

Railroad Construction, Rail Network Infrastructure, Geotechnical Planning

Tunnel Construction Examination Report, Technical Security Review: One of the largest railroad tunnels built until today stretches over 57km in length, completed after more than 17 years. Budgeted at CHF 6.3 Bio., the total construction costs ultimately amounted to CHF 12.2 Bio. In 2023, a heavy freight train derailed inside the tunnel, damaging one of the railroad tubes and causing an operational interruption of one year, with economic losses from stalemate estimated at CHF 150 Mio. Tunnel construction examination reports are highly relevant in railway tunnel construction. Focus areas of examination reports and technical security reviews can be hazard analysis, probabilistic damage assessments, improvement concepts related to tunnel design, railway track routing, modernization, secure tunnel construction, or economic due diligence. Examination reports and assessments can also include technical recommendations for improvement, including:

- a) **Air Ventilation System**, to ensure and protect the health of tunnel construction workers, and other skilled workers, including supply of fresh air, degassing of dust, emissions, and toxic air particles via ventilation ducts, ventilators, air filters, air quality monitoring systems, etc.
 - b) **Water Drainage System**, including management of the groundwater inflow, flooding, and other water intrusions, through the use of pumps, water collection pans, drainage wells, operation of a water treatment plant, etc.
 - c) **Fire And Noise Protection**, to guarantee the safety of construction workers and other skilled workers, operators, and passengers, focus on i.a., fire prevention, emergency signs, alarm systems, systems for fire-fighting, fire protection containers, evacuation tunnels, etc.
 - d) **Work Safety for Tunnel Workmen**, risk assessments based on site investigations, subsurface examination reports, deriving work security measures from damage reports of similar tunnel constructions, focus on i.a., site traffic, support elements, explosives etc.
2. **Tunnel Support Systems:** Assessment and analysis of stability and load-bearing safety, including i.a.
- a) Static loads, physical force interactions between subsoil and tunnel's supporting structure, prevention of soil failure at tunnel entrance, site and location specific factors, etc.
 - b) Stability-endangering vibrations, dynamic loads caused by heavy freight and high-speed trains during tunnel passage, traffic and machine operations, earthquakes, etc.
3. **Railroad Track Designs:** Analysis of the most secure and efficient railroad track routings based on expected means of transport, railway law, technical regulations, loading weights, bans on train encounters in tunnels, etc.
- a) Limitations on railroad track inclination and high speed for freight and passenger trains, etc.
 - b) Railroad track modernization through digitization, etc.
4. **Total Project Costs, Due Diligence:** i.a., evaluations on the tunnel planning phase, tunnel design, benchmarking list of input factor prices and services, cost analysis construction phase, i.a., tunnel boring machines, construction materials, tunnel service, and maintenance, applicable addenda items, etc.

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