



TUNNELLING
IS OUR
BUSINESS

Company Profile

Underground Construction & Tunnelling



Tunnel Baumleite, Schalkau, Germany

Foto: Wolfgang Sitter



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Executive Summary

BeMo Tunnelling GmbH (abbr. BeMo), with headquarters in Innsbruck, is a specialist in the design and construction of all kinds of underground structures, whether new construction, refurbishment, reinstatement or reconstruction.

Our experienced staff and know-how make us a world leader in our field, as can be seen from our excellent project record. A total of 400 kilometres of tunnels and underground structures of different sizes and dimensions have been built by BeMo over the past 50 years. Our annual turnover in tunnelling is approx. 150 Mio EUR.

Our highly qualified and committed team of experts (Project Managers, Project Engineers, Supervisors, Superintendents and Specialists) is known internationally for its broad scope of technical competence and innovative solutions for the design and delivery of complex and challenging tunnel works. It is our goal to maintain and strengthen our excellent global reputation.

BeMo Tunnelling creates value for everyday life by implementing complex infrastructure projects that contribute to the well-being of society in a safe, efficient and sustainable manner. Thanks to our professionalism together with the high quality of our services we are a preferred contractor for partners and clients alike.

We are fully committed to protecting the well-being, health and safety of our staff. We therefore work hand in hand with occupational health and safety organisations to continuously improve our structures, systems and efforts.

Current tunnelling activity is amongst other underground schemes in prestigious and challenging projects for public clients. In the following summary of tunnel-projects under construction BeMo plays a leading role either as Main Contractor or Joint-Venture Partner:

- ▶ Redevelopment Perjen Tunnel 1st Tube, Austria, ASFINAG
- ▶ Metro "Stadtbahntunnel" Karlsruhe, Germany, KASIG
- ▶ Stuttgart 21, Lot 3 Tunnels Bad Cannstatt, Germany, DB Netz AG
- ▶ Tunnel Herrschaftsbuck, Rheinfelden, Germany, RP Freiburg
- ▶ Tunnel Spitzenberg, Reichensachsen/Wehretal, Germany, DEGES
- ▶ Hydropowerplant Argenbach, Au, Austria, VKW
- ▶ Tunnel Bertoldshofen, B16 / B 472 By-Pass Road, Germany, Motorways Authority S. Bavaria
- ▶ Mining „Schacht Konrad“, Germany, DBE
- ▶ C510 Whitechapel and Liverpool Station Tunnels, Elizabethline, United Kingdom, Crossrail Ltd.



Strengener Tunnel, Strengen, Austria



Achrain Tunnel, Dornbirn, Austria



Exploratory gallery HEPP-Tauernmoos, Uttendorf, Austria

Executive Summary (cont'd)

Since 1964 the company's activities have been undergoing constant expansion. BeMo with its innovative tender proposals for difficult construction lots and its technological innovations was always at the forefront of the development of the New Austrian Tunnelling Method (NATM).

The great experience thus acquired led the company to set up a Division for Know-how Transfer, which exports the know-how of BeMo's engineers to many countries throughout the world.

In recognition of its merits for the advancement, promotion and further development of NATM, BeMo was granted the right to bear the Austrian state coat of arms in 1982.

To ensure that our products and services continue to remain on the technological leading edge and meet the requirements of an ever-changing global business environment, BeMo Tunnelling strives to provide our customers with state-of-the-art engineering solutions through continuous improvement and further development.

Environmental impacts, such as noise, dust and the consumption of resources, are unavoidable in the execution of our projects. BeMo Tunnelling is fully aware of its considerable responsibility to protect the environment while avoiding damage to property and conscientiously using resources. We endeavour to act in an environmentally accountable manner on every project.

BeMo was one of the first companies within the tunnelling industry of Germany and Austria to introduce and certify a Quality Management System (QMS) according to the ISO 9000 series in the year 1995, followed by certifications of OHSAS 18001 and SCC** in the year 2004 and ISO 14001 in 2007.

Meanwhile we have introduced an Integrated Management System (IMS), which we are continuously improving and developing. Our certified IMS consists of an Occupational Health and Safety Management System according to ISO 45001:2018, a Quality Management System according to ISO 9001:2015 as well as an Environmental Management System according to ISO 14001:2018.



Kings Cross Station Redevelopment, London, UK

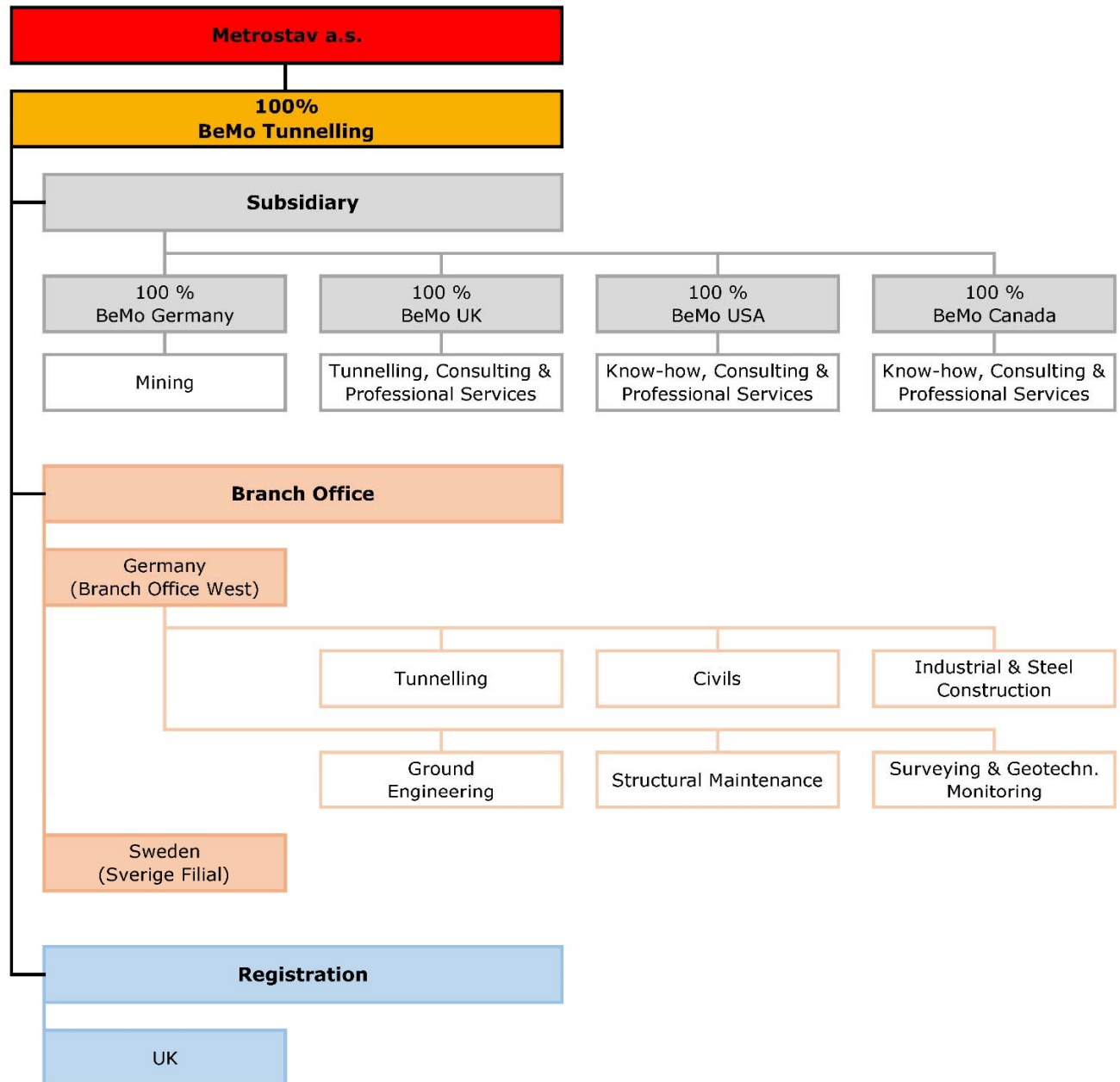


Powerhouse Cavern Kopswerk II, Partenen, Austria



Group Structure

Metrostav a.s. / BeMo Tunnelling GmbH



Company Profile

Name: BeMo Tunnelling GmbH (Abbreviation: BeMo)
 Companies Register (Court): FN 46175f ("Landesgericht Innsbruck")
 Legal form: limited liability company ("Gesellschaft mit beschränkter Haftung")
 Year founded: 1964



Managing Directors:

Activities / Areas of expertise

BeMo Tunnelling is a specialist in the engineering and construction of all kinds of underground structures, whether new construction, refurbishment, reinstatement or reconstruction.

TUNNELLING IS OUR BUSINESS and during the past decade we have continued to evolve towards becoming a full-line provider of construction solutions.

Nowadays, our group covers Tunnelling and also the fields of Civils, Industrial & Steel Construction, Ground Engineering, Structural Maintenance, Mining, Design, Mechanical Engineering & Plant, Surveying & Geotechnical Monitoring, Consulting, Professional Services and Know-How.

- ▶ Underground Construction & Tunnelling
 - ▶ Tunnels for major transportation projects including road, light-rail, metro, rail and underground stations
 - ▶ Shafts & Special Structures
 - ▶ Mining
- ▶ Design for Tunnels and Underground Structures
- ▶ Know-how Transfer & Consulting
- ▶ Power Plant Construction & Tunnelling
 - ▶ Tunnels and facilities for water and energy sector
 - ▶ Caverns
 - ▶ Water tunnels
 - ▶ Sewage tunnels
- ▶ Ground Engineering
- ▶ Civils, Industrial and Steel Construction
- ▶ Surveying & Geotechnical Monitoring for Tunnelling
- ▶ Tunnel Refurbishment, Reinstatement and Reconstruction
- ▶ Maintenance/Refurbishment of Buildings & Structures

State-of-the-art technology for all types of ground

Our experienced staff and know-how make us a world leader in our field, as can be seen from our excellent project record. Our highly qualified and committed team of experts is known internationally for its broad scope of technical competence and innovative solutions for the design and delivery of complex and challenging tunnel works.

- ▶ New Austrian Tunnelling Method (NATM)
- ▶ Sprayed Concrete Lining (SCL)
- ▶ Sequential Excavation Method (SEM)
- ▶ Shotcrete Tunnelling
- ▶ Scandinavian Method
- ▶ TBM-Tunnelling (EPB-/Slurry-/Hydro-/Mix-Shield
Single-/Double-Shield, Gripper, Partial-face)

Certifications:

Safety Management System certified according to the standards of ISO 45001 (former OHSAS 18001)

Environmental Management System certified according to the standard of ISO 14001

Quality Management System certified according to the standard of ISO 9001



BeMo Tunnelling



BeMo Tunnelling UK



Company Profile (cont'd)

Awards:

In recognition of its merits for the advancement, promotion and further development of the New Austrian Tunnelling Method (NATM), BeMo was granted the right to bear the Austrian state coat of arms in 1982

Tunnelling Industry Awards 2002
Major Project Award
North Downs Tunnel, Rochester, England, UK

Tunnelling Industry Awards 2004
Achievement Through Innovation
Development of LaserShell™ and TunnelBeamer™

American Shotcrete Association Award 2006
Outstanding Shotcrete Underground Project Award
Weehawken Tunnel and Bergenline Avenue Station
Project, Weehawken, New Jersey, USA

Trademarks:

CombiShell™
COMBISHELL™

LASERSHELL™

TunnelBeamer™
TUNNELBEAMER™

UltraShell™
ULTRA-SHELL™
Ultra-Shell™

Membership of trade and professional associations:

Member of the Association of Industrial Construction Companies Austria ("Vereinigung industrieller Bauunternehmungen Österreichs", VIBÖ)

Member of the Austrian Society for Geomechanics ("Österreichische Gesellschaft für Geomechanik", ÖGG)

Member of the Austrian Society for Concrete- and Construction Technology ("Österreichische Bautechnik Vereinigung")

Member of the Austrian Research Community Road Railway and Transit („Österreichische Forschungsgesellschaft Straße Schiene Verkehr", FSV)

Corporate Affiliate Member of the International Tunnel Association (ITA-AITES)

Member of the Swedish Construction Federation ("Sveriges Byggindustrier")

Member of the Swedish BK Bergsprängningskommittén



Background & History

BeMo Tunnelling is an internationally operating Austrian tunnelling company.

Beton- und Monierbau Gesellschaft m.b.H. (BeMo) was founded in October 1964, based on a philosophy of steady technical development, and engaged right from the beginning in the construction of tunnels. BeMo has always been a leading influence in introducing the New Austrian Tunnelling Method (NATM) to the international market. We have continuously developed the method with our special tender proposals for challenging projects. Since 1969 its activities were expanded to the neighbouring countries.

In co-operation with Prof. L. Mueller, a founder of the New Austrian Tunnelling Method (NATM), Beton- und Monierbau used NATM for metro construction in Frankfurt, Germany (special proposal by BeMo). This was the first time that NATM was applied successfully for an inner-city metro: Metro Frankfurt, Contract Section 25 – inner-city metro lot comprising of tunnels 4-7 m beneath the foundations of six buildings including the historic building "Frankfurt Roemer".

In recognition of its merits for the advancement, promotion and further development of NATM, BeMo was granted the right to bear the Austrian state coat of arms in 1982. In the meantime BeMo has proved that there are almost no geological or structural conditions to which the NATM cannot be effectively applied.

Since 1977 projects in the field of continuous excavation (TBM) were carried out. Besides metro construction projects BeMo was also the leading partner in numerous road- and railway-tunnel projects in Austria and Germany. The great experience acquired, the outstanding reputation in the field of tunnelling and the own divisions for structural engineering and tunnel design, mechanical engineering and tunnel survey & geotechnical measurement were the reasons for BeMo to establish the Division for Know-how Transfer in 1990.

Apart from the main countries Austria and Germany successful tunnel construction projects were carried out in England, Sweden, Spain and the USA. Several international recognised awards could be achieved with these projects.

Since the ending of 2013 BeMo has been part of the METROSTAV Group as an independent subsidiary.



Egge Tunnel, Willebadessen, Germany



Blisadona Tunnel, Arlberg, Austria



Hemberg Tunnel, Uentrop-Wennemen, Germany



Kings Cross Station Redevelopment, London, UK

Background & History (cont'd)

Since 31 December 1990, Metrostav a.s. has been the legal successor to the state-owned company of the same name (established in 1971). During its history, Metrostav a.s. has changed from a specialised firm, focusing on the construction of the Prague Metro, into a universal construction company whose name is automatically associated with reliability, quality and stability.

Metrostav a.s. is an esteemed partner and respected competitor in the area of reconstruction of national heritage monuments and in both industrial and housing construction. Its activities are spread over all construction areas and cover almost half the underground engineering market: as one of the few Czech companies it provides highly specialised underground works performed by mining methods. For the third millennium, Metrostav a.s. pursues a programme of sustaining and improving a high quality level in the key structural technologies such as reinforced concrete structures, insulation systems and various methods of driving underground works under the most challenging projects our clients may have.

Since 1998, Metrostav a.s. has been a holder of the internationally recognised ISO 9001 quality management certificate in respect of general contracting for construction engineering projects, awarded by BVQI in London. It can tender for large projects for the Army and implement plans in other security areas in both the Czech Republic and NATO member countries, because it was awarded the Certificate of the National Security Office. Revenues in 2012 amounted to 800 million EUR and the group had more than 3.400 employees.

BeMo's and Metrostav's activities cover all areas of building and they are a reference in undertaking civil engineering (underground construction, tunnelling, roads, railways, airports, water works, marine work) and building (residential and non-residential) both nationally and internationally.

Financially well backed and technically perfectly equipped, BeMo undertakes even extremely difficult and huge projects. Going back to 1964 our portfolio contains many milestone projects. Few companies can claim such accumulated experience in the field of underground construction. Whilst we take pride in achievements of the past, our philosophy is one of innovation, development, partnering and long lasting relations with our clients.



Corporate Logo, Metrostav a.s., Czech Republic



Metro TBM, Razeny, Czech Republic



Tunnellbuilding, Petřín, Czech Republic



Bridgebuilding, Trojský, Czech Republic

Major Project Award 2002

Winner: Eurolink JV – Morgan Tunnelling, Vinci, BeMo

Project: North Downs Tunnel, Channel Tunnel Rail Link (CTRL), Contract Section CTRL 410, Rail Link Engineering

The 3.2-km-long 116 Mio EUR North Downs Tunnel in Kent, UK forms part of Section 1 of the Channel Tunnel Rail Link. The tunnel, constructed beneath Bluebell Hill with up to 100 m of cover through upper, middle and lower chalk, is a 13 m wide, 10 m high single bore and was tendered and let under the spirit of partnering.

A value engineering workshop was undertaken at the design stage where the project manager / contractor identified substantial realistic savings. With an unprecedented safety record the project was completed 6 months ahead of schedule.

Judging Panel's Comments: The award goes to a project managed through the ECC/C Contract combined with the partnering approach. It was successfully completed 6 months early, yielded several millions of pounds as a saving shared by all parties, and must be seen by many as a model way of carrying out the contracting business. In view of this contract's critical position in the overall project's completion it was absolutely necessary for all parties of the partnering process to jointly carry out value engineering on-site resulting in a reduction of a primary shotcrete lining thickness, the removal of reinforcement from the secondary lining and a general slimming down of the tunnel invert.

The judges believe that this demonstration of teamwork through genuine partnering has been the main factor leading to the major success of this contract and the Committee applauds the result.

Article adapted from: Tunnels & Tunnelling International, June 2002



North Downs Tunnel, Rochester, UK



North Downs Tunnel, Rochester, UK

Tunnelling Industry Award 2004

BeMo Tunnelling and their UK partner Morgan Sindall (Infrastructure) (formerly: Morgan=Est) were awarded the Tunnelling Industry Award 2004 as winners in the category for "**Achievement Through Innovation**".

The **TunnelBeamer™** system had been developed around **LaserShell™**, a construction method introduced by BeMo Tunnelling and their UK partner Morgan Sindall.

The method employs an inclined face excavation for increased stability and improved safety, and provides robust face and vault support measures, while allowing access to clean and prepare the invert prior to the construction of structural lining.

LaserShell™ and **TunnelBeamer™** are registered Trademarks of BeMo Tunnelling and Morgan Sindall.



Achievement Through Innovation

Morgan Est & Beton-und Monierbau

Lasershell™ TunnelBeamer™



TunnelBeamer™, North Downs Tunnel, Rochester, UK



LaserShell™, Heathrow Terminal 5, London, UK

Outstanding Shotcrete Project Award 2006

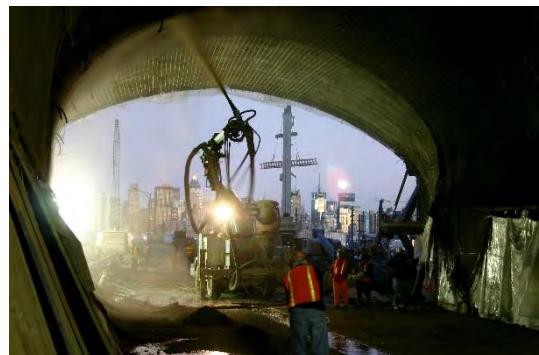
In January 2007, the Frontier Kemper, J.F. Shea, BeMo Tunnelling Joint Venture was awarded the American Shotcrete Association's Outstanding Shotcrete Underground Project of the Year Award 2006 at the American Shotcrete Association's (ASA) Membership Meeting and Annual Banquet for the Weehawken Tunnel and Bergenline Avenue Station Project, Weehawken, New Jersey, USA.



2006 Project of the Year, Underground Shotcrete, ASA



Weehawken Tunnel and Bergenline Avenue Station, Weehawken, New Jersey, USA



Weehawken Tunnel and Bergenline Avenue Station, Weehawken, New Jersey, USA

BCIA Award 2015 & NCE Tunnelling Award 2015

BeMo Tunnelling and their partners Balfour Beatty (UK), Morgan Sindall (UK) and VINCI (France) were awarded with the BCIA Product Design Innovation Award (Civil Engineering) in October 2015 and with two NCE Tunnelling & Underground Space Awards in December 2015 - "Product / Equipment Innovation of the Year" and "Technical Innovation of the Year" - for their innovative "Uphill Excavator" used at their construction site Crossrail, Contract C510 in London.

Contractor BBMV JV C510 decided to use an "uphill excavator" to dig out 30° inclined escalator shafts for Crossrail's Liverpool Street and Whitechapel stations. Conventionally, these shafts are excavated from the top down, as this is safer. On contract C510 it was decided to excavate from the bottom up because of the need to maintain an efficient working schedule with other contractors working on adjacent shafts.

The Uphill Excavator comprises both an excavating and shotcrete spraying arm complete with operator's cab which is suspended from the crown of the constructed tunnel and advances in line with tunnel progression. A bespoke walkway running alongside the excavator provides the engineer with a safe location from which to carry out work, while still ensuring they can be in visual and audible communication with the driver. The walkway also provides emergency egress for the operator at any point during the tunnelling operation. The Uphill Excavator enabled BBMV to construct key connections much earlier than would have been possible with traditional downhill methods and also significantly improved safety for operators.

The key to success of Uphill Excavator is the suspension rail system that is installed as it advances, and the machine itself which can act as an excavator, spraying arm and working platform.

The **British Construction Industry Awards** (BCI Awards or BCIA) were launched by the New Civil Engineer magazine and Thomas Telford Ltd - both owned by the Institution of Civil Engineers - in 1998.

The awards seek to recognise outstanding achievement in the construction of buildings, taking account of a wide range of factors including architectural and engineering design, but also consideration of the construction process, delivery to time and budget, and client satisfaction.

The **NCE Tunnelling & Underground Space Awards** were launched by the New Civil Engineer magazine in 2010.

Judges from over 30 industry leaders including key clients, contractors and consulting engineers recognise outstanding achievement in the construction of underground structures and tunnels.



British Construction Industry Award 2015

Judges' comment: "This innovation will have a lasting change on industry practice. It has not focused solely on commercial gain."



Uphill Excavator



NCE Tunnelling & Underground Space Awards 2015 "Product/Equipment Innovation of the Year" and "Technical Innovation of the Year"

Underground Construction & Tunnelling

BeMo Tunnelling is a specialist in the engineering and construction of all kinds of underground structures, whether new construction, refurbishment, reinstatement or reconstruction.

Over the past 20 years a total of 400 kilometres of tunnels and underground structures of different sizes and dimensions have been built by BeMo.

The span of operation in Underground Construction & Tunnelling includes:

- ▶ Tunnel Construction, Reconstruction and Modernisation
 - ▶ Tunnels for major transportation projects including road, light-rail, metro, rail and underground station contracts
 - ▶ Tunnels and facilities for the water and energy sector
 - ▶ Hydroelectric Power Plants & Dams
 - ▶ Underground Power Plants
 - ▶ Caverns, Galleries and Tunnels
 - ▶ Water Tunnels & Sewage Tunnels
 - ▶ Shafts & Special Underground Structures
 - ▶ Mining
- ▶ Know-how Transfer & Consulting
- ▶ Design for Tunnels and Underground Structures
- ▶ Tunnel Survey & Geotechnical Measurements for Tunnelling
- ▶ Tunnel Refurbishment, Reinstatement and Reconstruction
- ▶ Maintenance/Refurbishment of Buildings & Structures
- ▶ Slope-Protection

Our highly qualified and committed team of experts is known internationally for its broad scope of technical competence and innovative solutions for the design and delivery of complex and challenging tunnel works including:

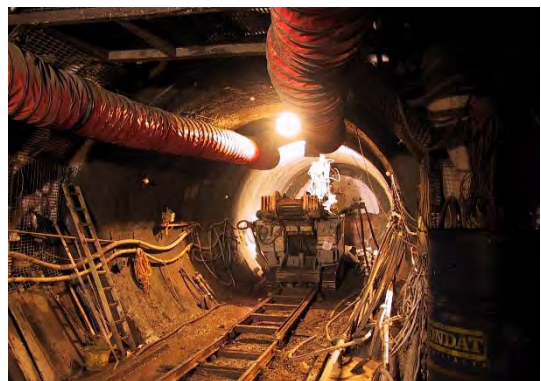
- ▶ New Austrian Tunnelling Method (NATM)
- ▶ Sprayed Concrete Lining (SCL)
- ▶ Sequential Excavation Method (SEM)
- ▶ Shotcrete Tunnelling
- ▶ TBM-Tunnelling
 - ▶ EPB-/Slurry-/Hydro-/Mix-Shield
 - ▶ Single-/Double-Shield, Gripper
 - ▶ Partial-face (roadheader)
- ▶ Scandinavian Method
- ▶ Rock-Tunnelling
- ▶ Tunnelling in soil and soft ground



Powerhouse Cavern Kopswerk II, Partenen, Austria



Metro Bochum Lot 306, Bochum, Germany



UWWTD Flow Transfer Works, T3 Tunnel Recovery Program, Hull, UK

Tunnel-Design

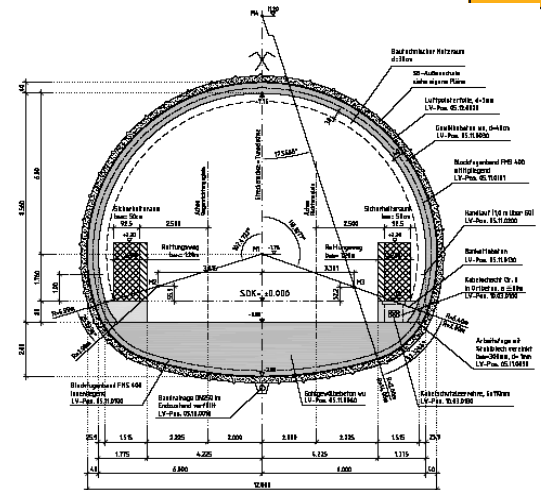
BeMo's design know-how is based on more than 40 years of experience.

Key services provided by **Tunnel-Design** are as follows:

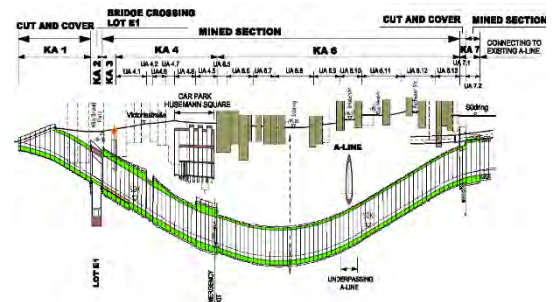
Detailed Design

Continuous feed-back from our tunnel-construction sites and being seamlessly involved in the projects enables optimisation of our designs with respect to

- ▶ Safety
- ▶ Quality
- ▶ Constructability
- ▶ Programme
- ▶ Cost saving



Detailed Design – Cross Section, New Ramholz-Tunnel, Sinntal-Sannerz, Germany



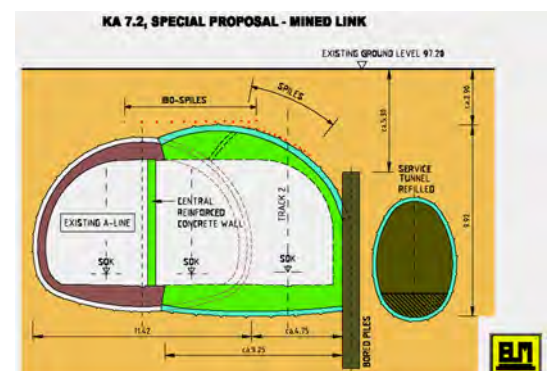
Detailed Design – Long Section, Metro Bochum Lot 306, Bochum, Germany

Value Engineering Proposals and Feasibility Studies

Together with the site teams Value Engineering Proposals are developed leading to higher quality, safety, innovation and overall cost reduction for our clients.



Cross Section – Client's design proposal, Metro Bochum Lot 306, Bochum, Germany



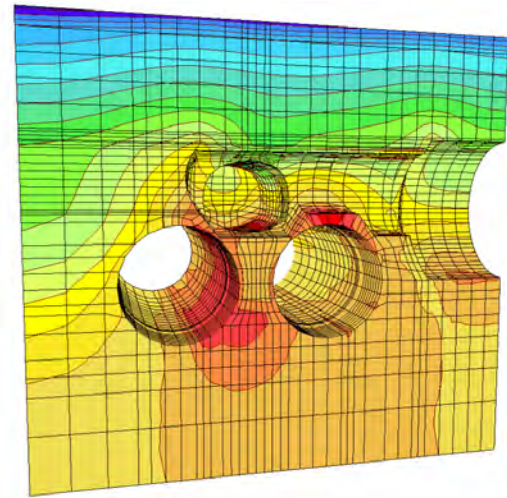
Cross Section – Value Engineering Proposal, Metro Bochum Lot 306, Bochum, Germany

Tunnel-Design (cont'd)

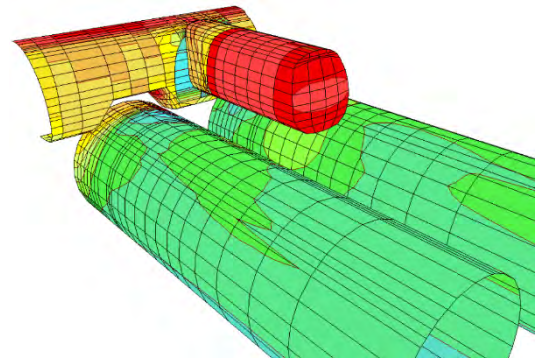
Numerical Modelling

Having more than 30 years of experience in this field **Tunnel-Design** has got the expertise for carrying out complex 2D and 3D analyses using state-of-the-art program packages for design purpose and feasibility studies enabling modelling of

- ▶ Construction process
- ▶ Nonlinear material behaviour for soil, rock, concrete, steel, etc.
- ▶ Steady state and transient seepage flow
- ▶ Consolidation
- ▶ Steady state and transient heat transfer
- ▶ Dynamics



Numerical Modelling – 3D-FE-Model, Shepherd's Bush Station, London, UK



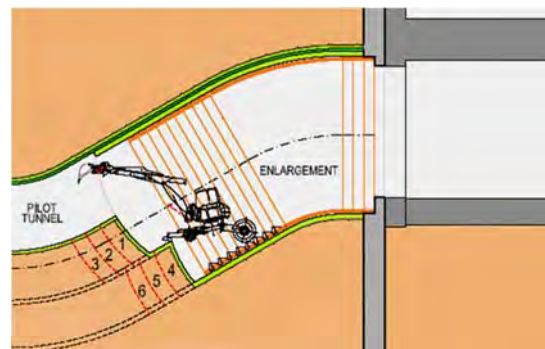
Numerical Modelling – Shell Model, Shepherd's Bush Station, London, UK

Method Selection

and

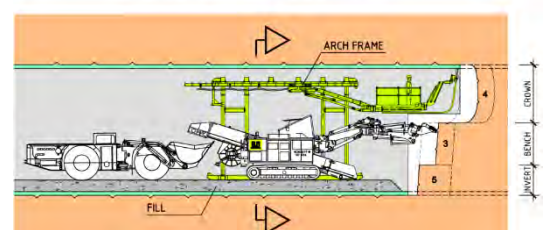
Construction Sequencing

In close cooperation with the site team and the Mechanical Engineering & Plant Department, construction methods and construction sequences are selected.



Construction Sequence Escalator Barrel, Kings Cross Station Redevelopment, London, UK

SYSTEM SKETCH ARCH FRAME



Construction Sequence, Metro Bochum Lot 306, Bochum, Germany

Division Know-how

Existing Know-how at BeMo Tunnelling

One of the **core competences** of our company is the **implementation** of tunnel projects using the New Austrian Tunnelling Method (NATM), also known as Sprayed Concrete Lining (SCL), Sequential Excavation Method (SEM) or Shotcrete Method.

This method allows the economic production of large underground cavities using shotcrete combined with rock anchoring as the means for securing the structure.

Experience in the use of shotcrete is therefore also to be regarded as one of our core competences. Tunnelling and in particular NATM are characterised by the need for **experienced and specialized personnel** on site, with miners (skilled labourers at the tunnelling work face) at the base and project engineers / managers for site management.

The experience of the miners is essential for the successful and economical execution of a NATM project. The broad know-how of the on site personnel is a major factor for the success of our enterprise.

In addition to these core competences, BeMo operates the following Divisions and Departments at the company headquarter:

- ▶ **Tunnel-Design & Structural Engineering**
- ▶ **Estimation & Work Preparation**
- ▶ **Technical Controlling**
- ▶ **Quality Management**
- ▶ **Mechanical Engineering & Plant Department**
- ▶ **Department for Survey & Geotechnical Measurement**
- ▶ **Department for Maintenance of Buildings & Structures**

The **Tunnel-Design-Department** is above all responsible for value engineering, special proposals, preparation of quotations for major projects and for the detailed design for the implementation of tunnelling projects.



Tunnelbeamer™ and LaserShell™, Heathrow Terminal 5, London, UK



CombiShell™, Heathrow Baggage Tunnel, London, UK



NATM in frozen ground, UWWTD Flow Transfer Works, T3 Tunnel Recovery Program, Hull, UK



Metro Almaty, Almaty, Kazakhstan

Division Know-how (cont'd)

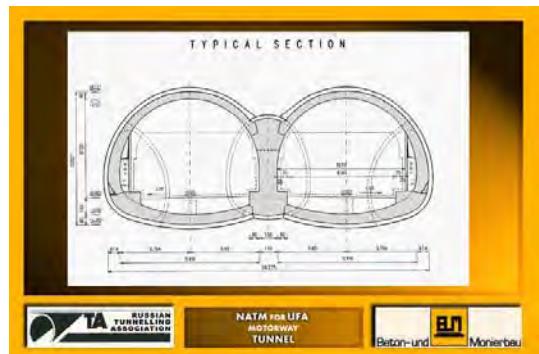
Our Know-how

Know-how for tunnelling and underground construction projects:

- ▶ Feasibility Studies
- ▶ Design Know-how
- ▶ Project Planning
- ▶ Project Development
- ▶ Estimation and Tender Preparation
- ▶ Value Engineering Proposals
- ▶ Method Selection and Construction Sequencing
- ▶ Operation and Maintenance
- ▶ Finance

Know-how about required resources for the construction of an Underground Structure and Know-How to complete structures safe, in time, within budget, and according to high quality standards:

- ▶ Personnel
- ▶ Plant & Equipment
- ▶ Energy and Materials



UFA – Know-how Transfer, Ufa, Russia



UFA – Know-how Transfer, Ufa, Russia



TunnelBeamer™ Training, Heathrow Terminal 5, London, UK

Division Know-how (cont'd)

Available Know-how from BeMo Tunnelling

Construction Know-how for your tunnel project

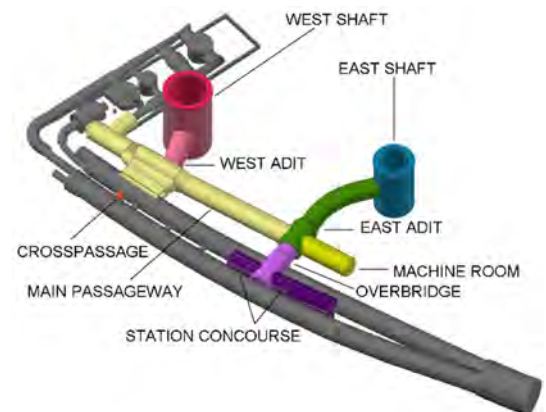
- ▶ We provide know-how and specialist-resources to international contractors
- ▶ Co-operation between international contractors to combine strength for a tunnel project
- ▶ Advantage for partners: use local (cost-saving) resources and get access to resources such as know-how, design experience, specialized personnel (blue and white collar) and tunnelling equipment.
- ▶ Advantage for cost-structure of project
- ▶ Tailored offer for partners can be proposed (right mix of local resources and specialist-resources is key to success)



LaserShell™, Heathrow Terminal 5, London, UK



LaserShell™ with SGI-Lining, Kings Cross Station Redevelopment, London, UK



3D-Model, Shepherd's Bush Station, London, UK

Please find a catalogue of BeMo's Know-how services on our website
<http://www.bemo.net>

Division Know-how (cont'd)

Know-how Transfer projects

Project	Year	Type of Technology Transfer	Client / Partner	Project-Implementation
CombiShell™ Heathrow Airport Baggage Tunnel	94-96	Detailed Design and assistance for the execution of a new tunnelling Method (Design, provide specialists, provide specialist equipment)	Miller Tunnelling, UK (now: Morgan Sindall (Infrastructure))	London, England, UK
Korean High Speed Railway and Seoul New Airport Highway	95-96	Provide specialists for tunnel supervision and special tunnel trades	Hyodong, South Korea	Taejon, Seoul, South Korea
Lower Kihansi Project	95-96	Project-execution study and supervision on site	Impregilo S.p.A., Italy	Iringa, Tanzania
Ufa Motorway Tunnel Detailed Design	96-96	Detailed Design and Know-how Transfer for UFA Motorway Tunnel	TA Moscow, Russia	Ufa, Bashkortostan, Russia
Ufa Motorway Tunnel Feasibility-Study	96-96	Feasibility Study for UFA Motorway Tunnel	TA Moscow, Russia	Ufa, Bashkortostan, Russia
North Hollywood Extension, Metro's Red Line	05-07	Detailed Alternative Design and Structural Analysis, Value Engineering (VECP)	Traylor Bros. Inc. / Frontier Kemper, USA	Los Angeles, California, USA
Heathrow Airport Terminal 5 LaserShell™ TunnelBeamer™	01-02	NATM-Alternatives for Tunnelling and Underground-Structure at Airport Heathrow Terminal 5. Development of LaserShell™ and TunnelBeamer™	Morgan=Est, UK (now: Morgan Sindall (Infra.)), Vinci, France	London, England, UK
Metro Puente Alto	03-04	Design, Technical Support, Provide specialists for NATM, preparation of special technical proposals	Consortio Chile V.E.I.,	Santiago, Chile
Metro Almaty, Zhibek Zholy Station	04-06	Design, Technical Support, Training and Provision of specialists and equipment for NATM	OAO Almatymetrokurylis, Kazakhstan	Almaty, Kazakhstan
Metro Los Angeles Gold Line Eastside Light Rail Transitway Extension	05-07	Design-input for NATM-Crosspassages between TBM-Metro-Tunnels, Consulting and Technical support, Provision of specialists for NATM for Eastside Extension Crosspassages in soft, pretreated ground below groundwater-level	Traylor Bros. Inc. / Frontier Kemper, USA	Los Angeles, California, USA
Beacon Hill Station Project, C170, Central Link Light Rail	05-08	Consulting, Provision of specialists for SEM/NATM in soft ground for Beacon Hill Station	Obayashi Corp., USA	Seattle, Washington, USA
San Vicente Pipeline, Emergency Storage Project, Reach 5	06-06	Estimation assistance, design-input for Reach 5, Consulting, Provision of specialists for NATM in Reach 5 conglomerate	Traylor Bros. Inc., USA	San Diego, California, USA
Metro Caracas Linea 5, Station Bello Campo	08-08	Feasibility-Design, Technical Support, Training	Metro de Caracas	Caracas, Venezuela
NATM Tunnel Tysons Corner	09-11	Consulting, Technical Support, Training and Provision of specialists for SEM/NATM in soft ground	Dulles Transit Partners	Vienna, Virginia, USA



Division Know-how (cont'd)

Know-how Transfer projects

Project	Year	Type of Technology Transfer	Client / Partner	Project-Implementation
New York East Side Access, Queens Bored Tunnels	10-12	Essential design-input for 3-cell NATM crosspassage between Yard Lead Tunnel and Emergency shaft structure; Consulting and Technical Support during execution; Know-how transfer; two SEM/NATM Tunnel Superintendents for round the clock coverage on site	Granite – Traylor – Frontier JV	Long Island City, Queens NY, USA
Seattle University Link Light Rail – Contract U220	11-12	Consultant for execution of SEM/NATM crosspassages between two segmentally lined TBM tubes; Technical Support, Know-how transfer; Senior NATM Tunnel Engineer on site	Traylor Frontier JV	Seattle, Washington, USA
Chinatown Station, San Francisco	12	Estimating assistance	US Contractor	San Francisco, USA
Regional Connector Los Angeles	13	Estimating assistance	US Contractor	Los Angeles, USA
First Street Tunnel Project – Washington, D.C. Clean Rivers Project Division P	13-14	Design-review for NATM-Adits in soft ground, consulting and technical support	Parsons Brinkerhoff (Lead Designer) in association with Skanska – JayDee JV	Washington, D.C., USA
Plymouth Tunnel	14	Estimating assistance, design input	US Contractor	Silver Springs, MD, USA
Green Valley Tunnel Edmonton	15	Estimating assistance, design input	US Contractor	Edmonton, AB, Canada
Seattle East Link	15	Estimating assistance, design input	US Contractor	Seattle, WA, USA
Guayasamin Tunnel	15	Expertise on fracturing of inner lining	Pontificia Universidad Catolica	Quito, Ecuador
Regional Connector Los Angeles	15	Design review SEM cross over cavern	Skanska – Traylor jv	Los Angeles, CA, USA
Chinatown Station, Central Subway, San Francisco	15	Consulting, technical support, training and provision of specialists for SEM / NATM works in soft ground (pipe umbrellas, shotcrete, divided cross sections, ...) and urban surrounding	Frontier Kemper	San Francisco, CA, USA
John Hart Generating Replacement Project, Vancouver Island	15	Consulting, technical support, training and provision of specialists for SEM / NATM works in soft ground (pipe umbrellas, shotcrete, ...)	Frontier Kemper	Campbell River, BC, Canada

Success Story CombiShell™

Scope

British Airways Heathrow Airport Ltd. was the client for the Heathrow Baggage Tunnel Transfer Tunnel works between Terminal 1 and Terminal 4. The running tunnels were constructed using the shield method, lined with steel fibre reinforced concrete segments. At each end of the main running tunnel enlargements up to a diameter of 9.4 m were required, with cross passages to the shafts.

CombiShell™ Method of Tunnelling

With the great flexibility offered by NATM, chamber geometries were developed which neatly enveloped the complex path of the baggage handling system whilst minimising overall excavation volumes. Located directly below operational aircraft stands, settlement considerations and safety of construction were of paramount importance. The novel tunnelling system utilised sprayed concrete for both the primary and secondary linings acting as a permanent composite structure. The design of the **CombiShell™** proposal was undertaken by Morgan Sindall (Infrastructure) (formerly: Morgan=Est; formerly: Miller Tunnelling), England and BeMo Tunnelling under a “technology transfer” agreement. BeMo utilised computer modelling techniques together with its more than 30 years of experience in order to achieve economical and practical schemes.

The construction of the junction demonstrated the flexibility of **CombiShell™** techniques and allowed a cost saving of some 30 % over traditional British methods requiring massive temporary supports. **CombiShell™** saves money - if and only if the contractor employs qualified personnel, because supervision and workmanship at the face is of the utmost importance.

CombiShell™ is a registered Trademark of BeMo Tunnelling and Morgan Sindall (Infrastructure).



CombiShell™, Heathrow Baggage Tunnel, London, UK



CombiShell™, Heathrow Baggage Tunnel, London, UK



CombiShell™, Heathrow Baggage Tunnel, London, UK



CombiShell™, Heathrow Baggage Tunnel, London, UK

Registered Trademarks

**TRADE MARKS
REGISTRY**  **REGISTRATION
CERTIFICATE**

Trade Marks Act 1994 of Great Britain and Northern Ireland

The marks shown below have been registered as a series of two marks under No. 2025555 as of the date 30 June 1995.

CombiShell

COMBISHELL

The marks have been registered in respect of:
Class 37:
Construction, maintenance and repair of tunnels.
In the name of Miller Civil Engineering Limited and Beton- und Monierbau GmbH

Sealed this day at my direction
P. R. S. Hartnack
P. R. S. HARTNACK, REGISTRAR
DATE 3 May 1996

CombiShell™, COMBISHELL™

 **UNITED KINGDOM OF GREAT BRITAIN**
OFFICE OF THE REGISTRAR OF TRADE MARKS

**CERTIFICATE
OF REGISTRATION** **CERTIFICAT
D'ENREGISTREMENT**

This Certificate of Registration is hereby issued for the Community trade mark identified herein. The corresponding entries have been recorded in the Register of Community Trade Marks.

In respect of the mark of registration for the purpose of the mark of registration identified herein, the entries in the Register of Community Trade Marks are hereby issued and the entries in the Register of Community Trade Marks are hereby issued.

N° 002484301

LASERSHELL

Registrar/Contrôleur, 01/04/2000 *The President/Le Président*
Richard de Tournay

LASERSHELL™

**TRADE MARKS
REGISTRY**  **REGISTRATION
CERTIFICATE**

Trade Marks Act 1994 of Great Britain and Northern Ireland

The marks shown below have been registered as a series of two marks under No. 2271284 as of the date 30 May 2001.

TUNNELBEAMER

TunnelBeamer

The marks have been registered in respect of:
Class 37:
Construction, maintenance and repair of tunnels.
In the name of Miller Civil Engineering Services Ltd and Beton- und Monierbau GmbH

Sealed this day at my direction
Alison Breckell
ALISON BRECKELL, REGISTRAR
DATE 2 November 2001

TUNNELBEAMER™, TunnelBeamer™

**TRADE MARKS
REGISTRY**  **REGISTRATION
CERTIFICATE**

Trade Marks Act 1994 of Great Britain and Northern Ireland

The marks shown below have been registered as a series of three marks under No. 2419150 as of the date 10 April 2006.

UltraShell

ULTRA-SHELL

Ultra-Shell

The marks have been registered in respect of:
Class 37:
Construction, maintenance and repair of tunnels.
In the name of Morgan Est Plc and Beton- und Monierbau GmbH

Signed this day at my direction
Robin Webb
ROBIN WEBB, Director of Trade Marks
and Designs UK Intellectual Property Office
DATE 6 April 2007

UK Intellectual Property Office is an operating name of the Patent Office

UltraShell™, ULTRA-SHELL™, Ultra-Shell™

Mechanical Engineering & Plant Department

The tasks of the Mechanical Engineering & Plant Department comprise essentially the following areas of operation:

Mechanical engineering / electrical engineering (basic tasks)

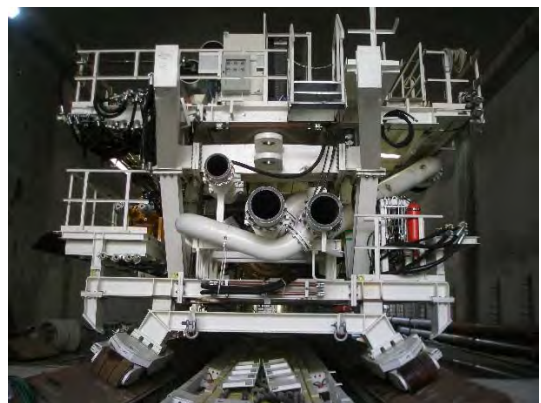
- ▶ Selection and procurement of mechanical equipment, machines, plant and electrical equipment
- ▶ Arrangement and operational planning for machines and plant
- ▶ Execution of repairs and maintenance at the plant yards, cost monitoring, repair documentation, expert inspections
- ▶ In-house developments of new site-specific equipment, adaption (re-design) of equipment, innovatory improvements on plant and machines

Project-specific tasks / detailed engineering services for company owned projects and the Divisions UK/USA & Know-how

- ▶ **Mechanical / electrical estimations / calculations (plant list) for individual projects for consecutive construction stages**
 - ▶ Site preparations / excavation / lining / completion works
- ▶ **Mechanical / electrical work preparations**
 - ▶ Basic logistics considerations (e.g. mucking by conveyor or dump trucks)
 - ▶ Equipment operational planning
 - ▶ Geometry and kinematic studies of excavation equipment
 - ▶ Ventilation calculations, mucking calculations, water pumps calculations
 - ▶ Design of complete facilities (e.g. compressed air excavations, compressor systems, locks systems), design of mucking concepts (track / non-track operation)
 - ▶ Preparation of cost comparisons of plants, determination of technical specifications and contractual layout of special equipment (e.g. excavation systems, conveyor systems)
 - ▶ Detailed investigations of operation requirements of steel formwork, mobile scaffolding, mobile curing gantries with respect to process flow and practice by using developed checklists
 - ▶ Design, planning and monitoring of installations of electrical equipment for the site(s) requirements from suppliers mains interchange point to the single consumers



Backup Slurry TBM, Metro Karlsruhe, Germany



Backup Slurry TBM, Metro Karlsruhe, Germany



Equipment for rail tracks dismantling, Arlberg Tunnel – Safety Engineering Upgrade, Langen, Austria



Muck shaft-hoist, Lainzer Tunnel LT 31, Vienna, Austria

Mechanical Engineering & Plant Department

► Site set-up planning

- Detailed shaft planning
- Lifting gear
- Ventilation and dedusting equipment
- Participation in the selection of shotcrete systems

► Site services

- Arrangements and handling of contracts for investments (plant and equipment)
- Selection of plant and equipment
- Check of suitability, performance of regular checks of the equipment concept
- Adjustment of main equipment concept to main construction progress situations (technical, contractual)
- Negotiation and contractual preparation for supply of electrical energy
- Design of emergency electricity supply concepts



Vault shutter/formwork , Schluechterner Tunnel, Schluechtern, Germany



Main Ventilation Plant Arlbergtunnel - St. Anton, Austria



Ventilation system side wall drift, Lainzer Tunnel LT 31, Vienna, Austria

Safety related tasks for our company owned facilities and sites

► Safety-related work preparation

- Evaluation of risks and hazards
- Implementation of measures to achieve high level of safety
- Design and production of refuge chambers according to project-specific requirements derived from evaluation of likely incident scenarios



Refuge chamber for 20 people and 12hours standalone operation

Mechanical Engineering & Plant Department

► Safety-related work preparation

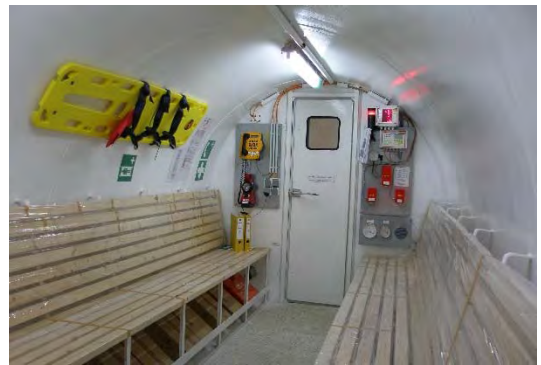
- Evaluation of risks and hazards
- Implementation of measures to achieve high level of safety
- Design and production of refuge chambers according to project-specific requirements derived from evaluation of likely incident scenarios



Emergency training, Strenger Tunnel, Strengen, Austria

► Safety site supervision

- Organisation and implementation of fire drills / emergency drills
- Determination of fire-fighting equipment
- Escape and rescue plans
- Safety-related inspections of sites, correction of safety defects
- Evaluation of accident reports, conclusion to accident causes, implementation of measures, accident statistics
- Detailed investigations of safety-relevant requirements for non-standardised special equipment (e.g. steel tunnel formwork), specification of safety relevant design details, supervision of production and commissioning on site, determination of details as a requirement to production and commissioning of special lining equipment



Refuge chamber interior



Firefighting Emergency Loco with oxygen supply for engine



Excavator with lifting equipment for compressed air tunnelling, Metro Karlsruhe, Germany



INNOVATION
IS OUR
BUSINESS

Project Datasheets Austria/Germany



Tunnel Spitzenberg, Reichensachsen (D)



Perjentunnel, Redevelopment First Tube (A)

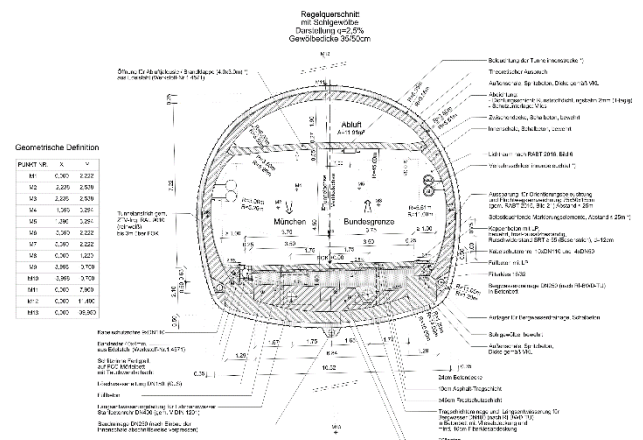
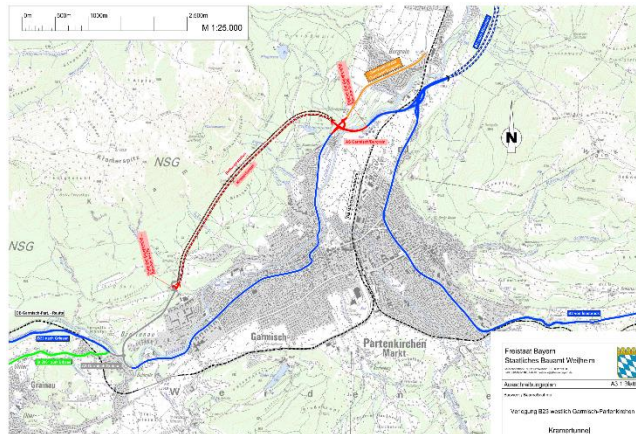


Plymouth Tunnel, Silver Spring, Maryland (USA)



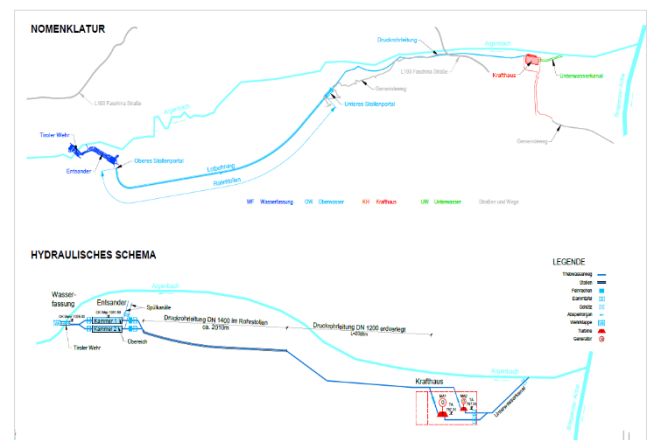
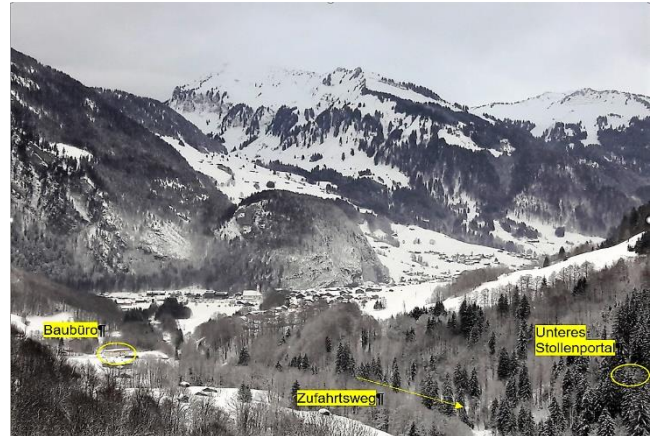
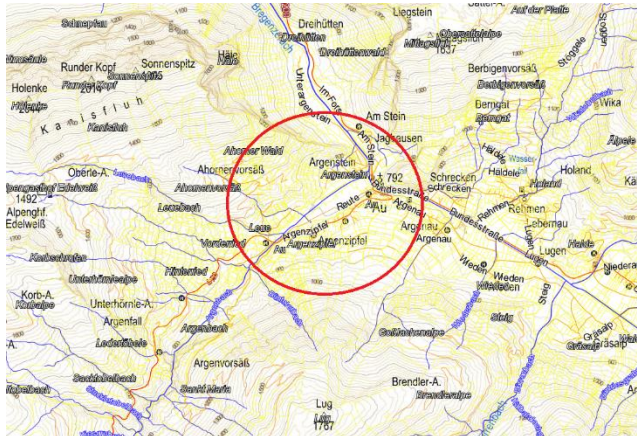
Hydropower Plant Argenbach (A)

KRAMERTUNNEL AND REROUTING B23, GARMISCH-PARTENKIRCHEN



Client: Staatliches Bauamt Weilheim Münchener Straße 39, 82362 Weilheim	Technical Data: Construction of a 2-lane road tunnel (1 tube) incl. completion of a rescue tunnel; ventilation shaft incl. ventilation structure (structural works), trough structure at the North Portal and tunnel access areas North and South.
Contractor: BeMo Tunnelling GmbH, Niederlassung West Wahrbrink 10, 59368 Werne in Joint Venture „JV Kramertunnel“ with Subterra a.s. (BeMo-Share 70 %)	Tunnel <ul style="list-style-type: none"> Length: 3,609.00 m Conventional Driving: 3,524.00 m <ul style="list-style-type: none"> - thereof in solid rocks: 2,977.00 m - thereof in soft ground: 574.00 m Cut-and-Cover method: 85.00 m Cross-section: ≤ 157.00 m² Execution: by drill and blast and roadheader, NATM Support: shotcrete, tunnel arches, wire mesh Secondary lining: in-situ concrete reinforced/unreinforced
Project Location: 82467 Garmisch-Partenkirchen Germany	Rescue Tunnel <ul style="list-style-type: none"> Length: 3,703.00 m Conventional Driving: 349.00 m <ul style="list-style-type: none"> - thereof in soft ground: 349.00 m Cut-and-Cover method: 22.00 m Cross-section: ≤ 43.00 m² Execution: by roadheader, NATM Support: shotcrete, tunnel arches, wire mesh Secondary lining: in-situ concrete reinforced/unreinforced
Geology: Kramer-Massif (predominant Carbonate/solid rocks and soft ground). Solid rocks: main dolomite, platy limestone, Kössen formation. Overlying quaternary soft ground material such as Morain-/rockfall sediments, mudslide-/gravel sediments, slope debris and alluvial valley sediments.	Shaft <ul style="list-style-type: none"> Depth: 118 m / Sinking Depth: 79 m / Ø: 4.50m Secondary Lining: in-situ concrete, reinforced
Start of Construction: December 2019	Other Project-Specific Information: <ul style="list-style-type: none"> Construction road junction Garmisch/Burgrain New construction operations building Ground engineering works (anchored retaining walls) as well as water drainage works (vertical filter well and gravel piles)
End of Construction: expected September 2023	
Project Total Value: 149,938,583.00 € (BeMo-Share: 104,957,008.00)	

SMALL HYDROPOWER PLANT ARGENBACH, LOT 2, PIPE TUNNEL



Client: Vorarlberger Kraftwerke AG Weidachstr. 6, 6900 Bregenz, Austria	Geology: Parts of stone layer series of "Helvetikum", "Ultrahelvetikum" and "Vorarlberger Flyschzone", which are characterized by a lot of marl clay, marl, sand stones and lime as well as transition areas between these geological formations.
Contractor: BeMo Tunnelling GmbH Bernhard-Höfel-Str. 11, 6020 Innsbruck	Technical Data: <ul style="list-style-type: none"> Main construction work, lot 2 Portal cutting at the lower portal Hmax 19.50 m Pipe umbrella in loose stone layers Length 20.00 m Pipe tunnel with sprayed concret lining: <ul style="list-style-type: none"> Length: 2,010.00 m cross-section: 30.00 m² Gradient: 4.3 % Conventional driving / complete excavation: <ul style="list-style-type: none"> - thereof in blast method: 1,990.00 m - thereof in soft ground drilling 20.00 m Support: <ul style="list-style-type: none"> driving classes are designed from sprayed vault cover without Anchors up to a two-layer development with arches and anchor systems.
Project Location: 6883 Au, Vorarlberg Austria	
Start of Construction: 25. February 2019 End of Construction: expected December 2020	
Project Total Value: 10,568,878.69 €	Other Project-Specific Information: Power plant facilities of the small hydropower plant Argenbach are situated at an altitude between 787,31 and 1031,50 m above Adrian Sea level. Road access to the tunnel portal is situated on 940 m above Adrian Sea level and will be provided by a forest road.

PROJECT DATA SHEET

TUNNEL BERTOLDSHOFEN, B 16 / B 472 BY-PASS ROAD



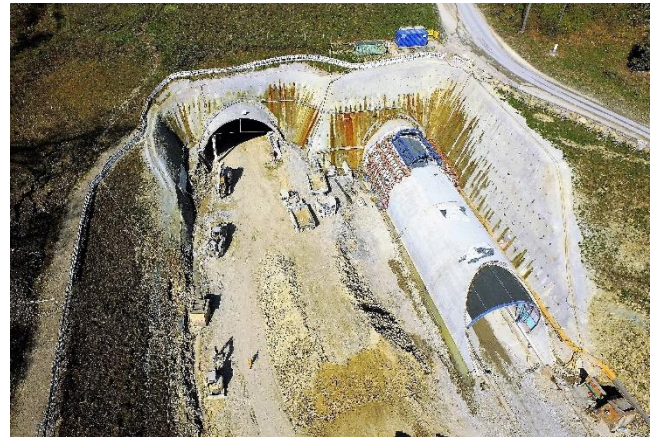
Client: Autobahndirektion Südbayern, Seidlstraße 7-11, 80335 München Germany	Geology: upper freshwater molasse, ground moraine, glacial outwash gravel
Contractor: BeMo Tunnelling GmbH, Niederlassung West Wahrbrink 10, 59368 Werne	Technical Data: Federal Roads B16 / B472 local bypass Marktoberdorf and Bertoldshofen, building of a two-lane road tunnel, one tube with two lanes in both directions Tunnel: <ul style="list-style-type: none"> length: 599.00 m standard section / widened section: 100 m² / 130 m² Excavation: excavator, loosening blastings Execution: NATM partly with pipe umbrella, side wall drift in widened cross-sections Final lining: in-situ concrete reinforced d = 35 – 60 cm with waterproofing membranes, PP-fibre concrete in the vault 1 technical and rescue tunnel <ul style="list-style-type: none"> length 170,00 m cross-section 13,00 m²
Project Location: 87616 Bertoldshofen, County Ostallgäu, Bavaria Germany	
Start of Construction: July 2018 End of Construction: expected January 2021	
Project Total Value: 23,505,765 €	Other Project-Specific Information: <ul style="list-style-type: none"> Precuts south portal by permanent discontinuous bored pilewalls with shotcrete infilling and top plates, back anchorages by strand anchors Operations building with retention basin and firewater basin Slope stabilization by nail wall Earthworks, Tunnel upgrade incl. extinguishing water pipe and road construction

PERJENTUNNEL, REDEVELOPMENT FIRST TUBE



Client: ASF INAG Bau Management GmbH, 1030 Wien	Geology: Quartz phyllite and dolomite
Contractor: BeMo Tunnelling GmbH	Technical Data: <ul style="list-style-type: none"> two-lane motorway tunnel, Redevelopment of the first tube Tunnel length: 2,992.00 m Demolition of the false ceiling, concrete renovation of the vault incl. further additional piping of the inner lining and new coating Renovation of the concrete pavement, side walkways (slotted channel and kerb with cover), extinguishing water pipe Extension of 2 existing breakdown bays, construction of additional niches, installation of doors and gates Construction of the invert in the area of the lifted pavement and installation of the new inner lining Deconstruction of temporary cross-cuts and construction of the connection for final cross-cuts / 8 x GQ (walkable) and 2 x EQ (accessible for emergency vehicles)
Project Location: 6500 Landeck, Tyrol Austria	
Start of Construction: December 2018 End of Construction: expected December 2020	Other Project-Specific Information: <ul style="list-style-type: none"> demolition and construction of supporting walls on the east portal (length 46 m) construction of a supporting wall on the west portal (new breakdown bay at the front portal area) Construction of the necessary front portal facilities Rebuilding of the existing operations buildings at the east- and west portal partly renovation of the main tunnel drainage
Project Total Value: 21,720,449.60 €	

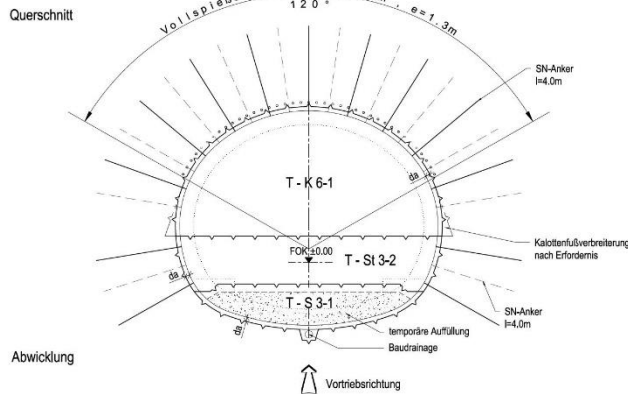
HERRSCHAFTSBUCKTUNNEL



Client: Regierungspräsidium Freiburg, Ref. 47.3, Dienststz Bad Säckingen, Rathausplatz 5 79713 Bad Säckingen	Geology: Layers of keuper (Gipskeuper), clayey Keuper (Lettenkeuper), lacustine limestone (Muschelkalk), Karst formation High ground water level approx. 404.60 mAD
Contractor: BeMo Tunnelling GmbH in Joint Venture with Subterra a.s. BeMo-share in JV 50 %	Technical Data: <ul style="list-style-type: none">double-lane motorwaytunnel, 2 tubes (North- and Southtube)Northtube Tunnel Length: 485.00 m Mined Excavation: 447.20 m Cross-Section: 101.00 m²Southtube Tunnel Length: 475.00 m Mined excavation: 428.65 m Cross-Section: 163.00 m²Final Lining: In-situ concrete (reinforced - Northtube: 40-60 cm/ Southtube 60-80 cm), waterproofing membrane ("KDB") water pressure tight, PP fibre reinforced concrete in the arch1 Cross Cut Length: approx. 19.00 m Cross Section approx. 18.00 m²Execution: drill and blast, using excavators, NATMSupport: shotcrete
Project Location: A 98, AD Hochrhein-AD Karsau 79618 Rheinfelden Germany	
Start of Construction: March 2017 End of Construction: expected February 2020	
Project Total Value: 31,489,122.00 € (BeMo-share: 15,744,561.00)	Other Project-Specific Information: Road Construction works in the tunnel including road surface, drainage, installation of empty conduits for cables, construction of emergency sidewalks.

PROJECT DATA SHEET

TUNNEL SPITZENBERG AND ROAD BA 2



Client: DEGES GmbH, Zimmerstraße 54, 10117 Berlin	Geology: layers of mottled sandstone containing fine and rough sandstone, clayey siltstone und mudstone in changing layers
Contractor: BeMo Tunnelling GmbH as technical leader in Joint Ventrue with Stutz GmbH and subterra a.s. BeMo-share in Joint Venture 33 %	Technical Data: <ul style="list-style-type: none"> 2-lane motorway tunnel, 2 tubes Tunnel length per tube: 599 m Excavation by mining per tube: 560 m <ul style="list-style-type: none"> - thereof blasting per tube: 480 m - thereof excavator driving per tube: 80 m Cut-an-cover method per tube: 39 m <ul style="list-style-type: none"> - thereof execution in watertight construction: 39 m Cross-section: 110 m² Excavation by boring, blasting, excavator, NATM/SEM Support: shotcrete, tunnel arches, reinforcing mesh, anchors, spiles, pipe umbrellas Innerlining: in-situ concret reinforced 40 - 75 cm thick with waterproofing membrane 2 cross-cuts / breakdown bays
Project Location: A 44, AS Waldkappel – AS Ringgau Tunnel Spitzenberg and raod BA 2 nearby Reichensachsen (Wehretal) at road B452 Germany	
Start of Construction: 10.01.2017 End of Construction: 30.06.2020	Other Project-Specific Information: <ul style="list-style-type: none"> Detailed design by BeMo (construction departement) From the Northportal up to approx. 100 m upper mottled sandstone (Röt) – application of C3A-free cements – using highly sulphate resistant concrete Overburden up to 50 m Pipe umbrellas in the first part of the tunnel
Project Total Value: 36.971.848,41 €	

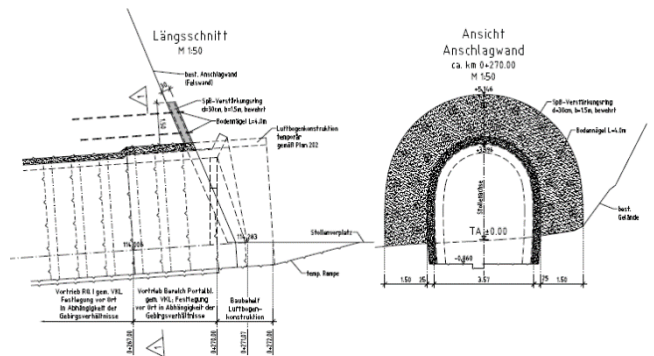
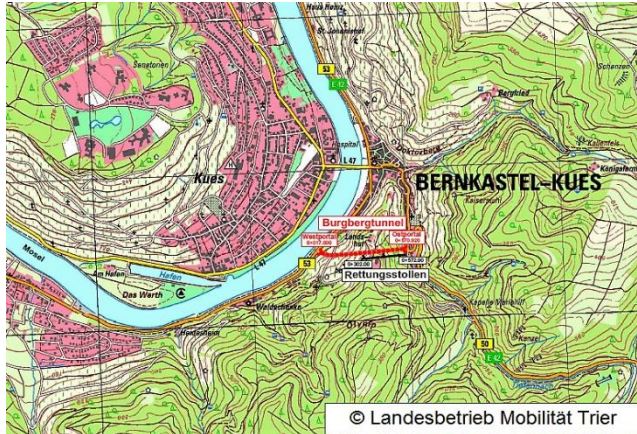
STUTTGART 21, PA 1.5, LOT 3, TUNNELS BAD CANNSTATT



Client: DB Netz AG DB Projekt Bau GmbH, Stuttgart, Germany	Geology: Gypsum keuper (approx. 80 % leached / approx. 20 % unleached with swelling anhydrite), Cover: intercity railway 110 m / interurban railway 4 m - 22 m
Contractor: BeMo Tunnelling GmbH (BeMo) commercial sponsor in joint venture 30 % in JV "Tunnel Cannstatt S 21" (Hochtief-BeMo-Wayss&Freytag)	Technical Data: Single and double track railway tunnel incl. branch-off structure Connection structure with lengths > 160 m (total approx. 710 m), 1 smoke extraction structure, emergency gallery with connecting gallery, Connection structure and crossing structure, emergency access and 3 intermediate headings Tunnel: length approx. 9,000 m A = from 25 up to 290 m² Tunnel mining technology: length approx. 8,500 m Tunnel cut & cover: length approx. 370 m Smoke extraction (shaft): depth approx. 40 m Ø = 8 m emergency gallery/ connecting gallery: depth approx. 26 m Ø = 7 m Execution: by excavator, partly blasting Excavation: NATM, shotcrete method, cut & cover
Project Location: Stuttgart 21, PA 1.5, Lot 3, Bad Cannstatt, Stuttgart, Germany	
Start of Construction: 2012 End of Construction: expected 2022	
Project Total Value: 290,000,000.00 €	Other Project-Specific Information: <ul style="list-style-type: none">Construction in inner urban areas with official requirements (noise, dust, traffic, etc.) and comprehensive requirements for water retention, compensation grouting at existing buildings and bridgesIn the Neckar River valley drive below urban environmentGel injections with acrylate in anhydrite areas

PROJECT DATA SHEET

BURGBERGTTUNNEL, ESCAPE TUNNEL & TUNNELUPGRADE



Client: Landesbetrieb Mobilität Trier 54292 Trier, Germany	Geology: shales (Hunsrück slate) with layers of milk quartz and gaps
Contractor: BeMo Tunnelling GmbH, Niederlassung West Wahrbrink 10, 59368 Werne	Technical Data: Construction of an escape tunnel with 2 cross-passages to the existing road tunnel (Burgbergtunnel between road B50 and B53) incl. upgrade of the existing tunnel with 1 emergency call niche and 3 hydrant niches <ul style="list-style-type: none"> emergency tunnel, length: 270 m cross-section: 14 - 33 m² 2 cross-passages, length: each 20 m Excavation: NATM, drill and blast method Execution: shotcrete (reinforced) Secondary Lining: 52 m (formwork) / 238 m sprayed concrete lining <ul style="list-style-type: none"> Construction of slot channels incl. retention basin (load capacity 106 m³) in prefabricated construction incl. pipelines fire-extinguishing pipelines incl. 3 hydrants in the tunnel Renovation of the tunnel drainage Restructuring of the portal buildings Replacement of the asphalt overlay
Project Location: 54470 Bernkastel-Kues Landkreis Bernkastel-Wittlich Germany	
Start of Construction: October 2018 End of Construction: September 2019	
Project Total Value: 3,745,964 €	Other Project-Specific Information: <ul style="list-style-type: none"> blasting in urban area / only 30 m distance between buildings and tunnelling works (tunnel portal) excavation with 6,8 % downward slope

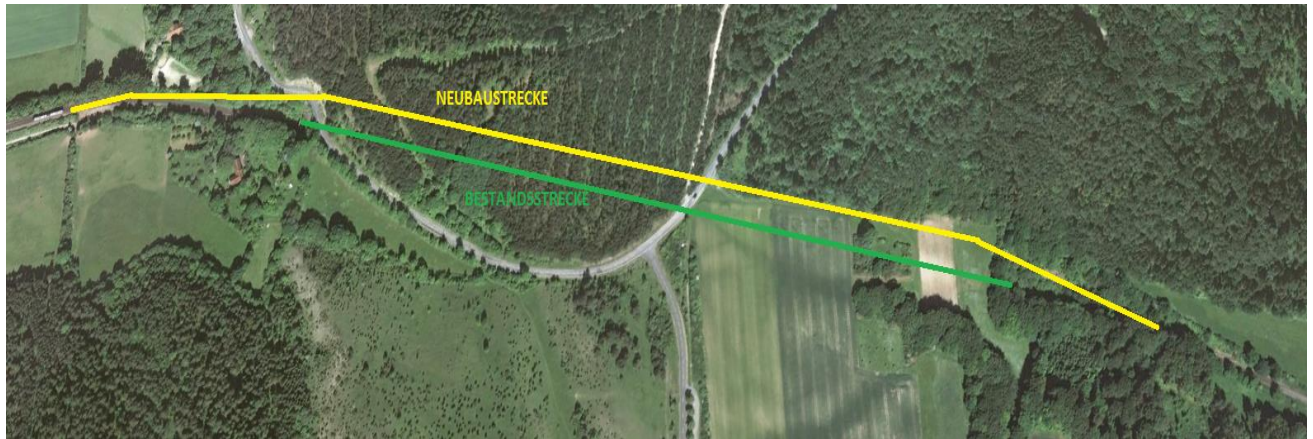
PROJECT DATA SHEET

WENDELBERGTUNNEL, UPGRADE OF THE EXISTING TUNNEL WITH AN ESCAPE GALLERY



Client: Staatliches Bauamt Traunstein Rosenheimer Str. 7, 83278 Traunstein Germany	Geology: Excavation in ground moraine and in unweathered dolomite. The ground moraine is basically a matrix consisting of an over-consolidated soil filled with gravel and boulders. Its properties are in principle marked by the binding matrix.
Contractor: BeMo Tunnelling GmbH	Technical Data: <ul style="list-style-type: none"> Upgrade of an Escape Gallery at the existing Wendelberg-Roadtunnel (B 21) Tunnellength: 290.00 m Mining Excavation: 250.00 m <ul style="list-style-type: none"> - thereof by blasting: 170.00 m - thereof by cut-and-cover: 40.00 m Cross Sections: 15.00 m² Execution by Drill-and-Blast-Method and roadheaders, NATM Preliminary cuts by shotcrete-injections Support: Shotcrete (reinforced), SN-Bolt, Swellex Bolt, Injection drill bolts, Spiles, Inner Tunnel Lining: partly by shotcrete alternating with in-situ concrete and sealing Cut-and-Cover (approx. 40 m) with cast in place waterproof concrete
Project Location: 83458 Schneizelreuth – Melleck Germany	
Start of Construction: December 2016 End of Construction: October 2018	
Project Total Value: 2,951,040 €	Other Project-Specific Information: Mining Excavation was done in single-shift-operating and exclusive by own personnel.

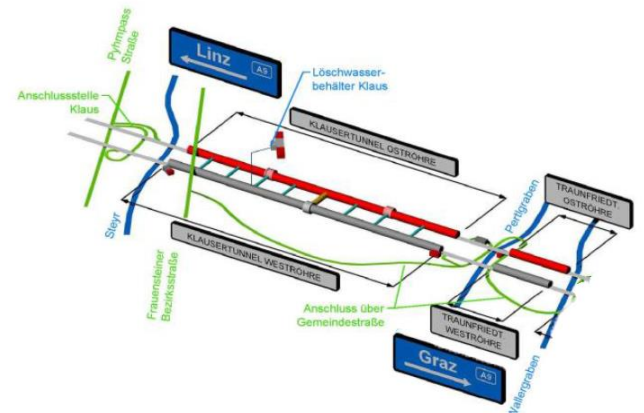
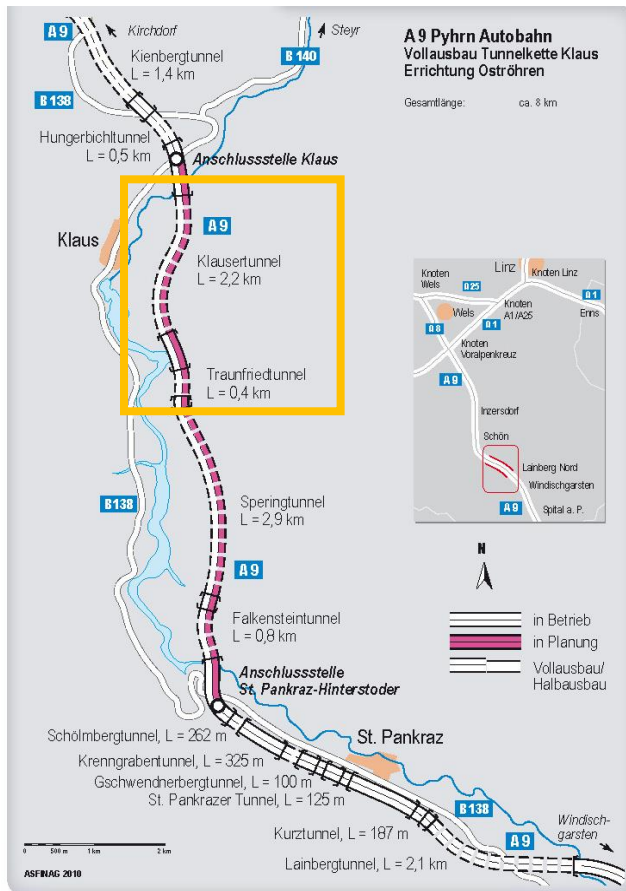
RECONSTRUCTION TUNNEL ZIERENBERG



Client: DB Projektbau GmbH, Frankfurt Germany	Geology: Nature Park "Habichtswald" Claystone and upper bunter sandstone
Contractor: BeMo Tunnelling GmbH (BeMo)	Technical Data: Reconstruction of a single-track railway tunnel, parallel construction in the vicinity of the existing old tunnel Length of Tunnel: 936 m Excavation material: 114.000 m³ Mining technology: 871 m Declination max.: 12 ‰ Cut & Cover method ca. 65 m Coverage max.: 3 – 60 m Excavation: drill and blast, excavator Execution: reinforced waterproof cast-in-situ secondary lining, NATM, driving mostly ascending (West to East) in vicinity to the portals under pipe roofing
Project Location: Zierenberg, Hessen Germany	
Start of Construction: May 2015 End of Construction: February 2018	
Project Total Value: 21,497,058 €	Other Project Specific Information: Blasting in low distance to the existing, historical tunnel

PROJECT DATA SHEET

A9 PYHRN MOTORWAY, COMPLETION TUNNELKETTE KLAUS LOT 4, TUNNELS KLAUS AND TRAUNFRIED

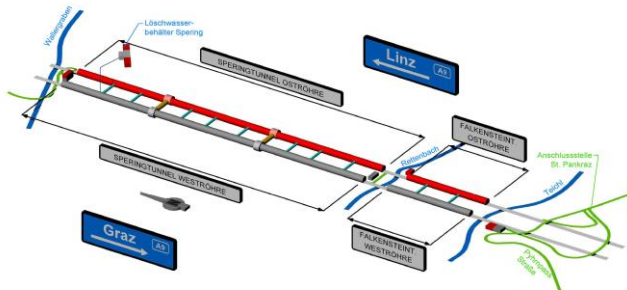


all graphics: ASFINAG / http://www.asfinag.at/unterwegs/bauprojekte/oberoesterreich/-/asset_publisher/1_47143/content/a-9-pyhrn-autobahn-vollausbau-tunnelkette-klaus

Client: Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaft (ASFINAG) Vienna	Geology: Northern Limestone Alps Mainly carbonate rocks of the middle and upper Trias. <u>Predominant nature of mountain:</u> Hillside debris/rubble (little in portal area); dolomite (ranging from low to heavily fragmented), Limestone (bulky up to heavily fragmented); Shale / clay marl,
Contractor: BeMo Tunnelling GmbH (BeMo) (technical sponsor) 50 % in JV with Wayss & Freytag Ingenieurbau AG (commercial sponsor)	Technical Data: <u>Completion Tunnelkette Klaus:</u> Completion of the A9 Pyhrn-motorway with creation of the tunnels Klaus and Traunfried, construction of the tunnel entrances and adaptation of the service turnaround lane Pertlgraben. <u>Lot 4:</u> Tunnel Klaus, Easttube total length: 7,106 ft/2,166 m Intermediate heading Frauensteinerstraße North Portal, Open cut tunnelling North (91+229 ft/28+70 m), Cut & Cover method (36 m/118 ft), Mining technique (1,857m/6,092.5 ft), tunnelroof already driven (emergency escape), bench and invert excavation, interior works Tunnel Traunfried, Easttube total length: 2,467 ft/752 m Roof, bench and invert excavation, interior works In addition: Electro-technics, remodelling of the Klaus elevated tank, fire water supply, operating stations and collectors, water pollution control facility The bridges (lots 1-3) and road works (lot 7) are built either in advance or simultaneously to the tunnel objects.
Project Location: Klaus a. d. Pyhrnbahn Austria	
Start of Construction: April 2015 End of Construction: structural works: January 2017 opening for traffic: September 2017 Project Total Value: 31,000,000 €	

PROJECT DATA SHEET

A9 PYHRN MOTORWAY, COMPLETION TUNNELKETTE KLAUS LOT 5, SPERING- AND FALKENSTEINTUNNEL



GRAFIK: ASFINAG



Client: Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaft (ASFINAG) Vienna	Geology: Northern Limestone Alps Mainly carbonate rocks of the middle and upper Trias. <u>Predominant nature of mountain:</u> Hillside debris/rubble (little in portal area); dolomite (ranging from low to heavily fragmented), Limestone (bulky up to heavily fragmented); Shale / clay marl, Windischgarstener disturbance (mainly Sperringtunnel)
Contractor: BeMo Tunnelling GmbH (BeMo) (TGF) 50 % in JV with Wayss & Freytag Ingenieurbau AG (KGF)	Technical Data: <u>Completion Tunnelkette Klaus:</u> Completion of the A9 Pyhrn-motorway within km 27.9+40 and 36.5+50 with creation of additional escape and emergency ways while ongoing traffic. <u>Lot 5:</u> Sperringtunnel Easttube total length: 2,894 m <ul style="list-style-type: none"> • Bench and invert excavation on the total length • Enlargement of two breakdown bays (each 60 m) • Removal of the existing base profile • Interior Construction • 8 accessible cross passage, approx. 16 m² • 2 with emergency vehicle accessible, approx. 52 m² Falkensteintunnel, Easttube total length: 752 m <ul style="list-style-type: none"> • Excavation and securing (on overall cross-section), approx. 77 m² • Interior Construction • 2 accessible cross passage, approx. 16 m²
Project Location: Klaus a. d. Pyhrnbahn, Österreich	
Start of Construction: November 2014 End of Construction: structural works: October 2016 opening for traffic: September 2017	
Project Total Value: 35,000,000 €	

REDEVELOPMENT S16 ARLBERG ROADTUNNEL



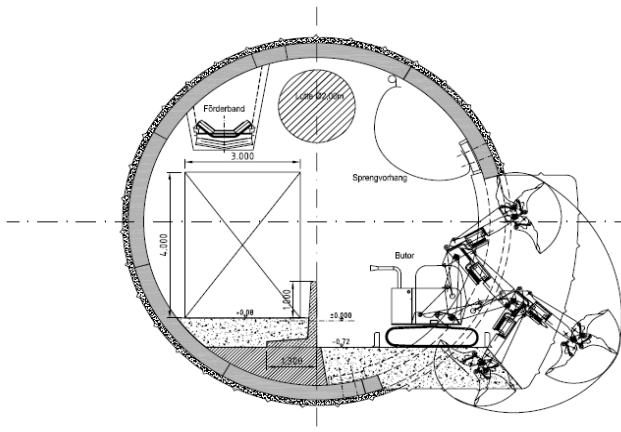
- Sprayed secondary lining on a sheeted membrane in the emergency bays, emergency tunnels and caverns.
- Installation of newest high-pressure water drizzle systems
- Complete renewal of the fire-water system

METRO „STADTBAHNTUNNEL“ KARLSRUHE



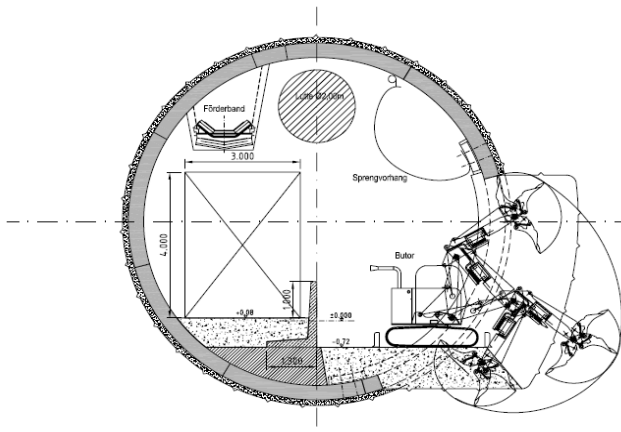
Client: Karlsruher Schieneninfrastruktur-GmbH (KASIG), Karlsruhe, Germany	Geology: <ul style="list-style-type: none"> Sediments from gravel and sand max overlay for tunnel drives 4-8 m Groundwater level from 4-5m below surface
Contractor: BeMo Tunnelling GmbH (BeMo) 100 % in JV "Stadtbahntunnel Karlsruhe" (BeMo-FCC)	Technical Data: <ul style="list-style-type: none"> 4.6 km metro project "Stadtbahntunnel" including double-track/triple-track and 7 underground stations Tunnel "Kaiserstraße" (double-track): 2,050 m <ul style="list-style-type: none"> Hydroshield Ø 9.3 m, lining with concrete segments Tunnel "Karl-Friedrich-Straße" (double-track including triple-track enlargements): 250 m <ul style="list-style-type: none"> Shotcrete-method (NATM) using compressed air (designed for up to 1.5 bar), Cast-in-situ concrete lining Cross-section: 80 – 180 m² Tunnels and ramps using open cut method: Ramps „Muehlburger Tor“, „Durlacher Allee“, „Ettlinger Strasse“ Tunnels „Ettlinger Strasse“, „Ettlinger Tor – Kongresszentrum“ Underground stations built in cut and cover method (Excavation and final concrete works under a 2 m thick steel reinforced cover)
Project Location: Karlsruhe, Germany	
Start of Construction: April 2010 Projected End of Construction: End of 2018	
Project Total Value: 443,330,000 € (incl. tunnelling: 102,290,000 €)	Other Project-Specific Information: <ul style="list-style-type: none"> Maintenance of traffic (tram, motorized private traffic, pedestrian) business operation and supply of energy, communication, water and sewer at any time Special heavy construction (pile walls, bulkheads, diaphragm walls, jet grouting, soft-gel injections, under water concrete, "GEWI"-piles, anchorages) between close surrounding property In-house detail design

NEW KAISER-WILHELM-TUNNEL (NKWT)



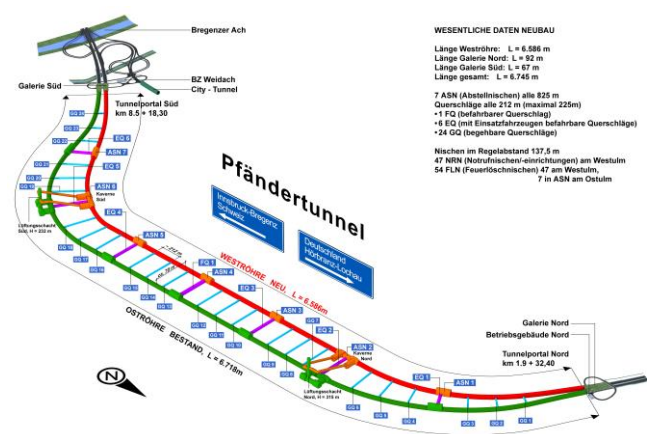
Client: DB Netz AG DB Projekt Bau GmbH, RB Mitte, Frankfurt/Main, Germany	Geology: Mainly Quaternary Sediments, talus material (soil), clay and rock (clay-slate, siltstone, fine sandstone with quartzite banks), water pressure approx. 3 bar
Contractor: BeMo Tunnelling GmbH (BeMo) sponsor in joint venture 99 % in JV "NKWT" (BeMo - FCC)	Technical Data: <ul style="list-style-type: none"> Single-track railway tunnel, 1 tube Total length of tunnel: 13,917.32 ft (4,242 m) <ul style="list-style-type: none"> Carinthian cut & cover South portal: 65.62 ft (20 m) Cross section: 862.40 SF (80.12 m²) 8 Cross-passages to the Old Kaiser-Wilhelm-Tunnel with diverse cross-sections (15 – 25 m²) Excavation by TBM (EPB Ø=10,15 m), cross-passages and starting-section by excavator, partly preparatory blasting (vibrations <10mm/s allowed) Spoil removal (rail only) limited to 1.000 m³/day Execution by TBM (EPB), lining with pre-cast concrete segments, starting-section by carinthian cut & cover method, NATM Sinking of shafts Ø approx. 6.5 m / depth approx. 13.0 m Grouting in the area of low cover (3,5 m) Cut & Cover approx. 40 m
Project Location: Rail line 3010, "Mosel line" Koblenz – Trier Ediger-Eller – Cochem/Mosel, Mosel river area, Germany	
Start of Construction: September 2009 End of Construction: September 2013	
Project Total Value: 78,587,200.00 €	Other Project-Specific Information: <ul style="list-style-type: none"> Structural Analysis and Detailed Design (work & as-built drawings) by BeMo's Tunnel Design Department Parallel construction in the vicinity of the existing old tunnel Underpassing the city of Cochem (cover approx. 3 - 28 m)

NEW KAISER-WILHELM-TUNNEL (NKWT)



Client: DB Netz AG DB Projekt Bau GmbH, RB Mitte, Frankfurt/Main, Germany	Geology: Mainly Quaternary Sediments, talus material (soil), clay and rock (clay-slate, siltstone, fine sandstone with quartzite banks), water pressure approx. 3 bar
Contractor: BeMo Tunnelling GmbH (BeMo) sponsor in joint venture 99 % in JV "NKWT" (BeMo - FCC)	Technical Data: <ul style="list-style-type: none"> Single-track railway tunnel, 1 tube Total length of tunnel: 13,917.32 ft (4,242 m) <ul style="list-style-type: none"> Carinthian cut & cover South portal: 65.62 ft (20 m) Cross section: 862.40 SF (80.12 m²) 8 Cross-passages to the Old Kaiser-Wilhelm-Tunnel with diverse cross-sections (15 – 25 m²) Excavation by TBM (EPB Ø=10,15 m), cross-passages and starting-section by excavator, partly preparatory blasting (vibrations <10mm/s allowed) Spoil removal (rail only) limited to 1.000 m³/day Execution by TBM (EPB), lining with pre-cast concrete segments, starting-section by carinthian cut & cover method, NATM Sinking of shafts Ø approx. 6.5 m / depth approx. 13.0 m Grouting in the area of low cover (3,5 m) Cut & Cover approx. 40 m
Project Location: Rail line 3010, "Mosel line" Koblenz – Trier Ediger-Eller – Cochem/Mosel, Mosel river area, Germany	
Start of Construction: September 2009 End of Construction: September 2013	
Project Total Value: 78,587,200.00 €	Other Project-Specific Information: <ul style="list-style-type: none"> Structural Analysis and Detailed Design (work & as-built drawings) by BeMo's Tunnel Design Department Parallel construction in the vicinity of the existing old tunnel Underpassing the city of Cochem (cover approx. 3 - 28 m)

PFAENDERTUNNEL, SECOND TUBE



Client: ASFiNAG Bau Management GmbH	Geology: „Molasse“ consisting of conglomerate, sandstone, marl-sandstone, marl and clay-marl, soil
Contractor: BeMo Tunnelling GmbH (BeMo)	Technical Data: <ul style="list-style-type: none"> Double-lane motorway tunnel, 1 tube <ul style="list-style-type: none"> Total length main tunnel: 6,744 m Excavation – soil (mining): 100 m Cross-section: approx. 112 m² 16 Crosspassages (CP) approx. 700 m <ul style="list-style-type: none"> 1 CP for vehicles (FQ: 48.84 – 55.74 m²) 6 CPs for emergency vehicles (EQ: 32.4 – 41.5 m²) 9 Crosspassages (GQ – 13.80 – 17.88 m²) 7 lay-by enlargements - length: 5 x 40 m, 2 x 80 m 4 ventilation caverns: length each 35 m 4 inclined tunnels (32.5 %): 29.04 – 37.97 m² Execution by Single Shield TBM, lining with concrete segments, crosspassages and soil by mining, NATM
Project Location: Rheintalautobahn A14, Bregenz - Lochau, Vorarlberg Austria	
Start of Construction: October 2007 Excavation (soil) - conventional: February 2008 Excavation starting section: April 2008 – September 2008 Excavation TBM: September 2008 – November 2009 End of Construction: February 2013	
Project Total Value: 129,985,241 €	Other Project-Specific Information: <ul style="list-style-type: none"> First road tunnel in Austria to be built by TBM; TBM: Ø 11.92 m, 180 m total length, 4,800 kW 4 ventilation caverns with 4 inclined tunnels to the existing ventilation-shafts Sprayed concrete lining (shotcrete) in breakdown bays; Galleries North and South incl. noise protection Service building North; water protection facilities North and South

OLD MAINZER TUNNELS MODERNISATION/RECONSTRUCTION



Client: DB Projekt Bau GmbH, NL Mitte, DB Netz AG, Frankfurt/Main Germany	Geology: Silt, clay (tertiary sequence)
Contractor: BeMo Tunnelling GmbH (BeMo) (formerly: Beton- und Monierbau)	Technical Data: <ul style="list-style-type: none"> • Enlargement and rebuilding of two existing double-track railway tunnels under full closure of operation • Length „Mainz Central Station Tunnel“: 662 m • Pipe roofing West/East portal each: 20 m • Length „Mainz South Tunnel“: 246 m • Pipe roofing West portal: 20 m • Carinthian cut & cover East portal: 20 m • Cross-section: 126 m² • Enlargement of existing tunnels (enlargement structure gauge: from 42 m² to 74 m²) using compensation-grouting (radial comprehensive grouting – BeMo special proposal), excavation support with reinforced shotcrete, reinforced waterproof inner lining
Project Location: Mainz Central Station, Mainz Germany	
Start of Construction: March 2007 End of Construction: June 2009	
Project Total Value: 36,340,000 €	Other Project-Specific Information: <ul style="list-style-type: none"> • Structural Analysis and Detailed Design (work & as-built drawings) by BeMo's Tunnel Design Department • Underpassing partly densely populated area • Renewal of Superstructure (drainage-system and cable lines)

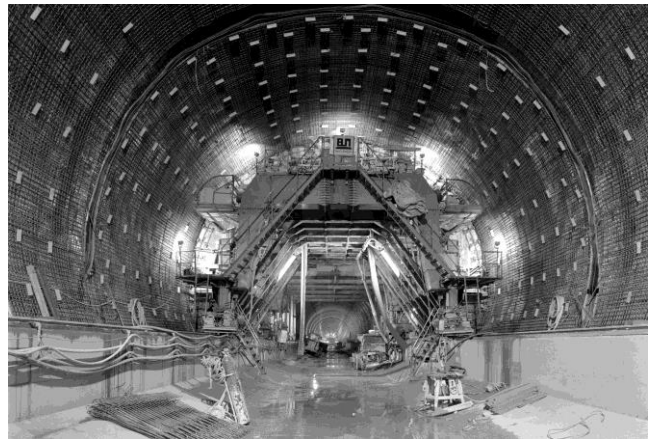
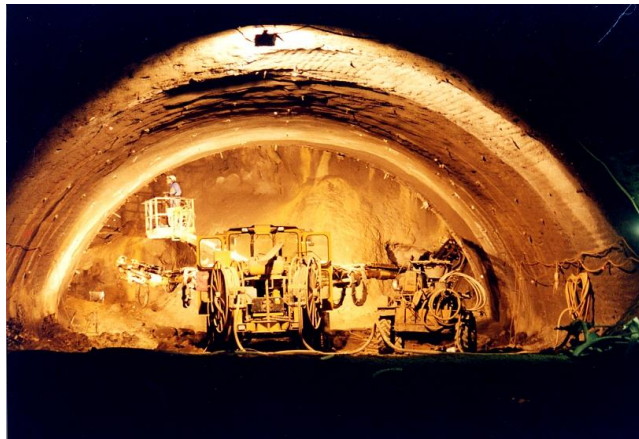
REINSTATEMENT / UPGRADE ARLBERGRAILWAYTUNNEL



Client: ÖBB Infrastruktur Bau AG, Vienna, Austria	Geology: Gneiss, phyllite, raibler layers
Contractor: BeMo Tunnelling (formerly: Beton- und Monierbau) Co-technical sponsor in joint venture 15% in JV "Arlbergbahntunnel ABT" (Rhombert – BeMo – Porr – Eiffage-Rail)	Technical Data: <ul style="list-style-type: none"> Reinstatement and enlargement of an existing double-track railway tunnel under operation Total length of tunnels: 10,250.00 m 6 Escape tunnels (Cross-passages - CP) <ul style="list-style-type: none"> each CP incl. 12 m tunnel 6 U-turn niches (Cross-passages - CP) <ul style="list-style-type: none"> each CP incl. 12 m niche Cross-section: 53.60 m² Access tunnel (cut&cover concrete box): 20 m (6m x 4.2 m) Shotcrete sealing - full: 1,600.00 m Shotcrete sealing - partial: 3,000.00 m Drains: 13,000.00 m² Enlargement, invert enlargement Ballast-free concrete track slab system („Feste Fahrbahn“) including turn-outs
Project Location: Langen am Arlberg, Vorarlberg, Austria	
Start of Construction: September 2005 End of Construction: 2010	
Project Total Value: 100,000,000 €	Other Project-Specific Information: <ul style="list-style-type: none"> Provision of logistics, trains for the execution of work with drivers, engines with train drivers and flagmen by the contractor.

PROJECT DATA SHEET

EGGETUNNEL



Client: Deutsche Bahn AG	Geology: Clay and marl (water columns above tunnel crown > 20 m)
Contractor: BeMo Tunnelling GmbH (BeMo) (formerly: Beton- und Monierbau) technical sponsor in joint venture 45 % in JV „Eggequerung“ (BeMo - Martin Rose - Himmel und Papesch - Gerdum und Breuer - Rohde - Stutz)	Technical Data: <ul style="list-style-type: none"> • Double-track railway tunnel, 1 tube • Tunnel length: 2,880 m • Excavation: 2,800 m • Cross section: 120 – 140 m² • Excavation by drill and blast / excavator with shotcrete support • Secondary lining: Watertight cast-in-situ concrete with reinforcement
Project Location: Willebadessen, Germany	
Start of Construction: January 1998 End of Construction: March 2003	Other Project-Specific Information: <ul style="list-style-type: none"> • Using a vacuum plant due to high inflow of water • Using a pipe roofing (roof pipe umbrella) • 5.6 km (2 x 2.8 km) ballastless concrete track slab system 'Rheda 2000' - subcontractor Heilit & Woerner • Track superstructure: Martin Rose GmbH & Co KG • Earthworks: Stutz GmbH & Co KG
Project Total Value: 65,000,000 €	



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Tunnel Spitzenberg, Reichensachsen (D)



Perjentunnel, Redevelopment First Tube (A)

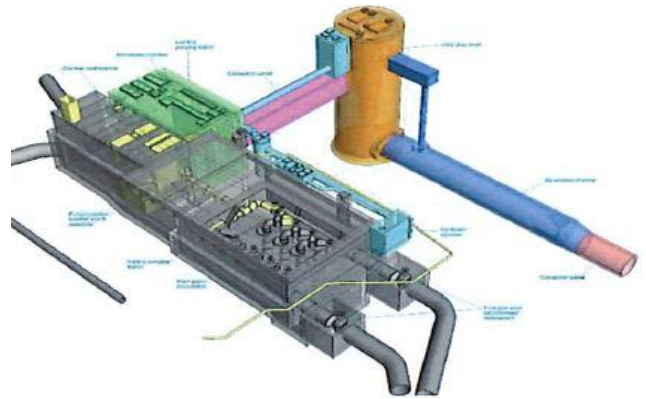


Plymouth Tunnel, Silver Spring, Maryland (USA)



Hydropower Plant Argenbach (A)

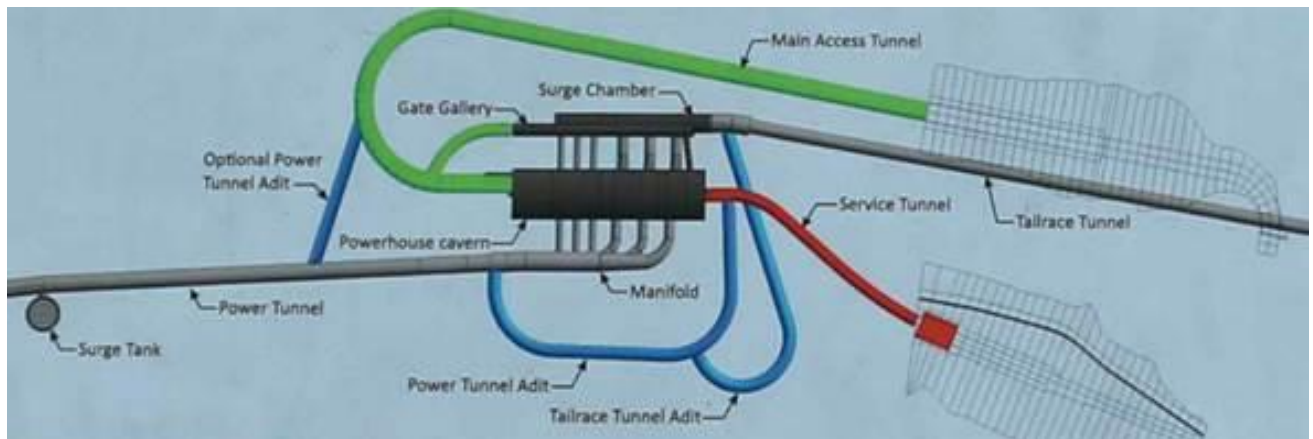
THAMES TIDEWAY TUNNEL PROJEKT, TIDEWAY WEST, LONDON



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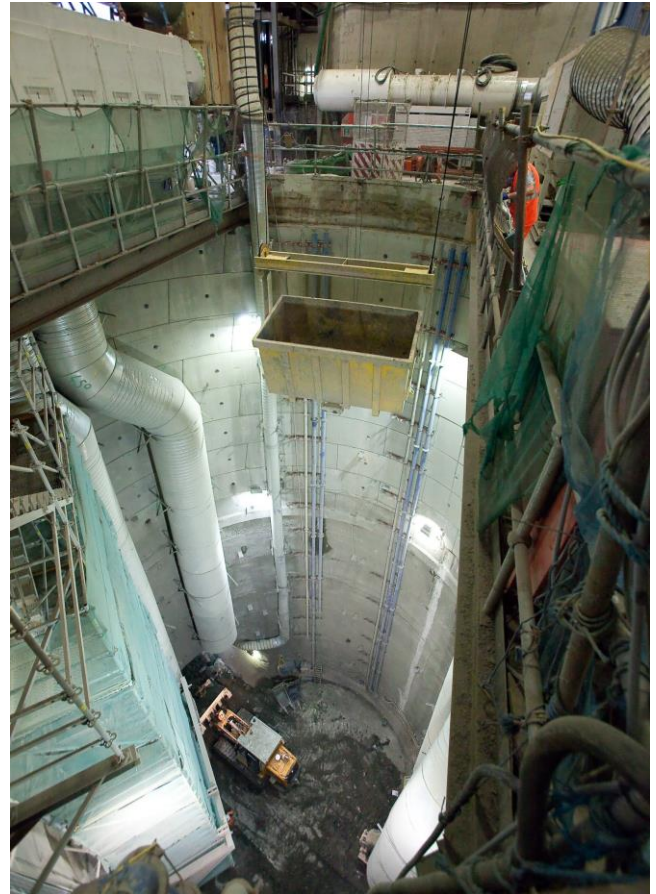
PROJECT DATA SHEET

JOHN HART GENERATING STATION REPLACEMENT



Client: BC Hydro	Geology: Sand, cobbles, boulders, wood, hard rock (basalt)
Contractor: Main Contractor: Inpower BC Tunnelling Contractor: Frontier-Kemper Constructors, Inc. Consultant for SEM / NATM works: BeMo Tunnelling Canada Inc. (as consultant for execution of NATM tunneling works in an unexpected soft ground zone; Technical support, Senior NATM Engineer and superintendents on site)	Technical Data: Power Tunnel: Total length: 1250 m Measures: 8.3 m high; 8.1 m wide Tailrace Tunnel: Total length: 400 m Measures: 10.7 m high; 6.5 m wide Main Access Tunnel: Total excavation: 300,000 m³ Measures: 7.5 m high; 9.5 m wide BeMo's work zone: 60 m long soft ground zone consisting of weak rock and sand After surprisingly entering a soft ground zone (sand, gravel, cobbles) excavation applying SEM / NATM using pipe arch canopies, spiling, face bolts, grouted face bolts, elephants feet in combination with shotcrete (dry/wet) as tunnel pre support.
Project Location: Campbell River, British Columbia, Canada	
Start of Construction: July 2015 (BeMo) End of Construction: May 2016 (BeMo)	
Project Total Value: 1,018,000 €	Other Project-Specific Information: Extreme mixed face conditions with loose sand required intense application of pipe roofing in double layers including ground improvement by using grouting via endcaps and via double packers with microfine cement. Dewatering measures by applying gravitational methods and vacuum dewatering.

C510 WHITECHAPEL AND LIVERPOOL STREET STATION TUNNELS



Client: Crossrail Ltd., London, UK - wholly owned subsidiary of Transport for London (TfL)	Geology: London clay, partly Lambeth Group, rarely River Terrace Deposits			
Contractor: BeMo Tunnelling GmbH (formerly: Beton- und Monierbau) in Joint Venture 10 % in BBMV JV (Balfour Beatty, Morgan Sindall and Vinci)	Technical Data: <p>Crossrail Contract C510 comprises the construction of two new inner city underground railway stations at Liverpool Street (400 m) and Whitechapel (560 m) including the Crossover at Vallance Road. The stations consist of construction shafts, platform and concourse tunnels, countless passages for access and ventilation some of which are inclined, and a link passage from the Crossrail Liverpool Street Station to the London Underground Northern Line at Moorgate Station. The two caverns at Vallance Road Crossover are the largest tunnels ever built in London Clay using Sprayed Concrete Lining (SCL). The works also include the construction of two geotechnical adits at Liverpool Street Station and one shaft at Whitechapel Station for compensation grouting.</p> <p>All underground structures were constructed by means of SCL as primary lining, using LaserShell™ and TunnelBeamer™. For the inclined passages a purpose built award winning ‘Uphill Excavator’ was used.</p> <p>Secondary Lining – at invert: at invert waterproof sheet membrane and cast in-situ concrete; – at vault: sprayed waterproof membrane and SCL</p>			
Project Location: London, UK				
<table border="0"> <tr> <td>Start of Construction:</td> <td>January 2011</td> </tr> <tr> <td>End of Construction:</td> <td>December 2017</td> </tr> </table>		Start of Construction:	January 2011	End of Construction:
Start of Construction:	January 2011			
End of Construction:	December 2017			
Project Total Value: 600,000,000.00 € (approx. GBP 500 million, NEC3 base tender value)	Other Project-Specific Information: <ul style="list-style-type: none"> • Structural Analysis and design work for execution of primary lining and participation in OCI-Phase (Optimised Contractor Involvement) by BeMo's Tunnel Design Department • Partnering Project (NEC3-Contract, Option C, Target contract with activity schedule) 			

SPILLVATTENTUNNEL LERUM-PARTILLE



Client: GRYAAB AB, Gothenburg, Sweden	Geology: <ul style="list-style-type: none"> Granodiorite, granitic gneiss, amphibolite Lowering of ground water table was not allowed
Contractor: BeMo Tunnelling GmbH (BeMo) (formerly: Beton- und Monierbau)	Technical Data: Construction of a sewer Sewer gallery ("Spillvattentunnel" – SVT) <ul style="list-style-type: none"> Total length of SVT: 8,000 m Cross-section SVT: 11 m² Access tunnel <ul style="list-style-type: none"> Total length: 320 m Inclination: 15 % Cross-section: 21,5 m² Cavern length/high/width: 286 / 5 / 8 m Excavation volume: 100,000 m ³ Execution: drill and blast, comprehensive grouting grouting umbrellas 21 m long with an distance of 15 m between them Support: steel fibre shotcrete, reinforced and unreinforced
Project Location: Gothenburg, Sweden	
Start of Construction: March 2007 Excavation access tunnel: April 2007 Excavation SVT: November 2007 End of Construction: December 2010 Excavation access tunnel: October 2007 Excavation SVT: June 2010	
Project Total Value: approx. 30,000,000 € (SEK 280,021,000)	Other Project-Specific Information: <ul style="list-style-type: none"> Miscellaneous concrete works (portals each at SVT and Access Tunnel), short open cut, enlargements Cover to ground level: 5 m – 10 m Special attention was required in sections where the tunnel passed under residential areas with drilled fresh water or energy wells and below streams.

PROJECT DATA SHEET

TRÖINGEBERG TUNNEL



Client: Banverket Västra Banregionen (Swedish Railway Authority Western Region) Sweden	Geology: Gneiss, Amphibolite
Contractor: BeMo Tunnelling GmbH (BeMo) Partner in joint venture 50 % in JV (BeMo - Aarsleff)	Technical Data: <ul style="list-style-type: none"> • Double-track railway tunnel, 1 tube • Tunnel length: 1,170 m • Cross-section: 125 m² • evacuation tunnel: 150 m • Cross-section: approx. 25 m² • Approx. 2,350 m open tracks, partly on dam, partly in open cuts • Drill & blast method, Full face excavation underneath residential area, Comprehensive grouting / no inner lining
Project Location: Heberg, Falkenberg Sweden	
Start of Construction: July 2005 Start of excavation tunnel: September 2005 End of Construction: 2007 Breakthrough tunnel: March 2007	
Project Total Value: approx. 22,000,000 € (approx. SEK 202,000,000)	Other Project-Specific Information: <ul style="list-style-type: none"> • Long project duration (works have to be performed in 2 shift operation only 5 days per week. • Main challenge: tunnel drive close to residential housing (overburden in the range of 15 – 30 m) • 2 tunnel portals main tunnel • 1 tunnel portal evacuation tunnel • 1 small pedestrian bridge

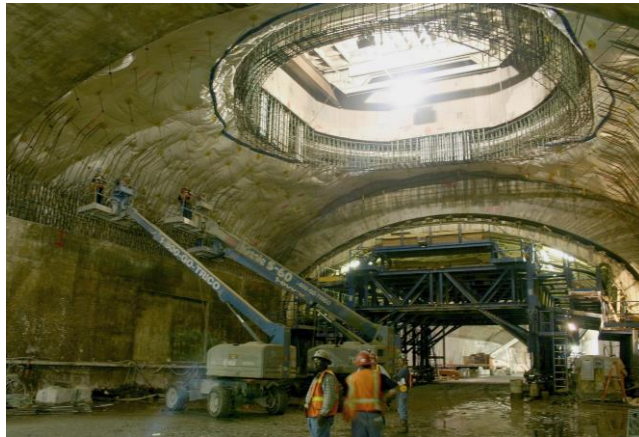
KINGS CROSS STATION REDEVELOPMENT



Client: London Underground Ltd. - LUL (formerly: Metronet Rail SSL Ltd., London, UK	Geology: London clay
Contractor: BeMo Tunnelling (formerly: Beton- und Monierbau) in joint venture with Morgan Sindall (formerly: Morgan=Est) 40 % in Morgan BeMo JV (MBJV)	Technical Data: <ul style="list-style-type: none"> Complex Underground Construction (Underground passenger hub, metro tunnels, shafts and passages) connecting existing metro-lines and stations between St. Pancras, Kings Cross Railway and Metro Station. Shotcrete (LaserShell™) used for permanent structures, Spheroidal-Graphite Cast Irons Lining (SGI-Lining). Passenger tunnels: 902.23 ft (275 m) Cross-section: 199.13 SF – 699.65 SF (18.5 m² - 65 m²) Escalator barrels: 246.06 ft (75 m) Cross-section: 882.64 SF (82 m²) Methods: Shotcrete Tunnelling, LaserShell™, SGI-Lining
Project Location: London, UK	
Start of Construction: 2002 (ITP, early works) End of Construction: 2008	
Project Total Value: 110,880,000 €	Other Project-Specific Information: <ul style="list-style-type: none"> Partnering Project (NEC-Contract, Option D, Target contract with bill of quantity) Challenging conditions due to construction in the vicinity of existing metro-lines under operation. Overburden 6 m – 25 m

PROJECT DATA SHEET

WEEHAWKEN TUNNEL, BERGENLINE AVE. STATION



Client: New Jersey Transit Corporation	Geology: Granite
Main Contractor: Washington Infrastructure Group (formerly: Raytheon Infrastructure) Contractor: Beton- und Monierbau USA, Inc. Partner in joint venture 15% in JV „Frontier-Kemper / Shea / Beton- und Monierbau)	Technical Data: <ul style="list-style-type: none"> Construction of an underground railway-station with vertical-shaft-access Reinstatement and enlargement of existing track railway tunnel Total length of tunnel: 1,200 m (3,937.01 ft) Underground station length: 280 m (918.64 ft) Station Cross-section: 188 m² (2,023.62 SF) Execution by drill & blast, demolition of old brick-lining using tunnel-excavator, shotcrete support, NATM
Project Location: Weehawken, New Jersey USA	
Start of Construction: 2002 End of Construction: 2006 Project Total Value: approx. 145,600,000 €	

Other Project-Specific Information: <ul style="list-style-type: none"> New underground station (shaft, surface ticket hall) Excavation, securing, re-cabling and expansion of tunnel Sprayed concrete lining (shotcrete), NATM
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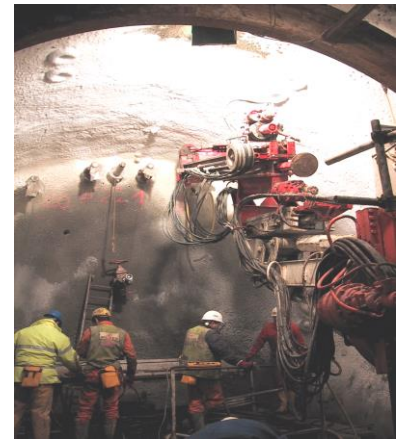
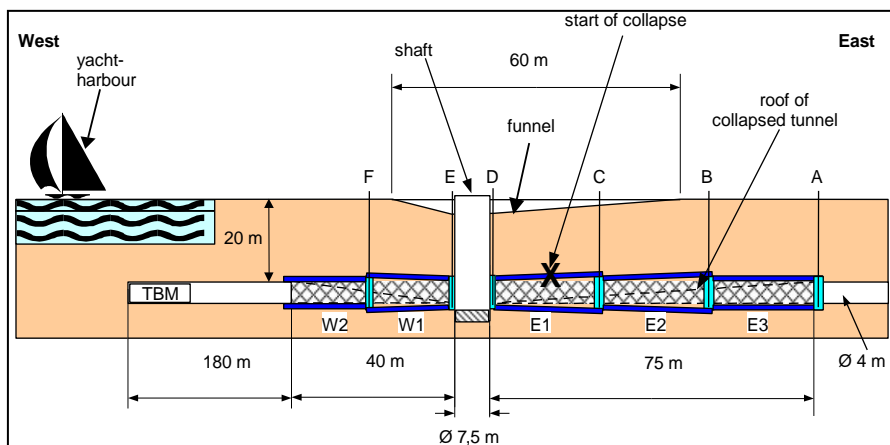
PROJECT DATA SHEET

RUSSIA WHARF TUNNEL, SOUTH BOSTON PIERS TRANSITWAY, CONTRACT E02CN15, BOSTON, MASSACHUSETTS



Client: Modern Continental Companies Inc. (as contractor of the Massachusetts Bay Transportation Authority – MBTA), Massachusetts, USA	Geology: Fill, Organic Clay, Marine Clay, Glacial Till						
Contractor: Beton- und Monierbau USA Inc. (100 % subsidiary of BeMo Tunneling GmbH) Partner in Joint venture 50 % in JV "Modern-Continental / BeMo USA"	Technical Data: Double-lane road tunnel Intersection (binocular) of 2 single-lane tubes <table> <tr> <td>Total length of tunnel:</td><td>653.54 ft</td></tr> <tr> <td>2 drives, length each</td><td>326.77 ft</td></tr> <tr> <td>Cross-Section „binocular“:</td><td>559.72 + 441.32 = 1001.04 SF</td></tr> </table> <ul style="list-style-type: none"> Excavation by SEM / NATM tunnelling in conjunction with ground freezing Inner lining with shotcrete using steel fiber concrete Waterproofing with 2 mm PVC membrane 	Total length of tunnel:	653.54 ft	2 drives, length each	326.77 ft	Cross-Section „binocular“:	559.72 + 441.32 = 1001.04 SF
Total length of tunnel:	653.54 ft						
2 drives, length each	326.77 ft						
Cross-Section „binocular“:	559.72 + 441.32 = 1001.04 SF						
Project Location: Boston, MA, USA							
Start of Construction: 2002 End of Construction: 2004							
Project Total Value: 16,200,000 €	Other Project-Specific Information: <ul style="list-style-type: none"> Undermining of settlement-sensitive timber foundation support piles of historical buildings in the area of the historical Boston Harbour. The tunnelcrown was only 17.72 ft beneath the structures basement level. 						

HULL UWWTD, T3 TUNNEL RECOVERY PROGRAM



Client: Yorkshire Water	Geology: Very soft alluvial ground build up in various layers of fine windblown sands, silt, clay, peat clay and gravel. Ground water pressure about 2 bar.
Main Contractor: Morgan Sindall (formerly: Morgan=est resp. Miller Civil Engineering)	Technical Data: <ul style="list-style-type: none"> Tunnel length: 405.18 ft (123.50 m) Cross section: 219.58 SF (20.40 m²) NATM excavation in frozen ground with tunnel excavator and shotcrete support Secondary lining: reinforced shotcrete with waterproofing
Contractor: BeMo Tunnelling GmbH (BeMo) (formerly: Beton- und Monierbau) Design, Technical Support, Supervision	
Project Location: Hull, UK	Other Project-Specific Information: <ul style="list-style-type: none"> NATM excavation in extremely challenging ground conditions. Repair of a collapsed segmental-lined TBM-tunnel. Structural analysis and design of artificially frozen soil and shotcrete works, design in partnership with client
Start of Construction: February 2000 End of Construction: August 2001 Project Total Value: 59,000,000 € (BeMo: 1.53 m€)	

NORTH DOWNS TUNNEL / MEDWAY CROSSING (CTRL 410/350) / HS1



Client: UNION RAILWAYS Ltd. (Rail Link Engineering) United Kingdom	Geology: Chalk
Contractor: BeMo Tunnelling GmbH (BeMo) (formerly: Beton- und Monierbau) Partner in joint venture 33.33 % in JV "Eurolink" (BeMo - Morgan - Vinci)	Technical Data: High speed railway tunnel, double-track, 1 tube (on railway line High Speed 1 – HS1) <ul style="list-style-type: none"> • Tunnel length: 3,290 m (Excavation 3,206 m) • Cross section: 140 – 160 m² • Excavation by roadheader and excavator with shotcrete support • Secondary lining: Cast in place concrete with reinforced invert and an unreinforced vault • Waterproofing: 2 mm PVC membrane High speed railway bridge, double-track <ul style="list-style-type: none"> • Bridge length: 1,261 m • Incremental launched bridge • Constructed using balanced cantilever and incremental launch techniques.
Project Location: Rochester, England, United Kingdom	
Start of Construction: October 1998 End of Construction: April 2002 August 2001 (tunnel excavation and lining)	Other Project-Specific Information: <ul style="list-style-type: none"> • Partnering Project (NEC-Contract, Option C, Target contract with activity schedule) • BeMo also responsible for the design of primary lining of the North Downs Tunnel • Earthworks North Downs Tunnel: 500,000 m³ • The Medway Bridge is the most complex prestressed concrete railway bridge in the UK
Project Total Value: 200,000,000 € (Tunnel and Bridge)	



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Project Datasheets International Know-How Transfer



Tunnel Spitzenberg, Reichensachsen (D)



Perjentunnel, Redevelopment First Tube (A)

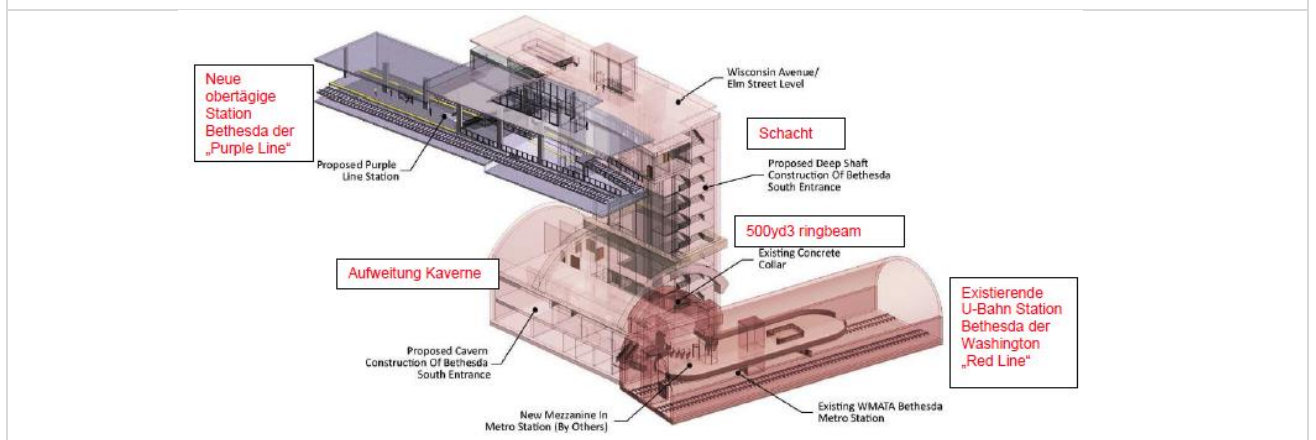
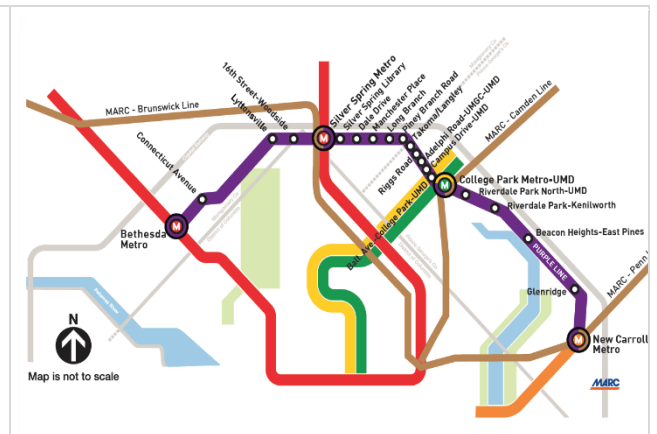
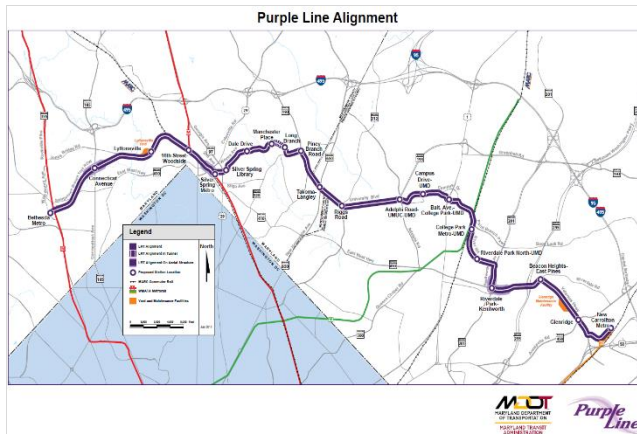


Plymouth Tunnel, Silver Spring, Maryland (USA)



Hydropower Plant Argenbach (A)

BETHESDA STATION, PURPLE LINE, BETHESDA, MARYLAND



Client: Maryland Department of Transportation/ Maryland Transit Administration Maryland, USA	Geology: Mainly competent rock
Contractor: Purple Line Partners (Fluor – Traylor JV) Consultant for SEM/ NATM: Beton- und Monierbau USA, Inc.: (100 % subsidiary of BeMo Tunnelling GmbH, Austria) 2 operating SEM/ NATM Superintendents during cavern excavation on site for appr. 10 months starting April 2020	Technical Data: <ul style="list-style-type: none"> Connecting cavern between Purple Line elevator shaft and existing Red Line (Washington DC Metro) Shaft: Complicated geometrical dimensions Depth: (33,5 m) 110 feet Cavern Dimensions: Length: (33,5 m) 110 feet Width: (21,4 m) 70 feet Height: (15,2 m) 50 feet Challenging blasting works (vibration issues, proximity of operating Metro, night limitations, etc.) Wet shotcrete application via 110 feet deep shaft
Project Location: Bethesda, Maryland USA	
Start of Construction: April 2020 End of Construction: expected January 2021	
Total Project Value: approx. 550,000 € (600,000 US\$)	Other Project-Specific Information: <ul style="list-style-type: none"> Urban surrounding in the center of Bethesda, Maryland (approx. 70,000 inhabitants) Know-how transfer of the New Austrian Tunnelling Method (NATM)

METRO LOS ANGELES, WESTSIDE EXTENSION, PHASE 1



Client: Los Angeles County Metropolitan Transit Authority, California, USA	Geology: Fernando and San Pedro formation, tar impacted sands
Main Contractor: Skanska-Traylor-Shea Joint Venture Consultant for SEM/NATM: Beton- und Monierbau USA, Inc. (100 % subsidiary of BeMo Tunnelling GmbH, Austria) 1 SEM/ NATM Superintendent on site for approx. 14 months	Technical Data: Know-how-Transfer Project of the New Austrian Tunnelling Method (NATM) at the Purple Line subway extension project in Los Angeles (westside extension underneath Wilshire Boulevard). The order includes construction consultancy for the excavation of cross-passages between two TBM-driven tubes. In the years 2016 and 2017 BeMo has already provided: <ul style="list-style-type: none"> • Design reviews • Equipment studies • SEM/ NATM - technical feasibility studies Technical details: <ul style="list-style-type: none"> • Support during excavation of 23 cross passages in very difficult ground conditions • ground improvement measures: jet grouting, dewatering, possibly freezing
Project Location: Wilshire Boulevard, Los Angeles, USA	
Period of BeMo Services: September 2019 – expected December 2020	
Total Project Value: approx. 400,000 € (470,000 US\$)	Other Project-Specific Information: <ul style="list-style-type: none"> • Site in urban, densely populated environment

REGIONAL CONNECTOR, CROSS OVER CAVERN, LOS ANGELES



Client: Los Angeles County, Metropolitan Transportation Authority USA	Geology: Fernando Formations									
Main contractor: Regional Connector Constructors (Skanska - Traylor JV) Consultant for SEM/ NATM: Beton- und Monierbau USA, Inc. (100 % subsidiary of BeMo Tunnelling GmbH, Austria) 1 SEM/ NATM – Senior Engineer, 1 SEM/ NATM - Superintendent during cavern excavation on site for approx. 10 – 12 months	Technical Data: <ul style="list-style-type: none">Provision of key personnel during SEM excavation and support of a cross over cavern, double side drift tunnel method1 pipe umbrella Length: 60 feet 2 layers of in total 54 pipesMeasures of cavern:<table><tr><td>Length:</td><td>287.22 feet</td><td>(87.54 m)</td></tr><tr><td>Width</td><td>approx. 58 feet</td><td>(17.60 m)</td></tr><tr><td>Height</td><td>approx. 36 feet</td><td>(11.00 m)</td></tr></table>Low overburden/ excavation underneath a lot of installations (storm sewer, gas, water, sewage etc.)Urban environment in downtown Los Angeles (undemeath W 2nd Street between S. Spring Street and S. Main Street)	Length:	287.22 feet	(87.54 m)	Width	approx. 58 feet	(17.60 m)	Height	approx. 36 feet	(11.00 m)
Length:		287.22 feet	(87.54 m)							
Width		approx. 58 feet	(17.60 m)							
Height	approx. 36 feet	(11.00 m)								
Project Location: Los Angeles, California USA										
Start of Construction: May 2018 End of Construction: April 2019										
Total Project Value: approx. 850,000 € (approx. 1,000,000 US\$)	Other Project-Specific Information: <ul style="list-style-type: none">Very challenging excavationfirst large-scale application of SEM/ NATM in Los Angeles									

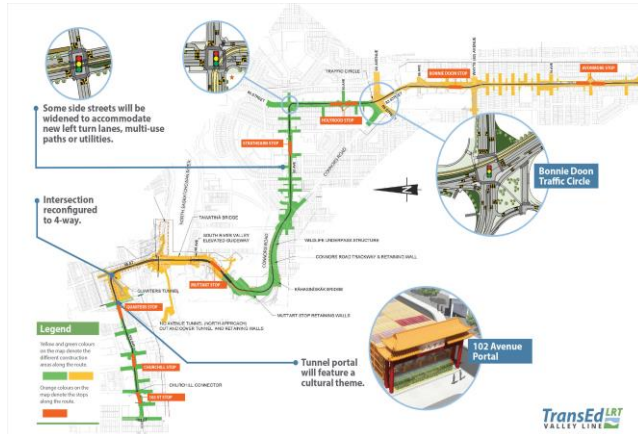
PLYMOUTH TUNNEL, PURPLE LINE, SILVER SPRING, MARYLAND



Client: Maryland Department of Transportation/ Maryland Transit Administration Maryland, USA	Geology: Top heading: Mixed face conditions consisting of sandy material on top and rock in the bottom; Bench/ invert: weathered to compact rock in different stages
Contractor: Purple Line Partners (Fluor – Traylor jv) Consultant for SEM/ NATM: Beton- und Monierbau USA, Inc.: (100 % subsidiary of BeMo Tunnelling GmbH, Austria) 2 operating SEM/ NATM Superintendents during tunnel excavation (top heading and bench/ invert) on site for 10 months plus 1 superintendent on site during execution of shotcrete inner lining (6 months)	Technical Data: <ul style="list-style-type: none"> Double track light rail tunnel as part of the Maryland Purple Line along the Northeast periphery of Washington DC Tunnel Length: (311 m) 1,020 feet SEM/ NATM top heading excavation followed by bench/ invert Liebherr LH950 tunnel excavator; Potenza shotcrete robots, E2C drill rig 2 pipe umbrellas (appr 40 pipes each) Length: (15,25 m) à 50 feet Systematic spiling over whole length of tunnel Challenging mixed face conditions require use of typical soft ground tunneling methods; excavation by tunnel excavator with bucket-, road header- and hammer attachments. Parts of invert had to be excavated using drill & blast method Application of wet shotcrete, batched with on site batching plant (Wiggert)
Project Location: Silver Spring, Maryland USA	
Start of Construction: May 2018 End of Construction: November 2019	
Total Project Value: approx. 992,750 € (1,092,025 US\$)	Other Project-Specific Information: <ul style="list-style-type: none"> The construction site is situated in a densely populated urban area Know-how transfer of the New Austrian Tunnelling Method (NATM)

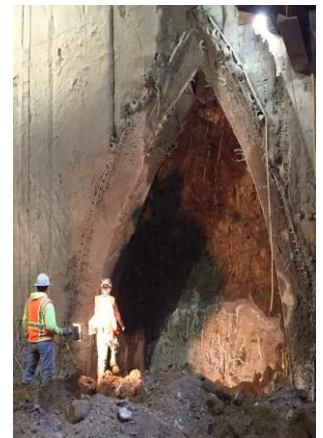
PROJECT DATA SHEET

QUARTERS TUNNEL, VALLEY LINE LRT, EDMONTON, CANADA



Client: City of Edmonton, Canada	Geology: Glacial Till partly permeated with water-bearing sand lenses (up to 1.5 m thick). Bedrock below Glacial Till with layers of carbon and bentonite.
Main Contractor: TransEd LRT (Bechtel-EllisDon Construction Joint Venture) Consultant for SEM/NATM: BeMo Tunnelling as Consultant for SEM/NATM: Supervision, Know-how Transfer, key personnel and plant on site; 1 Senior SEM/NATM Tunnel Manager/Engineer, 2 SEM/NATM Operating Superintendents, 1 SEM/NATM Surveyor (training of the site crew)	Technical Data: Know-how Transfer of the New Austrian Tunnelling Method (NATM) for the construction of an inner-city twin-tube tunnel. The Valley Line (LRT-System = Light Rail Transit) will connect the south-east with the west through downtown Edmonton by a 27 km long line including 25 stops. The first phase (13.1 km) will include the Quarters Tunnel at the intersection between 102 nd Avenue, Jasper Avenue and along the 95 th Street: <ul style="list-style-type: none"> • Southbound Tunnel Length: approx. 393.00 m • Northbound Tunnel Length: approx. 402.00 m • excavation by tunnel excavator SEM/NATM (ITC 312) • installation of pipe arch canopies at the tunnel portals The support contract contains the following services: <ul style="list-style-type: none"> • constructability reviews, plant studies and equipment selection • site set-up, ventilation requirements • assistance in ventilation issues and various SEM/NATM related issues • shotcrete mix design • machine rentals (ITC, drilling)
Project Location: Edmonton, Alberta, Canada	Other Project-Specific Information: <ul style="list-style-type: none"> • excavation of a tunnel in urban environment using SEM/NATM and spile umbrellas; shallow overburden (only 3.50 m) at the underpass of the intersection Jasper Ave • extreme weather conditions (up to -30°C)
Start of Construction: October 2016 February 2017 (tunnel drive) End of Construction: March 2018 Project Total Value: 1,985,332 EUR (2,900,000 CAD)	

CHINATOWN STATION, CENTRAL SUBWAY SAN FRANCISCO



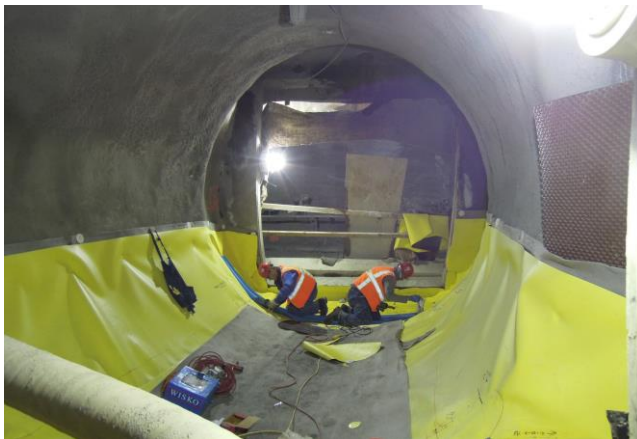
Client: City and County of San Francisco Municipal Transportation Agency (SFMTA)	Geology: Sandstone and weathered sandstone
Contractor: Main Contractor: Frontier-Kemper Constructors, Inc. Consultant for NATM / SEM works: BeMo USA Inc. as consultant for execution of NATM works. Technical support provided by Senior SEM Engineer and SEM Engineer + 2 SEM superintendents on site	Technical Data: Subway station in urban environment; Part of San Francisco's Central Subway Line Mined cavern beneath Washington/ Stockton Street (between Jackson and Clay Street) in San Francisco's most populated area; Main parts are: <ul style="list-style-type: none"> • Cross cut cavern • Platform caverns • Crossover cavern • 2 Emergency exits incl 1 emergency shaft Overall length of the mined cavern: 630 feet; Overburden between 55 and 85 feet; Application of sidewall tunnel drift method in combination with continuous presupport with pipe umbrellas Execution by tunnel excavator, road header attachment, wet shotcrete, spilling (rebar and grouted pipe spilling), face bolts, dewatering; tunnel pre-support by pipe roofing Application of NATM/SEM-side drift tunnel method over total length of Cross cut cavern, platform caverns North & South and Cross over cavern. Compensation grouting;
Project Location: San Francisco, CA, USA	
Start of Construction: December 2015 (BeMo) End of Construction: March 2018 (BeMo)	
Project Total Value: 2,500,000 € (2,650,000 US\$)	

FIRST STREET TUNNEL, WASHINGTON D.C. CLEAN RIVERS PROJECT



Client: D.C. Water & Sewer Authority, Washington, D.C., USA	Geology: Soft ground conditions, Sand, Silt and Clay
Main Contractor: Skanska – JayDee JV / WSP (formerly Parsons Brinckerhoff) as Lead Designer Consultant for SEM/NATM: Beton- und Monierbau USA, Inc. (100 % subsidiary of BeMo Tunnelling GmbH) Consultant for Designer WSP; Design-review for NATM-Adits in soft ground; consulting and technical support	Technical Data: Know-how-Transfer Project of the New Austrian Tunnelling Method (NATM) for the construction of the First Street Tunnel Project as a part of the D.C. Clean Rivers Project by D.C. Water. <ul style="list-style-type: none"> Design Review of all NATM-sections The tunnel will serve as storage for excess storm water Tunnel length: 2,700 feet (appr. 823,00 m) Tunnel diameter: 20 feet (appr. 6,10 m) Storage capacity: up to 9 mil gallons water (up to 34 mil litres)
Project Location: Washington, D.C., USA	
Period of BeMo Services: 05/2013 – 08/2014 Design and Construction Phases: 10/2013 – 12/2015 Design phase only: 10/2013 – 11/2014 Construction Phase only: 06/2014 – 12/2015	
Total Project Value: approx. 88,500 € (BeMo-share) 99,500 USD D.C. Clean Rivers Project – total: 1.9 billion € (2.6 billion USD) First Street Tunnel Project – total: 114 million € (157 million USD)	Other Project-Specific Information: <ul style="list-style-type: none"> Ground freezing as support of excavation Ice walls up to 10 feet thickness (appr. 3 m)

SEATTLE UNIVERSITY LINK LIGHT RAIL – CONTRACT U220



Client: Sound Transit, Regional Transit Authority, Seattle, WA, USA	Geology: Over-consolidated sand/clay, at some cross-passage locations more than 60 m overburden (ground water pressure 6 bar), partly additional measures necessary (spilling, vacuum dewatering, ground water lowering by means of surface wells, potentially gassy conditions)
Main Contractor: Traylor Frontier JV Consultant for NATM/ SEM: BeMo USA Inc., Reston, VA as consultant for execution of NATM cross-passages between two segmentally lined TBM tubes; Technical Support, Know-how transfer; Senior NATM Tunnel Engineer on site	Technical Data: <ul style="list-style-type: none"> 2 TBM tubes inner Ø 18.83 ft (5.74 m) length 2 x 9,842.52 (2 x 3,000 m) Excavation and support of 16 NATM cross-passages Cross sections approx. 20 - 30 m² (215.28 SF – 322.92 SF) Deep sump in one of the cross-passages Execution by mini excavator (Brokk, CAT) and attachment tools (shovels, road header, chisel); partly manual excavation Excavation of some cross-passages concurrent with TBM excavation Installation of shotcrete propping system in main tunnels All cross-passages located underground water table Waterproofing Secondary lining cast in situ / cast-in-place (CIP) concrete
Project Location: Seattle, WA, USA	
Start of Construction: November 2011 End of Construction: October 2012	
Project Total Value: approx. 315,000 € (410,000 USD)	

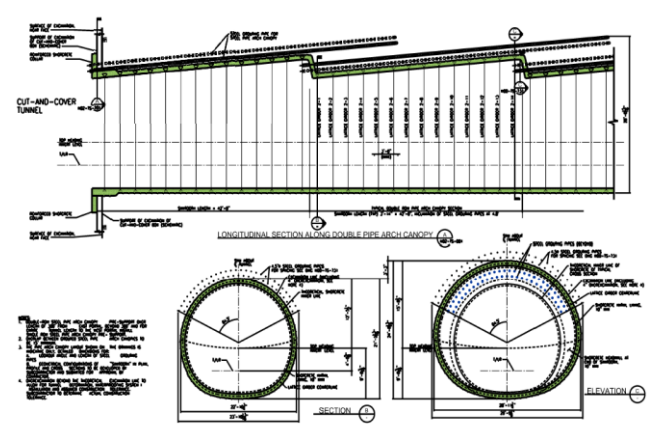
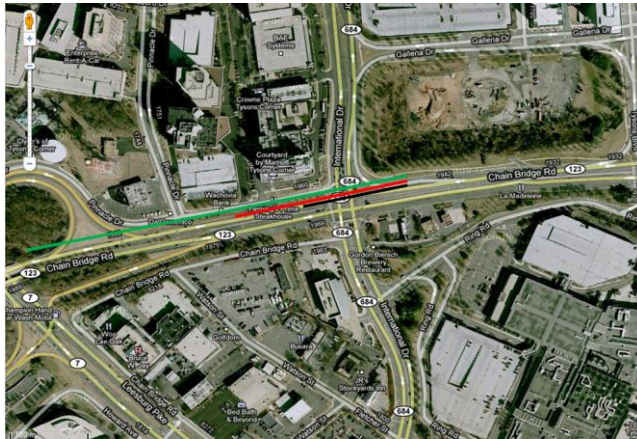
NEW YORK EAST SIDE ACCESS – CONTRACT CQ031



Client: Metropolitan Transit Authority MTA USA	Geology: Jet grouted soil
Main Contractor: Granite - Traylor - Frontier JV Consultant for 3-cell NATM crosspassage: BeMo USA Inc.: Essential design-input for 3-cell NATM crosspassage between Yard Lead Tunnel and Emergency shaft structure; Consulting and Technical Support during execution; Know-how transfer; two SEM/ NATM Tunnel Superintendents for around the clock coverage on site	Technical Data: <ul style="list-style-type: none"> • Essential design input for design of 3-cell crosspassage • Know-How-Transfer Project (application of SEM / NATM) for the construction of a 3-cell crosspassage between the segmentally lined Yard Lead Tunnel and a vertical concrete emergency shaft • 3 tunnel excavation phases (each approx. 16.4ft (5 m) in length) • 3 waterproofing / concrete phases • Cross sections: approx. 452.08SF / 301.39SF / 301.39SF (42 m²/ 28 m²/ 28 m²) • Excavation by mini excavator (Brokk) under spile umbrella and in jet grouted soil • Installation of steel frame "hamster cages" in main tunnel
Project Location: Long Island City, Queens, NY USA	
Start of Construction: June 2010 End of Construction: December 2012	
Project Total Value: approx. 500,000 € (650,000 USD)	Other Project-Specific Information: <ul style="list-style-type: none"> • Emergency shaft located in Amtrak area

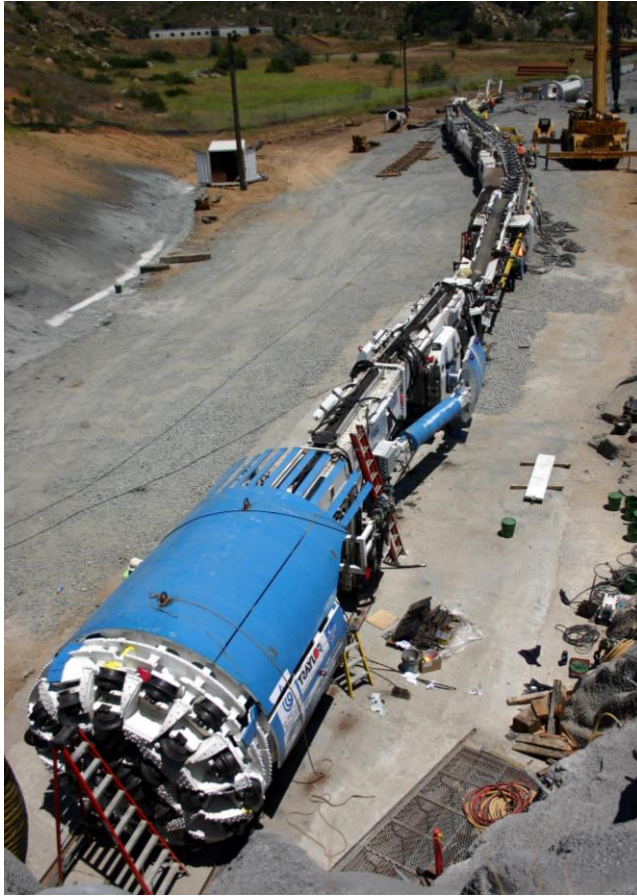
PROJECT DATA SHEET

NATM TUNNEL TYSONS CORNER, DULLES CORR. (DCMP)



Client: Metropolitan Washington Airport Authority (MWAA)	Geology: Costal plane and Piedmont sediments under shallow overburden
Main Contractor: Dulles Transit Partners LLC., Vienna, VA, USA Contractor: Beton- und Monierbau USA, Inc. (100% subsidiary of BeMo Tunnelling GmbH, Austria) specialised support for NATM soft ground tunnelling	Technical Data: <ul style="list-style-type: none"> Twin tube Metro tunnel (as part of an 11 miles Metro extension towards Dulles airport) Total length of tunnel: 2 x 1600 ft (2 x 500 m) Shallow overburden: 10 to 40 ft (3 to 12 m) only, with a main traffic Cross-Section (min): 390 SF (36.2 m²) This could be done only by applying a forepoling support (steel pipes for the canopy – pipe arch canopy), which created a specific sawtooth shape to the initial liner. The length of the pipes was 18 m and the sawtooth had 12 m. The general excavation and support sequence followed the principles of SEM/NATM The sawtooth was filled partially with shotcrete Waterproofing: 2 mm PVC membrane 40 blocks of the final liner were reinforced.
Project Location: Dulles Corridor Metrorail Project (DCMP), Tysons Corner, Virginia, USA	
Start of Construction: April 2009 End of Construction: December 2011	Other Project-Specific Information: <ul style="list-style-type: none"> Tunnel excavation undercrossing roads, utilities and hotels close-by Water-table approx. beyond springline Intensive ground monitoring
Project Total Value: 4,500,000 € (USD 6,100,000)	

EMERGENCY STORAGE PROJECT, SAN VICENTE PIPELINE



Client: San Diego County Water Authority (SCDWA), California, USA	Geology: Conglomerate below the water table, highly weathered granitic rock and hard granitic rock
Main Contractor: Traylor / Shea JV Consultant for NATM (Reach 5): Beton- und Monierbau as Consultant for Reach 5 (East and West): Design, Technical Support, Supervision, Know-how Transfer, Senior SEM/NATM Tunnel Engineer and SEM/NATM Tunnel Specialist Operator on site	Technical Data: <ul style="list-style-type: none"> Know-how Transfer for Reach 5 (East and West) Total length of the project: 17,454.00 m Diameter excavated: 3.50 m – 4.00 m Execution by hard and soft rock TBM, drill and blast, excavator in soft ground, back Reach 5 (5 East and West) <ul style="list-style-type: none"> - Total length of tunnel: 1,585.00 m - Execution by drill and blast 1,219.00 m - Execution by excavator 366.00 m - Diameter excavated (5E): 3.60 m - Diameter excavated (5W): 4.00 m
Project Location: San Diego, California, USA	
Start of Construction: January 2006 End of Construction: September 2006	
Project Total Value: approx. 500,000 €	

PROJECT DATA SHEET

BEACON HILL STATION PROJECT, C170



Client: Sound Transit, Central Puget Sound, Regional Transit Authority, Seattle, WA, USA	Geology: Highly variable glacial deposits including water bearing sands and silts approx. 50 ft below multiple perched water tables in an urban setting (very unique and challenging)
Main Contractor: Obayashi Corp. Consultant for SEM/NATM: BeMo Tunnelling as Consultant for SEM/NATM: Supervision, Know-how Transfer, SEM/NATM Tunnel Project Manager, SEM/NATM Tunnel Project Engineer and 3 SEM/NATM Tunnel Superintendents on site	Technical Data: <ul style="list-style-type: none"> Know-how Transfer of the Sequential Excavation Method (SEM)/New Austrian Tunnelling Method (NATM) for the construction of an underground station Main shaft with headhouse: 55 m (181 ft) deep x 15.8 m (52 ft) Ø Ancillary ventilation shaft with headhouse: 50.5 m (164 ft) deep x 9.3 m (30.5 ft) internal Ø Two platforms (north and south): 116.7 m (383 ft) long Two concourse cross-adits: 19.5 m (64 ft) long Tunnels excavated by SEM/NATM, excavator in soft ground with shotcrete lining and excavation in multiple drift sequences (ground conditioning and pre-support where needed). Final lining by cast-in-situ steel fiber-reinforced concrete with conventional bar reinforcement at junctions.
Project Location: Seattle, Washington, USA	Other Project-Specific Information: This deep "binocular" station is being mined through some of the most challenging soft ground conditions in the USA. The excavated volume of the station is approximately 60,000 cy (46,000 m³) and the station comprises a variety of geometries and cross sections ranging from 235 SF (22 m²) up to 1,670 SF (155 m²). This underground complex includes platform, concourse, cross-passage and emergency ventilation tunnels together with station egress and ventilation shafts. Various excavation sequences are in use for the different tunnels including the twin-sidewall drifts for the impressive 45 ft (13.7 m) wide by 42 ft (12.8 m) high concourse cross adits. This station has two train platforms approx. 165 ft (50 m) below the surface.
Start of Construction: June 2005 (SEM/NATM) End of Construction: April 2008 (X-passages SEM/NATM)	
Project Total Value: approx. 3,000,000 €	

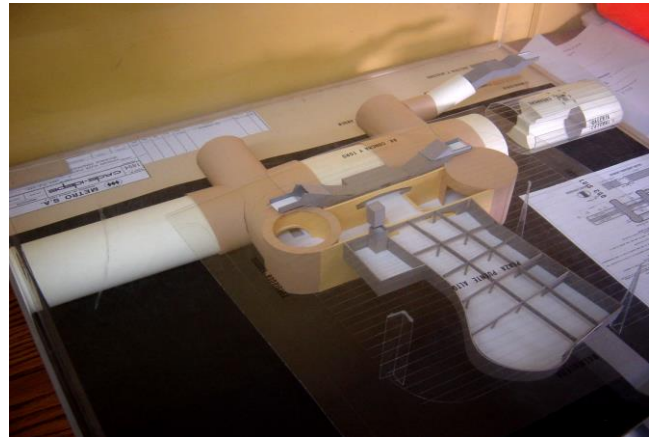
LOS ANGELES METRO GOLD LINE EASTSIDE EXTENSION



Client: Los Angeles County Metropolitan Transportation Authority, Los Angeles, California, USA	Geology: Alluvium, non-homogeneous sediment layers, medium dense clays to loose silts and sands, layer thicknesses 1-20 ft (0.3 - 6.1 m), methane gas, hydrogen, sulfide and methanol
Main Contractor: Traylor Frontier Kemper JV Consultant for NATM-Cross-Passages: BeMo Tunnelling as Consultant for NATM-Cross-passages: Design-input for NATM-Cross-Passages between TBM-Metro-Tunnels, Consulting and Technical support, Know-how Transfer, SEM/NATM Tunnel Engineer and SEM/NATM Tunnel Specialist Operators on site	Technical Data: <ul style="list-style-type: none"> • Know-how-Transfer Project of the New Austrian Tunnelling Method (NATM) for the construction of NATM-Cross-passages between segmentally lined twin tunnels • 6 Cross-passages: each approx. 36 - 38 ft (11 - 12 m) • Cross-section: 242.63 - 283.48 SF (22.54 - 26.34 m²) • Excavation by excavator under pipe arch (pipe roofing), installation of "hamster cages" in both tunnels • Execution by SEM/NATM
Project Location: Los Angeles, California, USA	Other Project-Specific Information: <ul style="list-style-type: none"> • Excavation 49.21 ft (15 m) below ground level • Sequential excavation in 3 - 9 ft (0.91 - 2.74 m) increments, top-heading, bottom-bench under pipe arch (pipe roofing), installation of "hamster cages" in both tunnels • Most cross-passages are located under the water table, and up to 1.5 bar of hydrostatic pressure
Start of Construction: 2005 End of Construction: 2007 On-site support: 09/2006 – 04/2007	
Project Total Value: approx. 474,000 € (610,000 USD)	

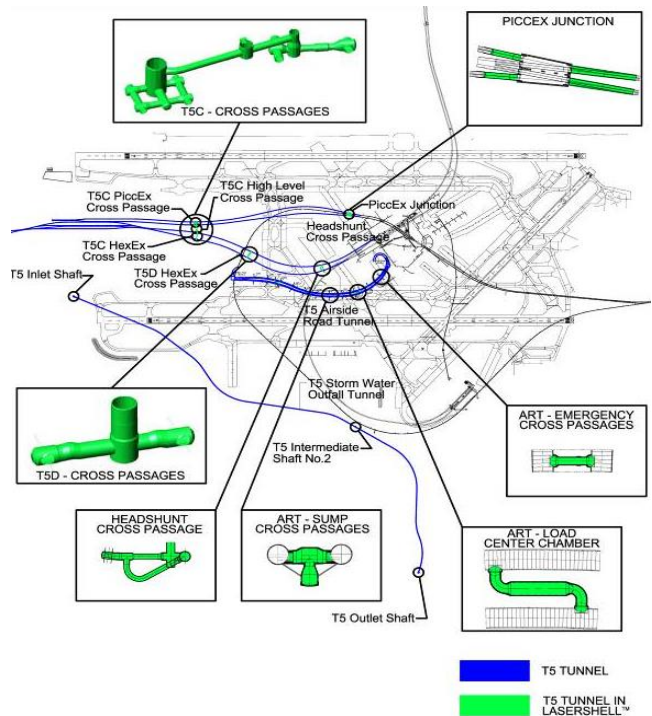
PROJECT DATA SHEET

METRO PUENTE ALTO, SANTIAGO DE CHILE



Client: Metro Santiago Chile	Geology: Conglomerate
Main Contractor Consorcio V.E.I. Consultant for NATM: BeMo Tunnelling as consultant for NATM: design, technical support, know-how transfer	Technical Data: <ul style="list-style-type: none"> Know-how Transfer of the New Austrian Tunnelling Method (NATM) for the construction of an underground station and a double track metro tube Station tube: 120 m Cross section: 160 m² Double track metro tube: approx. 1,500 m Metro cross section: 80 m² Preparation of technical special proposals NATM-Specialists provided Excavation by excavators - Lot completely in permanent shotcrete
Project Location: Santiago de Chile, Puente Alto Chile	
Start of Construction: 2003 End of Construction: 2004	
Project Total Value: Approx. 500,000 €	

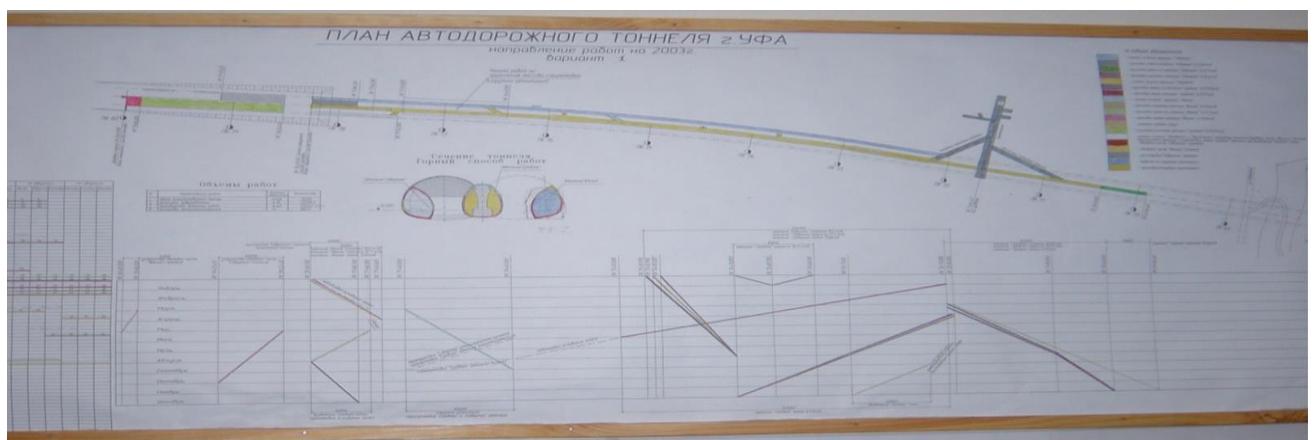
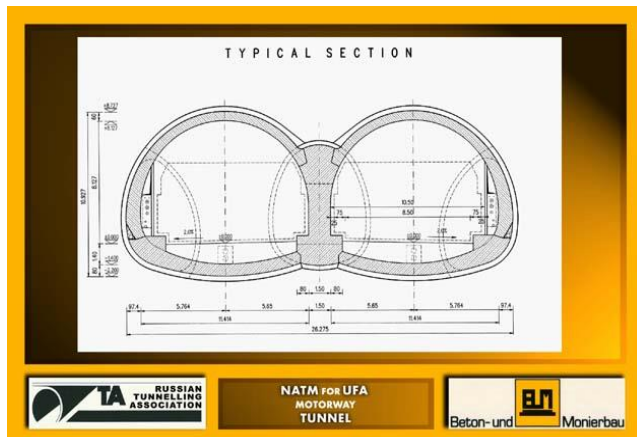
HEATHROW TERMINAL 5 (T5) / AIRSIDE ROAD TUNNELS



Client: British Airports Authority (BAA)	Geology: London clay
Main Contractor: Morgan / Vinci JV Consultant for NATM: BeMo Tunnelling GmbH as Consultant: Design (Structural analysis and detailed design), LaserShell™ and TunnelBeamer™ development, Technical Support, Supervision, Know-how Transfer, NATM Tunnel Engineers and NATM Surveyor on site	Technical Data: <ul style="list-style-type: none"> Know-how Transfer project of the New Austrian Tunnelling Method (NATM) with Morgan Vinci JV for the construction of complex underground- and tunnel-systems for TBM-cross-passages, ventilation shaft, access tunnels, startershafts and -caverns: 12 shafts and 30 underground- and tunnel-structures constructed using LaserShell™ shotcrete method for Heathrow Express Extension (HexEx) and Piccadilly Line Extension (PiccEx) Total length shotcrete works tunnels: 880 m T5 cross section: 15 – 130 m² ART cross section: 10 – 35 m² Total depth of shotcrete works shafts: 249 m Depth of shafts: 14 m – 35 m Diameter shafts: 3.7 m – 13.8 m
Project Location: London, England, UK	Other Project-Specific Information: <ul style="list-style-type: none"> Permanent shotcrete without waterproofing in LaserShell™ at the inner lining of cross cuts / emergency exits
Start of Construction: 2002 End of Construction: 2006 Project Total Value: 5,580,000 €	

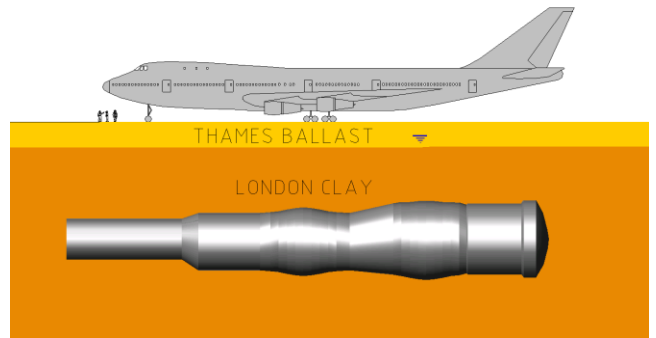
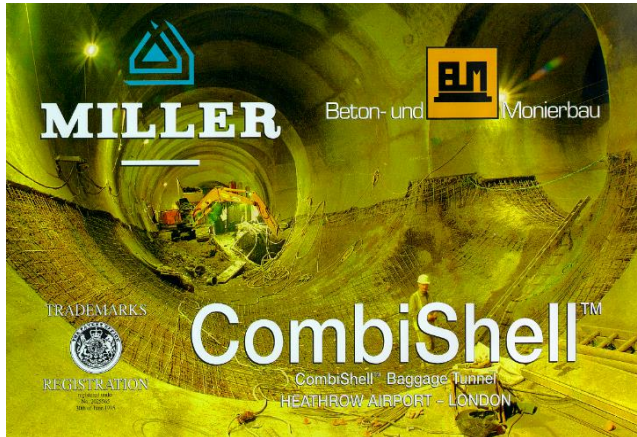
PROJECT DATA SHEET

UFA, DOUBLE TRACK MOTORWAY-TUNNEL



Client: City of Ufa Russia	Geology: Silt, marlstone
Main Contractor: US 30 Consultant for NATM: BeMo Tunnelling GmbH (BeMo) as Consultant for NATM: Design, technical support, Know-how-Transfer	Technical Data: <ul style="list-style-type: none"> Know-how Transfer of the New Austrian Tunnelling Method (NATM) for the construction of NATM double track motorway tunnel Technical support Total length of tunnel: 1,060 m
Project Location: Ufa, Bashkortostan, Russia	
Start of Construction: 2000 End of Construction: 2005	Other Project-Specific Information: <ul style="list-style-type: none"> Know-how Transfer
Project Total Value: 2,000,000 €	

HEATHROW BAGGAGE TUNNEL



Client: British Airport Authorities (BAA)	Geology: London clay
Main Contractor: Morgan=Est (Miller Civil Engineering)	Technical Data: <ul style="list-style-type: none"> Know-How Transfer of the New Austrian Tunnelling Method (NATM) for the construction of NATM junctions NATM junctions: 80 m <ul style="list-style-type: none"> Ø 7.5 m Ø 9.4 m Ø 5.3 m CombiShell™: Development and execution of a permanent shotcrete lining
Consultant for NATM: BeMo Tunnelling (formerly: Beton- und Monierbau) as Consultant for NATM Design, Technical Support, Supervision, Know-how Transfer	
Project Location: London, England, UK	Other Project-Specific Information: <ul style="list-style-type: none"> Development of CombiShell™ (permanent shotcrete for tunnel lining) Tunnelling work was carried out beneath live airport runways and the Piccadilly underground line.
Start of Construction: 1993 End of Construction: 1995	
Project Total Value: 20,000,000 € (shotcrete-part only)	



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