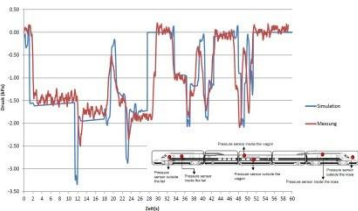


# AERODYNAMICS & VENTILATION

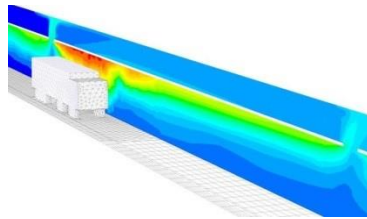
The multifaceted requirements regarding aerodynamics and ventilation place high demands on both operators and planners.

An early conception and planning by qualified specialists is the key to achieving maximum efficiency and safety during construction and operation.

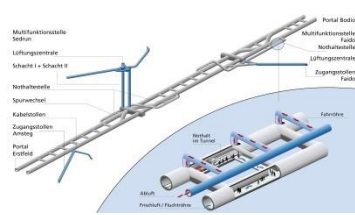
We gained valuable experience by completing successful projects. We support our clients with distinctive specialisation as well as in-depth knowledge in the fields of aero- and thermodynamics. Together, we develop the best solutions to be one step ahead of the requirements of the market.



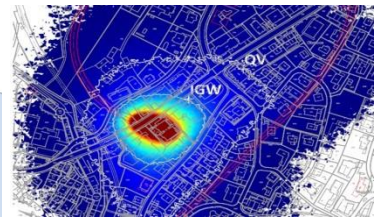
Pressure simulation and validation



Fire and smoke simulation



Ventilation and safety concepts



Simulation of the NO2 concentration at the tunnel portal

## Our Services

### Design – Tendering – Realisation – Commissioning

- Feasibility studies
- Conceptual design and dimensioning
- Comprehensive simulations for ventilation, climate, fire and smoke
- Detailed design and systems specifications
- Tendering and contract awarding
- Realisation, commissioning and approval
- Concepts for operation and maintenance
- Training of operational and safety staff

### Construction Site Ventilation

- Conception
- Optimisation of ventilation systems and reduction of energy consumption

### Maintenance and Refurbishment

- Control and assessment of all structural components and equipment
- Verification of the compliance with standards and identification of paths for improvement
- Improvement of control systems
- Optimisation of energy, operating and maintenance costs
- Planning of refurbishment projects, realisation and commissioning

### Aerodynamic Analyses

- Compressible tunnel aerodynamics
- Evaluation of train-induced pressure and wind loads
- Minimisation of aerodynamic loads on structures and vehicles
- Optimisation of tunnel cross-sections with respect to micro pressure waves and energy consumption
- Ensuring compliance with health and passenger comfort criteria

### Emission Surveys

- Analysis of fundamentals
- Analysis of the dispersion of emissions and pollutants
- Planning of corrective actions

### Expertise and Consulting Services

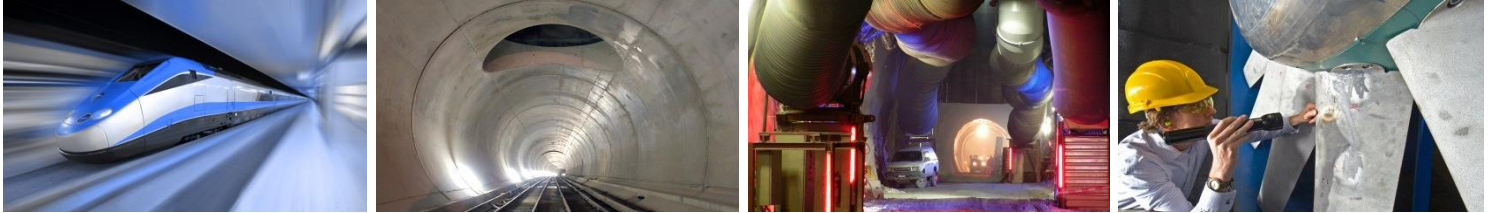
- Optimisation of ventilation, equipment and energy consumption
- Cost-benefit and cost-effectiveness analyses
- Second opinions and expert assessments
- Scenario-based analyses and quantitative risk analyses (QRA)
- Escape route concepts and evacuation procedures

## Our Competence

- Broad expertise
- Integral, innovative solutions
- Advanced modelling and simulation tools
- Strict adherence to budgets and deadlines
- Over 30 years of experience worldwide
- Active involvement in international research and development projects

## Your Benefits

- Fewer interfaces thanks to our multidisciplinary team
- Reduction of design and construction costs
- Higher reliability during planning
- Reduction of energy needs and operational costs
- Extension of maintenance intervals



## Selected References

Project	Uetliberg Tunnel Zurich, Switzerland	Project	Tunnels Tabladillo and Fuentecilla Madrid, Spain
Services	Ventilation	Services	Aerodynamic analysis
Client	Civil engineering department of the Canton of Zurich	Client	INECO
Project	Gothard Base Tunnel Switzerland	Project	Follo Line Tunnel Oslo-Ski Norway
Services	Equipment incl. ventilation	Services	Ventilation and safety
Client	ATG, AlpTransit Gotthard	Client	Jernbaneverket
Project	Tunnels Via Binaria and Via Expressa Rio de Janeiro, Brazil	Project	Pump storage power plant Belesar, Spain
Services	Ventilation and safety	Services	Construction site ventilation
Client	Porto Novo	Client	Geotunnel

**We are pleased to advise you in detail.  
Contact us.**



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(Schweiz), Brünn (Tschechische Republik),  
Bratislava (Slowakei), Lysaker (Norwegen),  
Gurgaon-Haryana (Indien), Kuala Lumpur  
(Malaysia), Madrid (Spanien)