STRABAG TUNNELLING
PROFILE STRABAG TUNNELLING
The Evolution of STRABAG Tunnelling

Beyond conventional method and mechanical machines since 1+965

50 years of Tunnelling Know-How
STRABAG TUNNELLING CORE COMPETENCES

STRABAG Portfolio of Tunnelling Methods

- Conventional tunnelling (NATM, SCL, Drill & Blast, Mechanized Excavation)
- TBM tunnelling (hard rock & soft ground – Open Gripper TBM, EPB Shield, Slurry Shield)
- Inclined TBM Tunnels
- Shaft sinking
- Open Cut
- Cut & Cover
- Cover & Cut
- Immersed tunnels
- Pipe jacking
- Raise Boring
STRABAG TUNNELLING CORE COMPETENCES

Fields of Tunnelling Activities

- Infrastructure Projects
  - Rail
  - Road
  - Metro
  - Sewer
  - Water
  - Collectors
- Hydropower Plants
- Mining
Current Projects

- MORE THAN 40 CURRENTLY RUNNING TUNNELLING PROJECTS IN ALL CONTINENTS except AUSTRALIA

  AUSTRIA, GERMANY, CANADA, DANMARK, SWITZERLAND, QATAR, CHILE, INDIA, SINGAPORE, ALGERIA, ITALY, NORWAY, SWEDEN

- HIGH SPEED RAIL, METRO, SEWER, WATER, UNDERGROUND WATER POWER, MINING
STRABAG NIAGARA TUNNEL FACILITY PROJECT

World largest Hard Rock TBM - CANADA

Client: Ontario Power Generation

Contract value: € 728 million

Construction period: 2005 – 2013

STRABAGs share: 100 %

PROJECT HIGHLIGHTS and CHALLENGES:

- Tunnel Length of 10.1 km
- Robbins Open Hard Rock TBM D = 14.44 m
- 1.7 million m³ of excavated material
- 400,000 m³ of concrete used
- 450,000 m³ of waterproofing membrane installation
- Pre-stress grouting of the concrete inner lining
- Peak man power of 600 employees from the local communities
- Canadian Tunnelling Project of the Year 2013
- CAD 1 billion in economic benefits to the Niagara region during the construction works
- 1,600 GWh of additional electricity produced for Ontario after completion
- Outstanding H&S records – Workers safety records twice as good as the industry average
- Completion 9 months ahead of target date – cost saving of CAD 100 million
- We received the Economic Impact Award from the local Chamber of Commerce for three consecutive years (2007 – 2009)
- Completion 9 months ahead of target date – cost saving of CAD 100 million
- Training and continuous education of local workforce and staff
Client: Alp Transit Gotthard AG
Contract value: € 1.112 billion
Construction period: 2002 – 2012
STRABAGs share: 100 %

PROJECT HIGHLIGHTS and CHALLENGES:

- TBM tunnel excavation:
  - Lot 151 Erstfeld: 2x 7.8 km
  - Lot 252 Amsteg: 2x 11.3 km
- 2 Hard Rock Herrenknecht TBMs / D = 9.55 m
- 2,765,000 m³ of excavated material
- 880,000 m³ of concrete used
- 2,100m of maximum overburden
- 56 m/day – 688 m/month – best excavation performance rates
- 46 °C of maximum temperature in the tunnel on the TBM in Lot Amsteg
- Use of “Monorail Train” suspended on the tunnel roof for the material logistic on the TBM – considerable innovative solution
- Excavated rock treatment and reused as a shotcrete and concrete aggregate
- Deployment of Rowa suspended working platform for the cross passages excavation to enable undisturbed TBM heading
STRABAG KORALM TUNNEL KAT2
Austria's longest High Speed Railway Tunnel - AUSTRIA

Client: ÖBB Infrastruktur
Contract value: € 570 million
Construction period: 2010 – 2018
STRABAGs share: 85 %

PROJECT HIGHLIGHTS and CHALLENGES:
- 37.9 km of tunnel excavation thereof 32 km TBM tunnelling
- 2x Hard Rock TBMs / D = 9.93 m
- 2x interlocked logistic shafts, 60 m deep
- TBM excavation supply via logistic shafts
- Limited space for site installation including 2 pre-cast segment factories
- Production and installation of 103,500 Pcs of pre-cast concrete lining segments and 17,250 invert segments
- 1 million m³ of concrete used for pre-cast segment production
- Set-up, assembly and management of two pre-cast concrete segment lining factories including batching plants
- Processing of 4.5 million m³ excavated rock and using as a concrete aggregate, for dam works and backfilling
- 56 km of bulk conveyor installation, commissioning and operation
- Safety concept in regard to the approx. 16 km long TBM excavation including ventilation
- To TBM excavation simultaneously running excavation of the cross passages
**STRABAG** METRO VIENNA – U1/9 & U1/10

Urban City Metro Construction - AUSTRIA

**Client:** Wiener Linien  
**Contract value:** € 88 million  
**Construction period:** 2007 – 2017

**PROJECT HIGHLIGHTS and CHALLENGES:**

- Large construction site in urban city environment
- Limited space
- Logistic challenge
- Management of local communities
- Cooperation and collaboration with the authorities
- Nearby environment – natural conservational area, parking facilities, etc.)
STRABAG KATZENBERG TUNNEL
High Speed Railway Tunnel - GERMANY

Client: Deutsche Bahn AG
Contract value: € 344 million
Construction period: 2003 – 2010
STRABAGs share: 30 %

PROJECT HIGHLIGHTS and CHALLENGES:

- Tunnel Length of 9.4 km
- Slab Track Installation
- Speed up 250 km/h
- Twin Tubes with cross passages every 500 m
- On-site semental lining factory with two production lines
- Longest Tunnel in Germany excavated by TBM
- Site Camp establishment
- Performance up to 32 m/day
- 2.4 million m³ of excavated material
- Two 70 m deep ventilation shafts
- Two Herrenknecht EPB Shields / D = 9.385 m
STRABAG CITY TUNNEL LEIPZIG

Inner city Tunnel and Station- GERMANY

Client: DEGES Deutsche Einheit
Contract value: € 280 million
Construction period: 2005 – 2010
STRABAGs share: 40 % - Technical Lead

PROJECT HIGHLIGHTS and CHALLENGES:

- Herrenknecht Mix Shield TBM / D = 9 m
- Tunnel Length of 2x 1.48 km
- TBM equipped with Sonic Softground Probing system
- 2 m of minimum distance of a building foundation to the tunnel lining
- 8 - 16 m of overburden
- Concrete with polypropylene fibres to increase the fire resistance of the pre-cast inner lining
- Four phases of jet-grouting to control the settlements
- Relocation of 2,200 tons heavy pontico from year 1844 to considerably simplify the construction of the station
- Cover & cut method to construct the station to limit the disturbance to local communities
- TBM tunnelling under more than 33 buildings of the Leipzig city center founded on a sensitive foundations
- TBM dismantling at Leipzig Hauptbahnhof, return to the drive start shaft at Bayerischer Bahnhof, reassembly and re-launch
STRABAG TUNNEL JENBACH - H8
High Speed Railway Tunnel - AUSTRIA

Client: BEG Brenner Eisenbahn
Contract value: € 150 million
Construction period: 2006 – 2010
STRABAGs share: 40 % - Technical Lead

PROJECT HIGHLIGHTS and CHALLENGES:

- Tunnel Length of 3.48 km
- Herrenknecht Mix-Shield Slurry TBM / D = 13.03 m
- Under-passing of highway, Inn river, railway and highway bridge structure
- Difficult geological and hydrological conditions
  - Entire tunnel length under ground water level
  - Excavation in river sediments, mostly gravel and sand
  - Low overburden along the tunnel alignment
- Underwater box excavation with support of secant pile walls and consecutive underwater concrete
- Fabrication of 13,872 concrete segment rings (7+1)
- 66,000 m³ of concrete used for ring production
- 163 m of weekly performance
- Continuous measurement of the surface deformation, especially on the highway, bridge and the railway. The measurements are shown in real time on a TBM screen and the management office
- Retractable TVN Machine (pipe jacking) for excavation of the emergency tunnels - first time using of Herrenknecht innovative technology
STRABAG BUDAPEST METRO LINE 4 - STAGE 1
Urban City Metro Line - HUNGARY

Client: BKV Budapest
Contract value: € 202 million
Construction period: 2003 – 2011
STRABAGs share: 50 %

PROJECT HIGHLIGHTS and CHALLENGES:

- Tunnel Length 2x 7.3 km
- TBM tunnelling 2x 5.35 km
- 2x Herrenknecht EPB TBMs / D = 6.05 m
- Danube River crossing with an overburden of only 6 m between the tunnel crown and the river bed
- Depth of the tunnel ranges between 17 – 32 m.
- Crossing above the north-south Metro Line 3
- Crossing above the north-south Metro Line 3
- Comprehensive exploration testing program to determine and verify the geological conditions under the Danube River
- Own production of the pre-cast concrete tunnel lining segments
- Excavation through six stations
- Tunnelling in an urban city environment
- Material supply and logistic through a construction location in a Budapest city centre
- Very strict noise and vibration limits
- Limited space for site installation
STRABAG METRO NOORD ZUIDLIN
Urban City Metro Line - NETHERLAND

Client: Gemeente Amsterdam
Contract value: € 355 million
Construction period: 2008 – 2013
STRABAGs share: 50%

PROJECT HIGHLIGHTS and CHALLENGES:
- 7.5 km twin single truck tunnel
- TBM tunnelling 2x 3.1 km divided into four sections
- 2x Herrenknecht Mixshield TBMs / D = 6.88 m
- Tunnel alignment running under the historic city of Amsterdam
- Extensive compensation grouting measures for soil improvement and settlement control
- Excavation of cross passages using ground freezing
- Emergency shaft excavation using sinking caissons
- Challenging geological and hydrological conditions - water level only 1-2 m below the surface
- Material logistic, including spoil removal and precast segment lining delivery
STRABAG SEC SEWER PROJECT

15 km long Sewer Project - CANADA

Client: Municipality of York Region
Contract value: € 300 million
Construction period: 2011 – 2015
STRABAGs share: 100 %

PROJECT HIGHLIGHTS and CHALLENGES

- 15 km of tunnel excavation using four EPB TBMs / D = 3.62 m
- Excavation of 17 shafts, diameters up to 16 m, up to 50 m deep
- Ground Engineering design optimization – secant pile walls, ground freezing, gel injection, diaphragm walls
- Construction site located in the residential areas and the surrounding sensitive nature environment
- Construction site located in the residential areas and the surrounding sensitive nature environment
- Geology challenges due to extremely varying glacial deposits and multiple water horizons, as well as large number of boulders and presence of methane gas
- Geology challenges due to extremely varying glacial deposits and multiple water horizons, as well as large number of boulders and presence of methane gas
- Simultaneous operation of 4 TBM’s
STRABAG RIO TINTO
Tunnel Boring System (TBS) Trial - AUSTRALIA

Client: Rio Tinto
Contract value: € 10 million
Construction period: 2012 – 2014
STRABAGs share: 100 %

PROJECT HIGHLIGHTS and CHALLENGES:

- Trial phase of new developed TBS
- Non-circular profile of 27 m²
- Operation of the TBS 600 m under the surface in a fully operational mine
- Very high level of coordination, communication and collaboration between all involved parties
- Very high H&S and Environment requirement
- Implementation of Rio Tinto’s ZERO HARM culture
- Employment of local labour force – 100 %
STRABAG ROHTANG PASS HIGHWAY TUNNEL

Greenfield project in the Indian Himalayas - INDIA

Client: Board Road Organization
Contract value: € 245 million
STRABAGs share: 60 %

PROJECT HIGHLIGHTS and CHALLENGES:

- 8.8 km long tunnel
- 3,000 m above see level in the north of India
- Overburden of up to 1,900 m
- Very challenging geology and logistic
- Deployment of suspended tunnelling logistic back-up platform to enable early closure of the ring parallel to heading works
- Up to 100 m ground probing ahead of the face
- Spoil removal from tunnel using conveyor belt and rock crushers
- Escape tunnel situated below the roadway
- Escape tunnel situated below the roadway
STRABAG SÖDERSTRÖM TUNNEL PROJECT
Urban City Infrastructure Tunnel Project - SWEDEN

Client: Trafikverket
Contract value: € 227 million
STRABAGs share: 50 %

PROJECT HIGHLIGHTS and CHALLENGES:
- Immersed tunnel comprising three 100 m long elements
- Immersed segments linked up with the tunnels excavated in the rock at both banks
- Immersed segments founded on four piled and one raft construction
- 2012 work environment award
- Urban city environment

2012 WORK ENVIRONMENT AWARD
Söderströmstunneln City Line JVS is the recipient of the award for good and systematic work environment.

The JVS - Söderström Tunnel with the dedicated help of the site management created a focus on the work environment as a natural part of the mission.

The JVS and their excellency on the work have achieved a good working environment by:
- systematic identification of risks and the implementation of preventive measures
- exemplary incident reporting
- methodical follow up on occurred incidents
- a solid working environment commitment of all works
- good order on site

Kiiti Åke Arvidsson
City Line Project Manager
Fredrik Moback
City Line Environmental Manager
STRABAG TUNNEL TERFENS-VOMP - H5

High Speed Railway - AUSTRIA

Client: ÖBB Infrastruktur AG
Contract value: € 202 million
STRABAGs share: 66.66 %

PROJECT HIGHLIGHTS and CHALLENGES:

- Total length of the tunnels = 8,480 m
- 3,991 m loose ground and 3,744 m hard rock excavation

- 50 m deep inclined dewatering wells carried out in very limited space – very difficult ground conditions
- 550 m excavation in compressed air (1.2 bar)
- Tunnel cross-section up to 190 m²
- Simultaneous excavation of 4 tunnel faces using an intermediate access tunnel
- Optimization of workflow to accommodate the schedule - excellent excavation performance – up to 20 % more compared to the original schedule
- High sensible project environment through the density of development of the valley base (residential and commercial buildings, Inntal highway, existing rail line), by partially unstable valley sides and due the intensive use of water resources of the project area
Main Sewer to the Alkimos Wastewater Treatment Plant - AUSTRALIA

Client: Western Australia Water Corporation
Contract value: € 150 million
Construction period: 2008 – 2010

PROJECT HIGHLIGHTS and CHALLENGES:

- main sewer line employing pipe-jacking technology with diameter of 2 m and tunnel length of 6,300 m
- 13 jacking/receiving shafts along with a maximum depth of 20m.
- Complex and highly variable regional geology with both sand and hard rock.
- Project completed 3 months ahead of schedule (despite a 4 month approval delay at the beginning of the project).
- Excellent accuracy: The latest technology in precision guidance employed. Deviations from target point were within +/- 20mm.
- Reduction in potential environmental impact: Trenchless tunnelling techniques means less environmental, social and visual impact to the surrounding area.
- A maximum of 84m of tunnelling achieved in one 24 hour period.
STRABAG  SOUTHERN SEAWATER DESALINATION PROJECT
Desalination Project - AUSTRALIA

Client: Southern Seawater Alliance
Contract value: € 25 million
Construction period: 2010 – 2011

PROJECT HIGHLIGHTS and CHALLENGES:
- Construction of two intake tunnels using pipe jacking technology – 2x ID 2,400 mm / Length of 861 m and 855 m respectively
- Construction of two brine discharge tunnel using pipe jacking technology – 1x ID 2,000 mm / Length of 965 m
- TBM offshore recovery carried out successfully three times
- Reduction of the environmental impacts through the use of the tunnelling technology
- Project completion in budget and ahead of schedule
- Project awarded with the CCF Earth Award 2011 in WA and the tunnelling Project of the Year 2011
Client: Alto Maipo SpA
Contract value: US$ 495 million
Construction period: 2013 – 2018
STRABAGs share: 100 %

PROJECT HIGHLIGHTS and CHALLENGES:

- Very complex construction project
- Non-standard, very high H&S and environmental standards
- 46.5 km of tunnel excavation in total
- 2 x Hard Rock Herrenknecht TBMs
- Construction site located up to 2,400 m above see level
- Remote location – challenging logistic
- Very sensitive nature environment
- Challenging contract requirements. Local law and standards
- Set-up of a well-organized international team
- Local supply chain engagement
- Employment of local labour and staff
STRABAG MINING ACTIVITIES IN SOUTH AMERICA
CHILE

For more than 20 years is Zueblin International GmbH Chile (Member of STRABAG Group) active in mining in following areas:

- Mine Extensions through Shafts and Tunnels
- Tunnel construction
- Mineral transport
- Construction of hydro-electric power plants
- Mines: Yanacocha (Peru), Candelaria Norte, El Teniente, Rancagua, Copiapo, Collahuasi, Los Pelambres, etc.
- Clients: Codelco,
- Total project value to 2014: € 430 million
SUCCESS COMES FROM WORKING SAFELY TOGETHER

LEARNING IN ONE'S OWN TEAM »

OPTIMISING ON ONE'S OWN INITIATIVE »

TEAMS WORK and win

ALWAYS! HEALTH AND SAFETY FIRST

- Constructing Better Health (CBH) in UK
- Target Zero Commendation Award in UK
- Work Environment Award in Sweden
- International Tunnelling Award – Project of the year in Australia
- Tunnel project of the year in Canada

SUCCESS COMES FROM WORKING WITHOUT BORDERS
WHY is **STRABAG** THE BEST CHOICE FOR YOU?

- Global Player
- In-House Capability
- Strong Financial Basis
- Highly experienced People
- STRABAG „The“ best Partner for YOU!
- Highest standards for H&S Environment
- Extensive Tunnelling Experience
- In-House Design & Innovation Centre
- Alignment with YOUR values