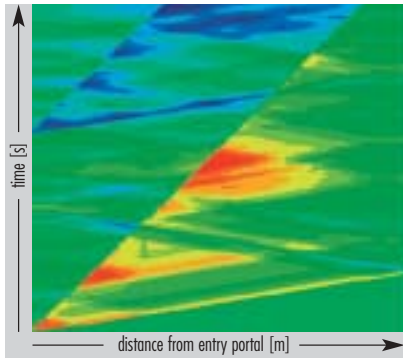
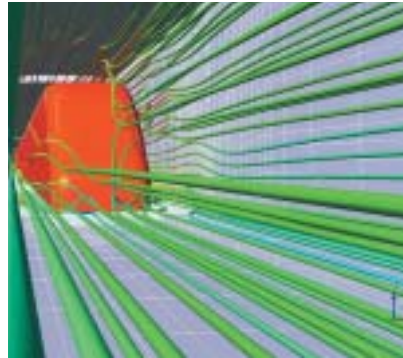


RAILWAY AERODYNAMICS



Measurement and Simulation of Railways and Metros in Tunnels and on Open Track

HBI HAERTER LTD
CONSULTING ENGINEERS
ISO 9001-2000 CERTIFIED **HBI**

Know-how and Solutions from HBI

Aerodynamics – Invisible but important

Railway aerodynamics affect the safety, the reliability, the economy and the comfort of train and metro systems. In tunnels, the rolling stock, the civil structures and the equipment need to comply with the increased loads, power requirements and adverse boundary conditions. Various aerodynamic aspects are crucial for the success of a rail or metro project.

Our services – Your needs

HBI's know-how gained over the past 40 years is beneficial to your railway business. In the field of aerodynamics HBI engineers possess a wide-range of experience in analyzing the various interconnected aerodynamic issues and in integrating the required measures into a tunnel or metro project. With our services we provide reasonable solutions for a wide range of customers (see table below).

Our tools – Your benefits

The computer-based numerical tools we regularly use to solve aerodynamic problems include:

- THERMOTUN which is used to predict pressures and air flow velocities in simple tunnels or complex metro systems
- CFX computational fluid dynamics (CFD) which is used to predict external and internal flows of trains

Aerodynamic properties are measured by:

- unsteady pressure transducers
- fast data acquisition systems (1D, 3D)
- ultrasonic flow sensors
- high-speed video recording

Additionally, acoustical and vibrational issues are measured and simulated.

HBI Haerter Ltd. – Services in the field railway aerodynamics

HBI Haerter Ltd provides	You are and you need		
<ul style="list-style-type: none"> = simulation, analysis = measurement 	Civil planner Contractor	Rail Operator Rail Authority	Rolling Stock Manufacturer
design of tunnels and metro stations (cross-sectional area, portal, shafts, gradients, shafts)			
determination of train-induced loads acting on tunnel structure, equipment and vehicle			
commissioning of new rolling stock and checks of performance during operation			
validation and certification of aural comfort and health according UIC codexes			
analysis of aero-acoustical phenomena such as sonic boom and design of measures			
aerodynamic train characteristics for numerical purposes including coasting performance			
wind speeds and loads on platforms of underground and open stations			
determination of open track aerodynamics such as lineside safety and slipstreams			
data on traction power requirements and optimisation of train speed			
analysis of rail impact on ventilation and influence on tunnel climate			
optimisation of energy consumption			

Aerodynamic Simulations and Measurements – Examples from HBI Projects



Left hand: Train for aerodynamic measurements equipped with pressure sensing devices (white arrows); Right hand: Double-deck IC-trains – Study of their effect on landside infrastructure, pressure fluctuations in tunnels and their sensitivity to side-winds

HBI experience – Examples and tasks

Brenner Base Line, Austria: Optimised track gradients with respect to traction power; aural comfort and pressure loads (🚆)

Lötschberg Base Tunnel, Switzerland: Traction power requirements; aural comfort and pressure loads for trains with design velocity of 250 km/h (🚆, 🌬️)

Banverket, Sweden: Fundamental aerodynamic guidelines in tunnels and underground station for Swedish Rail (🚆, 🌬️)

Gotthard Base Tunnel, Switzerland: Portal design (anti-recirculation shafts); all pressure comfort and load issues; traction power requirements (🚆, 🌬️)

Yong Dong Tunnel, Korea: Natural draft phenomena for dilution of Diesel emission (🚆)

Alstom Ltd, France: Aerodynamic properties of high-speed train (🚆, 🌬️)

Magnetic Levitation Train Link, Germany: Draft relief shafts for comfortable underground platforms (trains speeds 250 km/h) and shafts to eliminate sonic boom (🚆)

Raillink Mattstetten-Rothrist, Switzerland: Pressure relief shafts in 8 tunnels for better aural comfort with reduced cross-sectional area of main tunnels (🚆, 🌬️)

HSL Zuid, Station Biljmer, The Netherlands: Loads on roof-structure of above-ground station during train passage at 280 km/h (🚆, 🌬️)

Guadarrama Tunnel, Spain: Traction power requirements; aural comfort and pressure loads for trains with design velocity of 350 km/h (🚆)



More extreme pressure fluctuations in single-track than in double-track tunnels; white arrow indicates pressure relief shaft

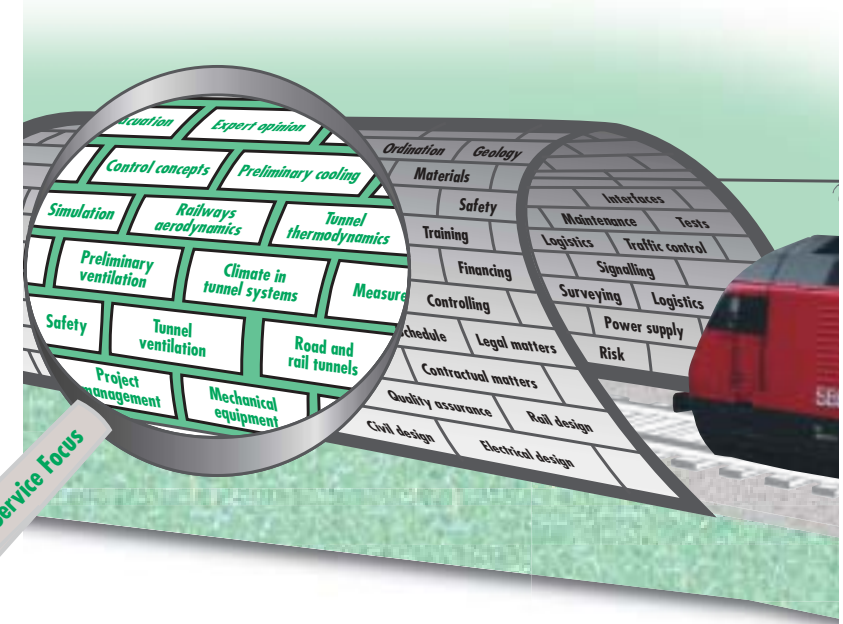
HBI – Key Services For Your Projects

HBI – Planning of 500 tunnels since 1963

HBI HAERTER LTD is a firm of consulting engineers. The services focus on the design, planning and realisation of projects concerning tunnel ventilation, airquality studies, safety issues as well as the aerodynamics and thermodynamics of road and rail tunnels. HBI offers the entire range of services related to tunnel ventilation from first feasibility studies to final acceptance tests including detail studies, project realisation, site supervision, measurements. HBI also has wide experience with refurbishment and optimisation of the operation.

With more than 500 successful reference projects, HBI is an internationally leading consultant specialized in tunnel ventilation. Quality, innovation and reliability characterize the services of HBI. HBI is an enterprise of the Engineering Beteiligungsgesellschaft Ltd, Locarno, which is owned by the employees of the subsidiaries. HBI is an independent consultant that cooperates with various sorts of organisations. HBI originates from SHB Schindler Haerter Ltd founded in 1963. From the offices in Berne and Zurich (Switzerland), and in Heidenheim (Germany), more than 25 specialists work on the worldwide projects.

HBI Services – Important building blocs for your project



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