

HSR AERODYNAMICS

High-speed rail (HSR) tunnels suffer from significant pressure fluctuations, generated by trains, which can have a significant impact on passenger comfort and health, as well as on structural integrity of rolling stock and tunnel infrastructure.

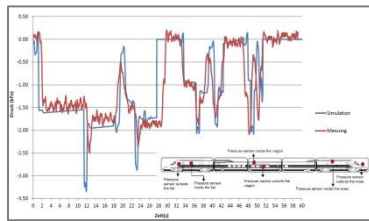
Optimizing the tunnel cross-section during design phase leads to considerable savings and guarantees passenger comfort and structural integrity.

We assess the complex interaction between high-speed trains and tunnels and verify adequate mitigating measures, tailored to specific project goals like reducing energy consumption, increasing train speed, reduction of maintenance costs.

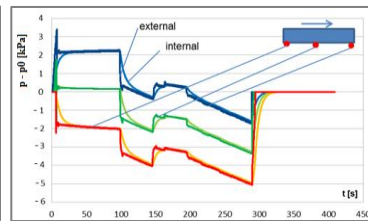
We support our clients with valuable experience from successfully completed projects and in-depth knowledge of compressible aerodynamics in tunnels.



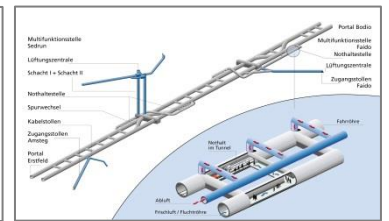
Shape of rolling stock plays a major role in the complex interaction between high-speed trains and tunnels



Validation of simulated pressure fluctuations through our large set of experimental data



Verification of health criteria through simulation of evolution of internal and external pressure (Follo line tunnel)



Development of ventilation and safety concepts for HSR tunnels

Our Services

Services all along the Life Cycle of a Rail Tunnel

- Verification that aerodynamic criteria to fulfil ERA Technical Specification for Interoperability (TSI) of Infrastructure and Rolling Stock are respected
- Enabling higher speed or use of new rolling stock through aerodynamic analysis
- Enabling new operating conditions with increased train frequencies through analysis of aerodynamic effects
- Support in case of aerodynamic problems through analysis and implementation of corrective aerodynamic actions

Smooth Commissioning through detailed Design Criteria

- Health and comfort criteria for passengers
- Rolling-stock integrity
- Structural loads on tunnel components

Aerodynamic Analysis

- Simulation of compressible tunnel aerodynamic phenomena
- 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

Prevention of Sonic Boom

- Analysis of design baseline
- Analysis of sonic boom generation and intensity
- Planning of corrective actions if needed

Investigation and Implementation of corrective Actions

- Optimization of train speed
- Optimization of tunnel cross section
- Pressure-release shafts
- Optimization of portal shapes
- Aerodynamic optimization of rolling stock

Expertise and Consulting Services

- Focussed aerodynamic analysis in all phases of tunnel design, construction and operation
- Analysis and optimization of existing or new tunnels and rolling stock
- Identification, verification, assessment and implementation of corrective actions
- Support in developing national and international regulations
- Second opinions and expert assessments

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

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



Selected References

Project	Follo Linie Tunnel Oslo-Ski Norway	Project	Tunnel de Saverne France
Service	Aerodynamics, ventilation and safety	Service	Preliminary aerodynamic analysis
Client	Jernbaneverket	Client	Implenia
Project	Tunnels Tabladillo and Fuentecilla Madrid, Spain	Project	Gotthard Base Tunnel Switzerland
Service	Aerodynamic analysis	Service	Equipment incl. ventilation
Client	INECO	Client	ATG AlpTransit Gotthard
Project	Tunnel Santa Marina Extremadura, Spain	Project	Mirror Group AEN/CTN 25-SC 4/GT2 Aerodynamics
Service	Aerodynamic analysis	Service	Assessment of aerodyn. TSI criteria
Client	Adif	Client	Spanish Development Ministry

**We are pleased to advise you in detail.
Talk with us.**



Marco Bettelini

Dr. sc. techn., ETH, Zurich
MSc. Mechanical Engineering, ETH, Zurich
Risk and safety specialist ETH/EPF/USG
Department Head

mbettelini@amberg.ch



Amberg Engineering Ltd.
Trockenloostr. 21
8105 Regensdorf-Watt
Switzerland
Phone: +41 44 870 91 11
information@amberg.ch
www.amberg.ch

Regensdorf, Sargans, Chur (Switzerland), Bratislava (Slovakia), Brno (Czech Republic), Drammen (Norway), Gurgaon-Haryana (India), Kuala Lumpur (Malaysia), Madrid (Spain), São Paulo (Brazil), Singapore