germany) Lot C121; GDF SUEZ Energie Deutschland AG	Utility tunnel: 4 cooling water pipelines; length: 300 m each, 1 fish return pipeline length: 300 m Pipe Jacking using 2 slurry-supported TBMs, external diameter: 4.1 m	Pipe Jacking, Slurry Mode
2008/2015	Schuman-Josaphat Tunnel (Belgium); Department Mobiliteit en Vervoer	Double-track railway tunnel; length: 1,400 m;	Pipe Jacking, Open Mode, Top-Down Method
2008/2013	Liefkenshoek Rail Link, Antwerp (Belgium); Infrabel	Double-track railway tunnel; length: 12 km; shield diameter: 8.32 m; internal diameter: 7.30 m; segmental lining	Hydroshield

EPB shield
Hard Rock TBM
Mixshield/Hydroshield
Drill and blast method
Cut and cover method
Top-Down method
Road header
Gripper-TBM
Tunnel excavator



Project References

CONSTRUCTION PERIOD	PROJECT AND CLIENT	SCOPE OF WORKS	CONSTRUCTION METHOD
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	Bagger- und Sprengvortrieb
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	Wehrhahnlinie Lot 2, Germany; City of Duesseldorf	Metro tunnel with connecting platform to Station Heinrich-Heine Allee,drive lenght: 75 m, Ground freezing	Drill and blast method
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
2007/2010	Koralm Railway Line between Graz and Klagenfurt, B1581 (Austria); ÖBB Infrastruktur Bau AG	Contract Section 3 - Hengsberg Tunnel; 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
2007/2009	Völkermarkt Bypass (Austria); Land Kärnten	Lilienberg Tunnel; two-lane road tunnel; length: 1,090 m	Drill and blast method and tunnel excavator
2007/2010	U6 Metro Link to Fasanenhof (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
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
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 and tunnel excavator
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

CONSTRUCTION PERIOD	PROJECT AND CLIENT	SCOPE OF WORKS	CONSTRUCTION METHOD
2004/2009	Grouft Tunnel (Luxembourg); Administration des Ponts et des Chaussées	Twin-tube, double- and triple-lane motorway tunnels; l ength: 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 Verkehrsbetriebe 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
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, (Germany); Stadt Dortmund, Stadtbahnbauamt	Contract Section S10.1, 2nd Stage; 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
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

EPB shield
Hard Rock TBM
Mixshield/Hydroshield
Drill and blast method
Cut and cover method
Top-Down method
Road header
Gripper-TBM
Tunnel excavator

Project References

CONSTRUCTION PERIOD	PROJECT AND CLIENT	SCOPE OF WORKS	CONSTRUCTION METHOD
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
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
1998/2002	Botlek Tunnel (Netherlands); NS Railinfrabeheer (Dutch Railway)	Single-track railway tunnel; length 3,670 m; shield diameter: 9.75 m; internal diameter: 8.65 m; segmental lining	EPB shield
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	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
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
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), Federal Republic of Germany	Road tunnel; lenght: 2,561 m, shield diameter: 13.75 m, internal diameter: 12.35 m, incl. start shaft (42.5 m x 22.5 m) and end shaft (20 m x 20 m), single-skin precast concrete segment 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
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	Tunnel excavation by tunnel excavator, 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

EPB shield
Hard Rock TBM
Mixshield/Hydroshield
Drill and blast method
Cut and cover method
Top-Down method
Road header
Gripper-TBM
Tunnel excavator