

## Dr.-Ing. Ulrich-Peter Rehm



Status	born 20.12.1964; married since 1990, 2 great sons
School education	1984 A-level
Studies	1985 - 1991 Civil-engineering at the Technical University of Karlsruhe/Germany; Specialised in rock- and soil mechanics.  1992 – 1998 Ph.D. on silo- and soil mechanics at the Institute for Construction Management at technical University of Karlsruhe/Germany. Research and development as scientific assistant on cohesive soils. Programming of expert systems. Supervision and lecturing of graduands.
Career	since 2008 <b>Dr. Ulrich Rehm Tunnelling Consultant GmbH</b> Chief Executive Officer  2005 <b>Tunnelling expert adviser of Herrenknecht, worldwide consultancy</b>  2004 <b>Lecturer for mechanised tunnelling at University of applied science Stuttgart/Germany</b>  2001 <b>Director of research &amp; development of TBM manufacturer Herrenknecht</b>  1998 <b>Director of the geotechnical department of TBM manufacturer Herrenknecht company</b>

## Experiences

Soil- and rock mechanical calculations for static design of soft- and hardrock tunnel boring machines (TBM) (examples: St. Gotthard/Switzerland, Gripper TBM  $\varnothing$ 9m; Guadarrama/Spain, double-shield TBM  $\varnothing$ 9,5m; Madrid M30 EPBM  $\varnothing$ 15,20m, Sydney/Australia Mixshield  $\varnothing$ 10,7m ;Hallandsas/ Suède Mixshield  $\varnothing$ 10,5m; Zuerich-Thalwil/Suisse; single-shield TBM;  $\varnothing$ 12,2m; Limmern/Suisse; double-Gripper-TBM  $\varnothing$ 8m; Uma Oya/Sri Lanka; double-shield TBM  $\varnothing$ 4,2m).

Feasibility studies and risk analysis for world-wide TBM projects in soft- and hardrock (Mexico City, Teheran, Sydney, Rio de Janeiro, Cairo, Italy, Copenhagen, Stuttgart, Sri Lanka)

Application of classical rock mechanical models (CSM, NTNU, BÜCHI, EWENDT, SANIO) for prediction of performance rates and tool consumption for hardrock TBM (shielded and open gripper TBM)

Design of TBM components (cutterhead, hardrock tools, tool distribution, muck flow, wear protection, back-up systems)

Design of logistical mucking solutions

Spoil conditioning concepts for EPBM

Ground treatment works (jet-grouting, freezing)

Bentonite-slurry application concepts, separation plant design

Environmental studies for muck disposal

Planning of world-wide job-site logistics; concepts for assembly and disassembly of TBM

Trouble-shooting on-site for difficult tunnel projects (Sydney, New Delhi, Rotterdam, Hamburg, Berlin, Freiburg, Teheran, Loetschberg, St. Gotthard, Mexico City, Turkey, Sri Lanka).

Feasibility studies on several TBM tunnel projects (Germany, Spain, Australia, Georgia, Switzerland)

Member of important tunnel associations (DAUB, ITA, ÖIAV); attendance on international working groups for TBM standards

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Development of numerical models for TBM design (face-pressure, cutter head drive-torque, thrust forces, slurry circuit, etc.).

Cost estimation and quantification for TBM projects (bill of quantities)

Claim Management (Dublin/Ireland, Freiburg/Germany, Singapore, Vienna, Vancouver)

Official court-surveyor (Canada, Austria); mediator for tunnel issues

R&D activities:

- Soil and rock treatment (application of foam and polymers); design of foam generators, ground treatment concepts
- Rock support measures for Gripper-TBM.
- Optimisation of segmental lining (gaskets etc.)
- Optimisation of chipping process for hardrock TBM.

Presentation at world-wide TBM-conferences, lecturer for TBM master courses on hardrock and softrock tunnelling (Germany, Switzerland, Italy, Malaysia)

Official Coach for project management system iTWO of the German Railway Company (Deutsche Bahn AG).

## Projects involved

**(1) Stuttgart/Germany – Stuttgart21:** Railway tunnel

- Heavily swelling heterogeneous mixed ground conditions; settlement sensitive inner-city tunnelling, preparation of tender documents, risk analysis, cost estimation (( $\varnothing$  11,0m Hardrock/EPB)

**(2) Copenhagen/Denmark – Newhaven:** Road tunnel

- Big diameter inner-city tunnel in glacial ground conditions; feasibility study and cost estimate for TBM tunnel ( $\varnothing$  14,45m Mixshield)

**(3) Copenhagen/Denmark – Cityringen:** Metro tunnel

- Long inner-city tunnel in glacial ground conditions under historic buildings; risk analyses and TBM expertise (Mixshield and EPBM)

**(4) Copenhagen/Denmark – Fehmarnbelt link:** Railway and road

tunnels

- Feasibility study for 3 long and very big tunnels (⊙18m) between Denmark and Germany in glacial ground conditions , risk analysis and cost estimate

**(5) Salzburg/Austria – Seekirchen: Railway tunnel**

- Environmental study for a big tunnel profile in mixed ground conditions (Mixshield).

**(6) Waldkirch/Germany – Hugewaldtunnel: Refurbishment road tunnel**

- Rock tunnel to be refurbished with innovative concept to avoid traffic interruption

**(7) London/England – Crossrail: Railway tunnels**

- Biggest infrastructure project in the world (2009) with 17 bil.€; new east- west connection under London within heterogeneous ground and inner-city challenges; preparation of tender docs; support of design team as TBM expert for EPB and slurry-TBM (⊙7,1m)

**(8) Mexico City/Mexico - Emissor Oriente: Sewage tunnel**

- Longest sewer system in the world with approx. 60 km of length and very deep coverage. Feasibility study for hard- and softrock sections due to changed ground conditions; performance optimization on-site (⊙8,1m)

**(9) Mexico City/Mexico – Rio dela Compania: Sewage tunnel**

- TBM tunnelling concept for very soft ground conditions for EPBM; optimization of tunnelling works on-site (⊙6,3m)

**(10) Beijing and Hangzhou/China – Metro line 1,9, 10: Metro tunnel**

- TBM analysis on-site; development of spoil conditioning concept for improved performance of the EPBM in grainy ground (⊙6,2m)

**(11) Melbourne/Australia - Kew North/North Yarra: Sewage tunnel**

- Tender docs review and expertise on pipe jack in heterogeneous ground (mixed face conditions), risk analysis (⊙1,9m)

**(12) Teheran/Iran – Metro Line 6: Metro tunnel**

- Segment design and all related TBM constructions; segment plant design; tunnelling concept (spoil conditioning, face pressure calcs; soil mechanical FEM calcs) (⊙9,15m)

**(13) Cochem/Germany - Kaiser Wilhelm Tunnel: Railway tunnel**

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- Tunnelling concept for big EPBM/HardrockTBM with very low coverage under houses; ground treatment concept, tunnelling optimization on-site spoil conditioning concept (⊙10,17m)

**(14) Sparvo/Italy – Galleria di Sparvo:** Railway tunnel

- Tunnelling concept and risk analyses for the biggest EPBM in the world (to that time) ⊙15,55m EPBM within heavily methane gas containing claystone; development of spoil conditioning concept for improved performance

**(15) Kuala Lumpur/Malaysia – Klang Valley Mass Rail:** Metro tunnel

- Risk analyses for a variable-density TBM (VD TBM) with highly innovative ground treatment concept. (⊙6,8m)

**(16) Karlsruhe/Germany – Kombisolution:** Metro tunnel

- Tunnelling concept and risk analyses for very low coverage under sensitive buildings (Mixshield); concept for jet-grouted tunnel (NATM) (⊙9,32m)

**(17) Shenzhen/China – GSG Yitianlu Tunnel:** Railway tunnel

- Improvement of slurry technology on the job-site; big Mixshield ⊙13,17m under sensitive buildings; improvement of TBM tunneling concept

**(18) Eskisehir/Turkey – high-speed train connection:** Railway tunnel

- tunnelling concept for EPBM ⊙13,72m in highly squeezing rock conditions; spoil conditioning concept; practical support on the job-site

**(19) Qatar – Metro Doha:** Metro tunnel

- Feasibility study for the use of a variable density TBM (VD TBM)

**(20) Auckland/NewZealand – Waterview:** Road tunnel.

- TBM bids review of all bidders (Japan, China, France, Germany) and assessment for a very big EPBM ⊙14,41m in mixed ground conditions

**(21) Sydney/Australia – Airport Link Tunnel:** Subway tunnel

- Trouble shooting on-site due to heavy clogging and wear (clay and sandstone); innovative cutting tool development and improved slurry concept; concept for ground treatment works against inner-city settlements. Mixshield ⊙10,17m.

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**(22) Istanbul/Türkei – Bosporus:** Road tunnel

- Consultancy on the feasibility of TBM tunnelling in heterogeneous mixed face conditions with high water-pressure; checking of technical tender docs (⊙14,4m)

**(23) Limmern/Switzerland – hydro-power plant:** 24°-inclined adit tunnel

- TBM expert for double-gripper hardrockTBM; checking TBM-design

**(24) Vienna/Austria – commercial court:** Metro tunnel

- Authorized court-expert for TBM tunnelling in litigation for line U2/5 (Mixshield)

**(25) Sri Lanka, Uma Oya Multipurpose project:** Headrace tunnel

- TBM expert for 2 double-shield hardrockTBM; tunnelling logistics and Job-site installation; TBM design and tunnelling concept; final workshop acceptance; logistical concepts

**(26) Oberhausen/Germany – Emscher:** Sewage canal section BA 40

- Feasibility (segmental lining), tunnelling concept, cost estimate for 2x10 km segmental lining

**(27) Tibilisi/Georgia - Liakhvi River Crossing:** Pipe-line

- Feasibility study and risk analyses for river crossing (segmental lining)

**(28) Tibilisi/Georgia – Kura East:** Pipe-line

- Feasibility study and risk analyses for river crossing (pipe-jack)

**(29) Medellin/Kolumbien – Interceptor Norte:** pipe-jack

- Workshop to contractors and client on pipe-jacking technology; consultancy on reinforcement optimization for concrete pipes (DN 2600)

**(30) Vancouver/Canada – Capilano Filtration Project:** Water tunnel

- Hardrock-TBM expert for the client in pre-litigation phase to defend claim from the contractor (main beam gripper TBM)

**(31) Oberhausen/Germany – Emscher:** Sewage canal section BA 30

- Comprehensive consultancy of the client (41 km of pipe-jacking; DN1600 – DN 2800) in terms of tunneling concept and cost control

**(32) Rastatt/Germany:** High-speed-train tunnel

- Pricing of bill of quantities, tunnelling concept for the client

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(Mixshield); optimization of underground works

**(33) Esfahan/Iran:** Cable tunnel

- Trouble shooting for a small segmental lining slurryTBM(3,15m); improvement of slurry-tunnelling concept

**(34) Andana/Turkey:** Headrace tunnel

- Trouble shooting for a single- and double-shield hardrockTBM in terms of TBM specification, operational aspects and tunnel lining concept

**(35) Seoul/Korea:** Hardrock tunnel

- Workshop on TBM design for hardrock tunneling (with Prof. Jamal Rostami/USA)

**(36) Makkah/Saudi-Arabia:** Metro-tunnel

- Risk analyses and TBM feasibility study for multi-mode TBM type (EPBM/Mix)

**(37) Riyadh/Saudi-Arabia:** Metro tunnel

- Checking tunneling tender documents; recommendation of TBM specifications

**(38) Guadalajara/Mexico:** Metro tunnel

- Development of TBM bidding documents for a contractor (who finally won the tender)

**(39) Potash tunnel/UK:** Hardrock tunnel

- Feasibility study and support on tender document preparation for access-tunnel to potash fields

**(40) Seattle/USA – SR99:** Road tunnel

- Practical support for the biggest TBM in the world (to that time)  
 Ⓞ17,48m on spoil conditioning; trouble shooting after severe disruption of tunnelling.

**(41) Perth/Australia - Forrestfield Airport Link:** Metro-tunnel

- TBM Expert consulting the owner (PA) from bidding to construction phase; evaluating variable-density (VD) TBM proposals, assessing VD TBM tunnelling concepts; checking VD TBM manufacturing; supervising tunnelling activities

## Dr.-Ing. Ulrich-Peter Rehm

**(42) German Railway Company (DB AG) - certified Coach for project management system iTWO:**

- Trainer for new project management system iTWO of the German Railway Company (DB AG); topics: cost planning, billing and purchase, controlling (of complex construction projects).

**(43) Minsk/Belarus: Deep Shaft**

- Geotechnical study and performance assessment for Shaft Boring Roadheader SBR  $\varnothing$ 9m, shaft depth: 700 m through mixed face conditions for potash salt mining.

**(44) Santiago d. Chile/Chile: Alto Maipo Hydroelectric tunnel project**

- TBM expert for assessment of feasibility and safety issues for a small single gripper TBM  $\varnothing$ 4m in critical hard-rock conditions.

**(45) Chennai/India: Metro tunnel**

- EPB TBM expert for performance optimisation and preparation of claim report for unforeseen geology.  $\varnothing$ 6,6m in mixed face conditions.

**(46) Lisbon/Portugal: Drainage tunnel**

- EPB TBM expert for preparation of bid proposal for contractor; mixed face conditions, inner City tunnel; cost estimation for TBM tunnelling  $\varnothing$ 6,5m.

**(47) Hull/England: Pipe line tunnel**

- Mixshield TBM expert for supervision of tunnelling works and related job-site installations under the river Humber; glacial mixed face ground conditions  $\varnothing$ 4,5m.

**(48) Virginia/USA: Chesapeake Bay Bridge Road Tunnel**

- EPB TBM expert for design calculation of big EPB TBM components  $\varnothing$ 13,2m

**(49) Baku/Azerbaijan: Baku Sewer Tunnel**

- TBM and tunnel expert for inspection of tunnel quality as preparation for litigation  $\varnothing$ 3-3,5m.

**(50) Genova/Italy: Slurry circuit design**

- Design of a 2x9km slurry circuit with special slurryfier-box for muck conveyance and disposal.

**(51) Lyon/France: Metro Line B**

- TBM expert for bidders tender proposal support for variable density TBM  $\varnothing$ 9,7m, development of tunnelling concept.



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