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TUNNEL DESIGN

GEOTECHNICAL ENGINEERING

CONSTRUCTION MANAGEMENT

INSTRUMENTATION & MONITORING

WATERPROOFING & WATER CONTROL

TUNNEL REHABILITATION

MINING SUPPORT SERVICES

Dr. SAUER & PARTNERS

Tunnel Rehabilitation

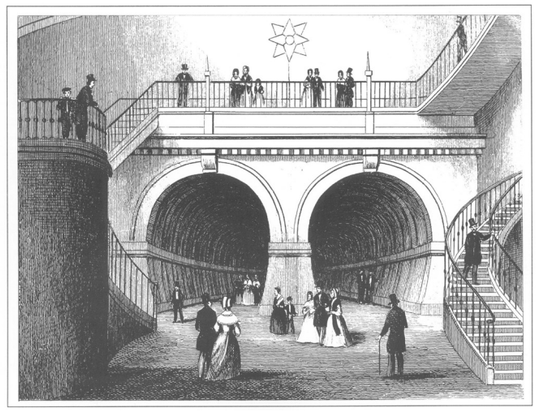
NATM (New Austrian Tunnelling Method) principles, flexible waterproofing membranes, and shotcrete shells offer cost-effective solutions for refurbishing and enlarging tunnels that do not meet clearance requirements or that suffer from structural or serviceability issues. Dr. Sauer & Partners has international experience in the rehabilitation of numerous tunnels to enhance their functionality and to extend their design life.

TUNNEL REFURBISHMENT

Refurbishment is required when the quality of a tunnel's structural lining has deteriorated beyond an acceptable level. Damage is often caused by water inflow and corrosion. Dr. Sauer & Partners' solutions include the design of various types of waterproofing and drainage systems and the repair or replacement of the structural tunnel lining. Refurbished tunnels are dry, safe, and structurally sound for an increased service life beyond their original design life.

MARC BRUNEL THAMES TUNNEL >
London, UK

∧ BEFORE ∧ LINING REPLACEMENT ∧ WATERPROOFING ∧ AFTER



THE THAMES TUNNEL, constructed by Marc Brunel between 1825 and 1843, was the world's first bored tunnel river crossing. Originally designed for horse and foot traffic, the tunnel today is part of the London Overground transit system. Dr. Sauer & Partners designed the rehabilitation scheme and supervised the implementation of the re-profiling, shotcrete, and waterproofing works.

Our application of NATM principles has extended the design life of the historic Thames Tunnel to suit modern-day requirements. The tunnel's inner profile was expanded to accommodate contemporary rail vehicles. The tunnel was also outfitted with waterproofing and drainage systems, and a cast-in-place concrete lining was used to retain the Thames Tunnel's original architectural details.

Dr. Sauer & Partners' Services

Dr. Sauer & Partners provides detailed design and construction support services for tunnel rehabilitation:

- **INSPECTION AND CONDITION ASSESSMENT**
  Inspect tunnels using optical measuring devices, laser scanning, and non-destructive testing to locate structural or functional deficits
- **FINITE ELEMENT ANALYSIS**
  Assess tunnel linings using Finite Element Analysis to determine structural capacity and the rehabilitation measures needed for compliance with guidelines and codes
- **DESIGN**
  Design refurbishment and enlargement measures, including detailed sequencing of the construction processes
- **GEOTECHNICAL ENGINEERING**
  Devise pre-support and ground improvement measures for tunnel enlargements
- **CONSTRUCTION MANAGEMENT**
  Manage and supervise construction during the implementation of the rehabilitation scheme to ensure quality and safety
- **MONITORING**
  Ensure the instrumentation and monitoring of tunnels and adjacent structures during the rehabilitation work

TUNNEL ENLARGEMENT

Installing an overhead catenary system for traction power supply or providing for the operation of twin-deck rail cars to raise passenger capacity in an existing tunnel usually requires increasing the clearance envelope of that tunnel. This involves removing the tunnel lining and, as required, the surrounding ground to the desired profile and installing a shotcrete support system. A flexible waterproofing membrane is installed against the primary shotcrete lining and then a secondary, permanent concrete lining is constructed. Our rehabilitation concepts ensure the durability and serviceability of the tunnel and of the installed utilities and facilities.

∧ *Removing the thick masonry lining and the surrounding ground and installing a thin shotcrete shell.*

∨ BEFORE ∨ AFTER

< BERRY STREET TUNNEL
Pittsburgh, PA, USA

PITTSBURGH'S BERRY STREET TUNNEL was built in 1865 as a four-metre-wide, single-track rail tunnel. In 1873, it was widened to eight metres to accommodate double tracks and lined with masonry. Following its rehabilitation in 1997 led by Dr. Sauer & Partners, the Berry Street Tunnel is today a busway connection between downtown Pittsburgh and the new Pittsburgh International Airport. The rehabilitation scheme realigned the tunnel at a higher elevation, changed the tunnel's cross-section from horseshoe to rounded, and encompassed the installation of a waterproofing system and a new concrete final lining. Since then, the tunnel has been fully operational and completely dry.