



Under the Alps: **The Gotthard Base Tunnel**

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TEAM ALPHA

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Overview

- Background
- Specifications
- Technology
- Construction
- Safety
- Cost
- Current State
- Road Ahead
- References



Background

- Route over Gotthard Pass is one of the most important passages through the Alps
- Traffic has increased more than 10x since 1980
- Existing road and rail tunnels are at their limits
- Need to provide faster and flatter passage through the Swiss Alps



Background

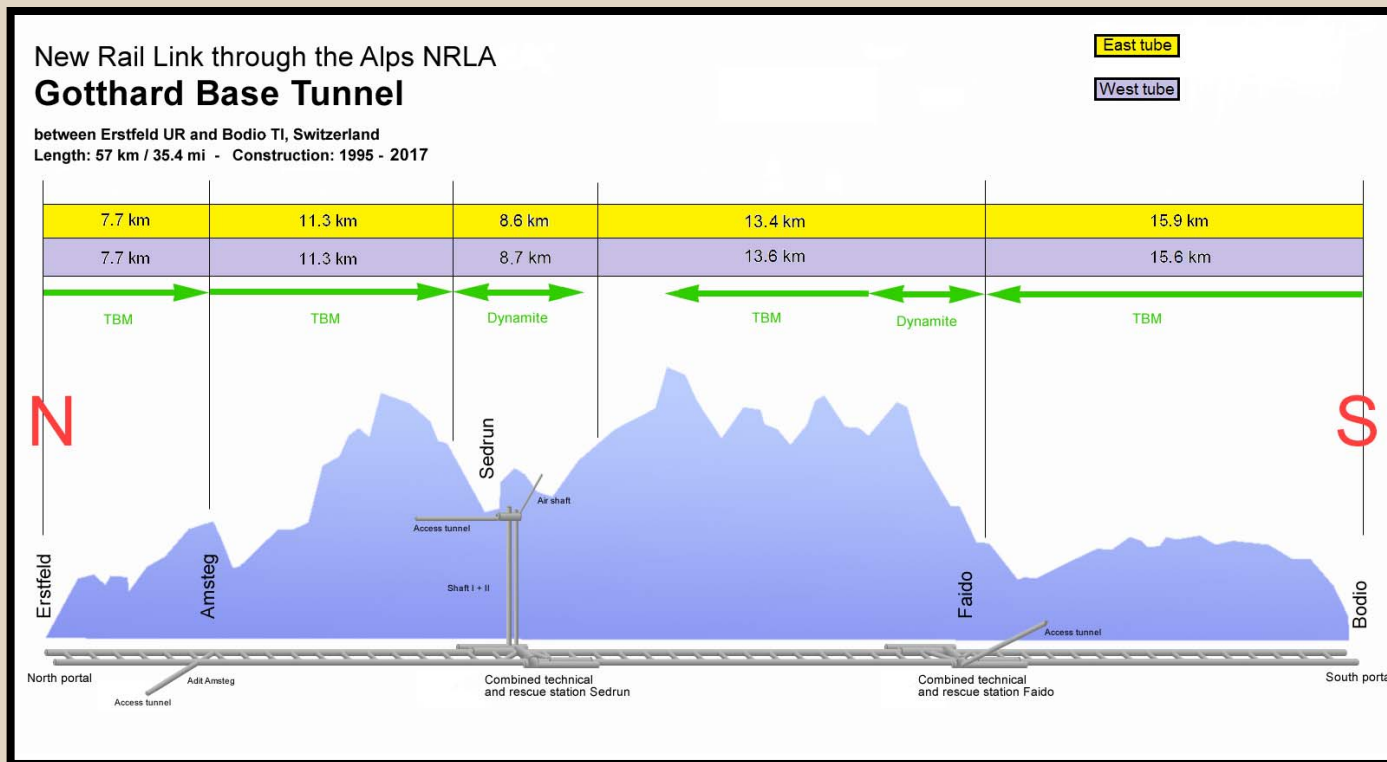


(yellow: major tunnels, red: existing main tracks, numbers: year of completion)

- Longest tunnel
- Drilling began in 1996
- Between Switzerland and Italy
- Largest engineering project since the Panama Canal

Specifications

- Two tunnels, each 35 miles long
- 31 feet in diameter
- Max overburden – 1.5 miles



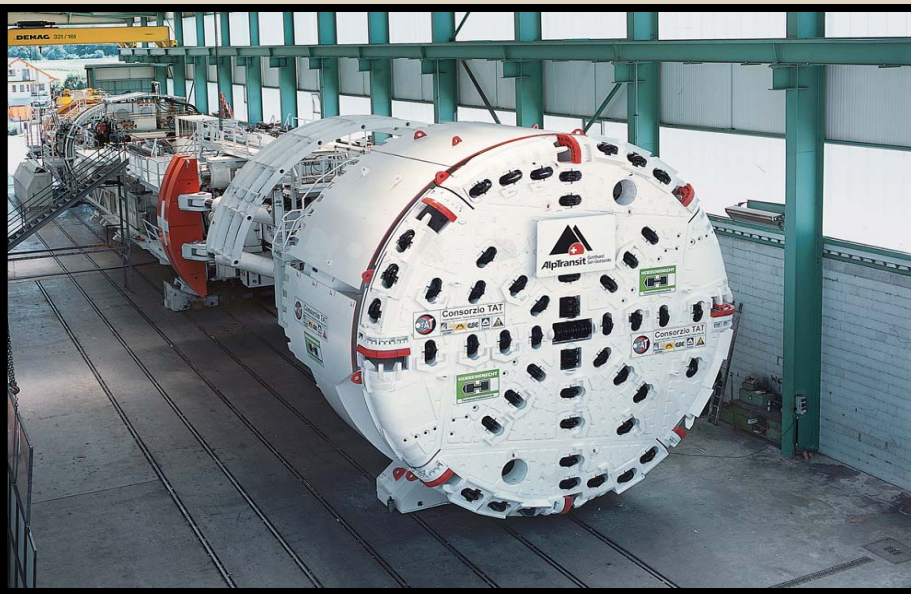
Specifications

- 26.5 million metric tons of excavated rock
- 200-250 trains/day
- 8 drilling machines
- 130 ft/day of drilling



Technology

Tunnel Boring Machine (TBM)



- 9.7m Diameter
- Power: 3,500 kW (5000 hp)
- Torque: 8500 kNm (6.2 million ft-lbf)



Technology

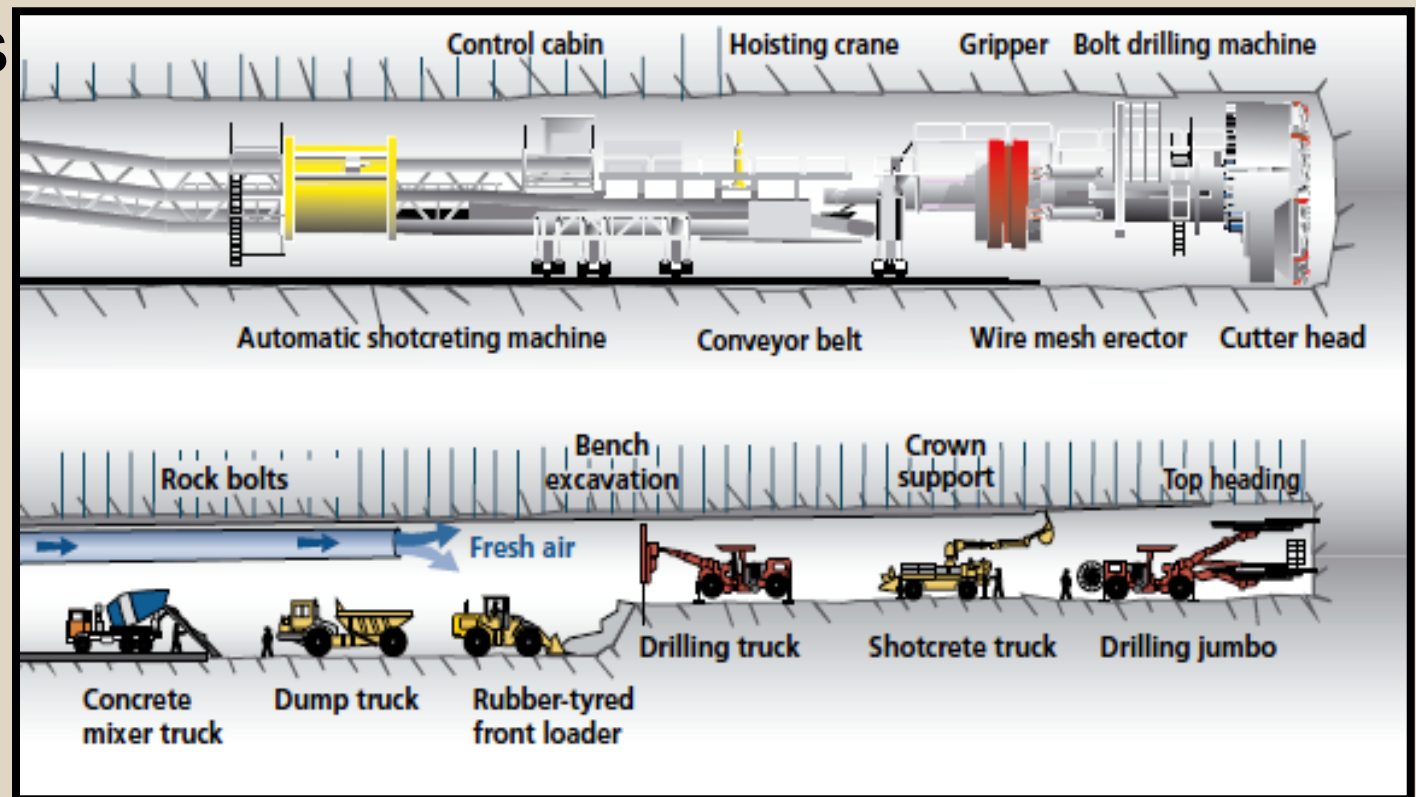
Electronic Cab Signaling

- Allows constant monitoring
- Signals are always visible to the driver
- Allows more trains to run at once



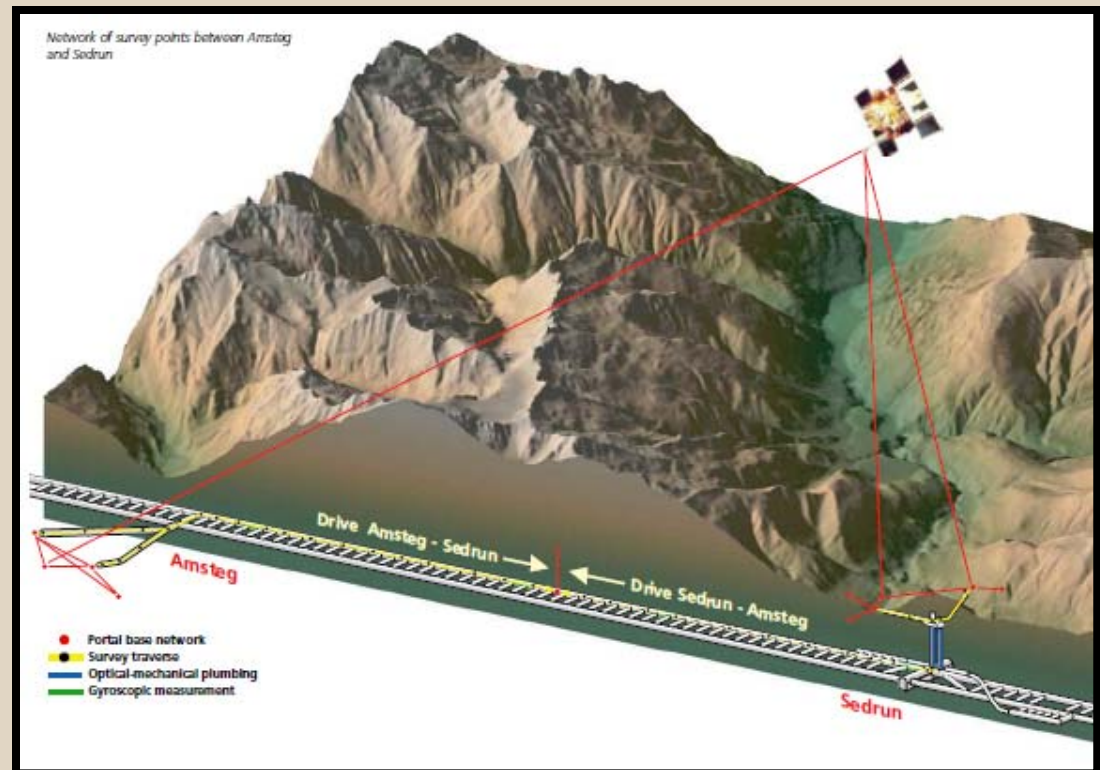
Construction

- Drilling, blasting and TBM
- Geological forecast
- Steel Arches
- Shotcrete



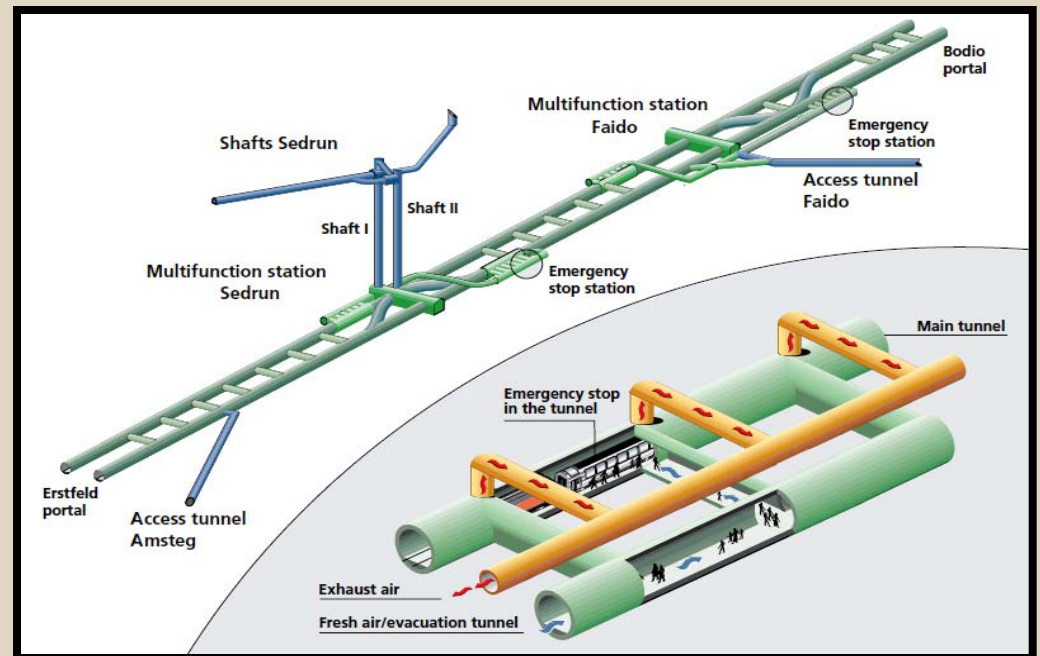
Construction

- Satellite mapping
- High precision measurement
- Alps still moving



Safety

- The great debate
- Ventilation
- Gas sensors
- 8 workers died
- Train safety system
- Emergency shelters

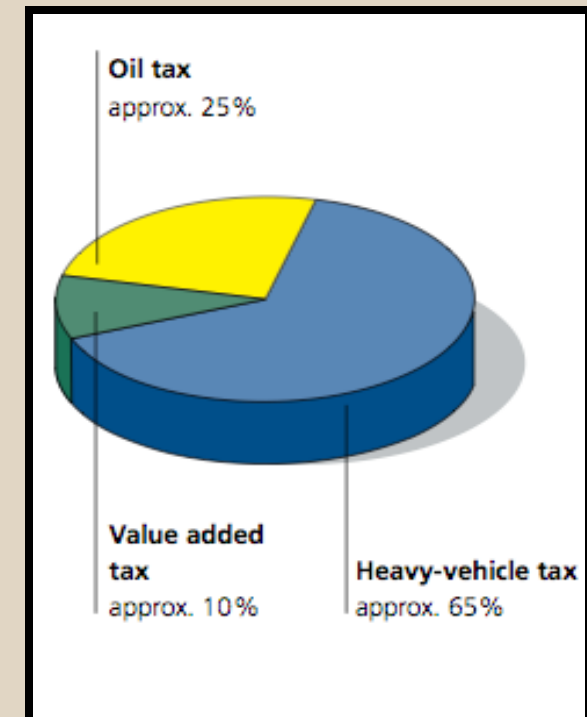
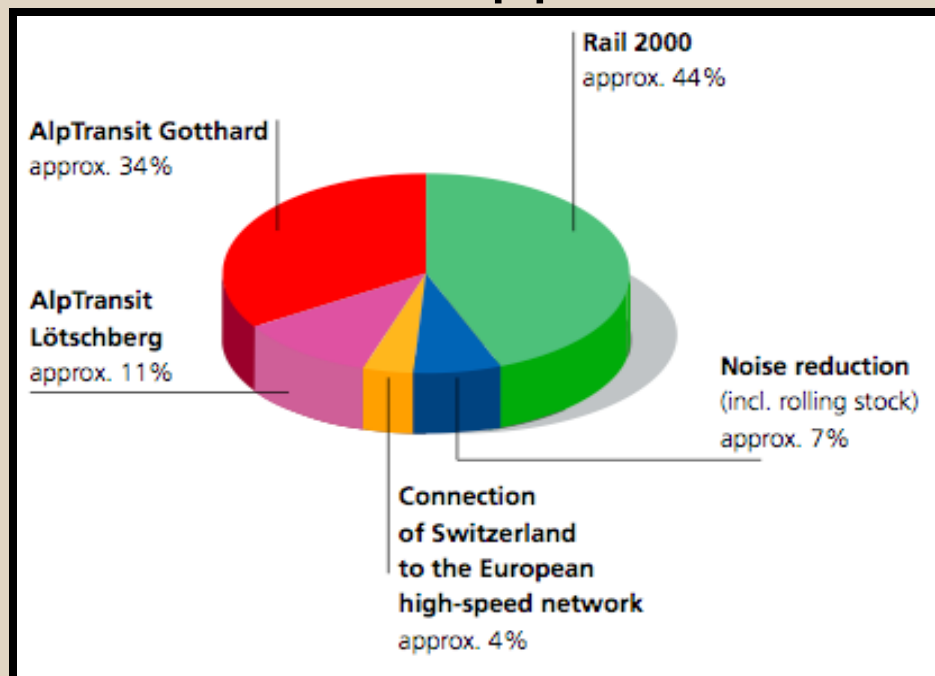


Beware: Balrog, the Demon of Fire



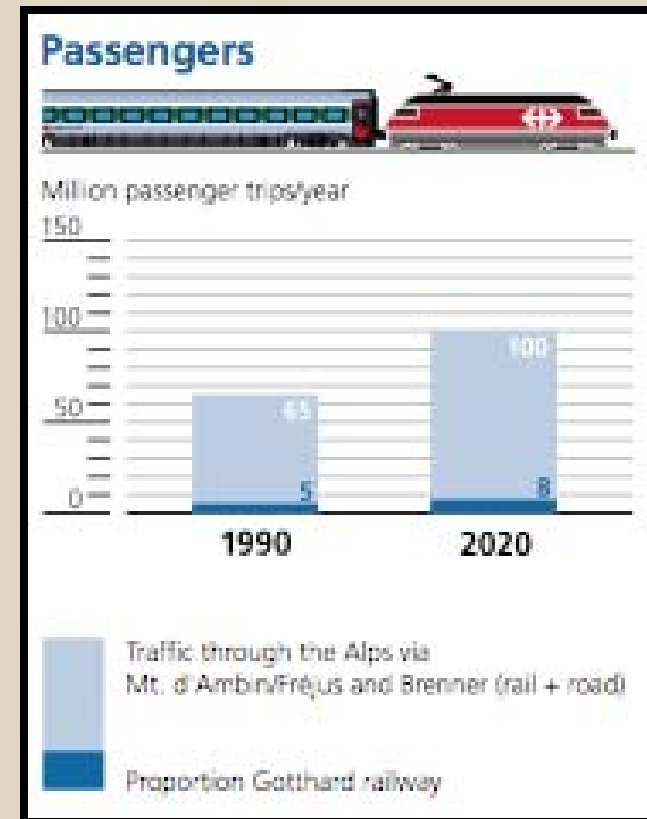
Cost

- Financing approved in 1998
- Funding from taxes
- \$30.1 billion invested initially
- + \$19.1 billion approved in 2008



Cost

- Initial Gotthard cost: \$7.2 billion USD
- Final Gotthard cost: \$10.1 billion USD
- 60 year payback period
- 88% said “money well spent”



Current State

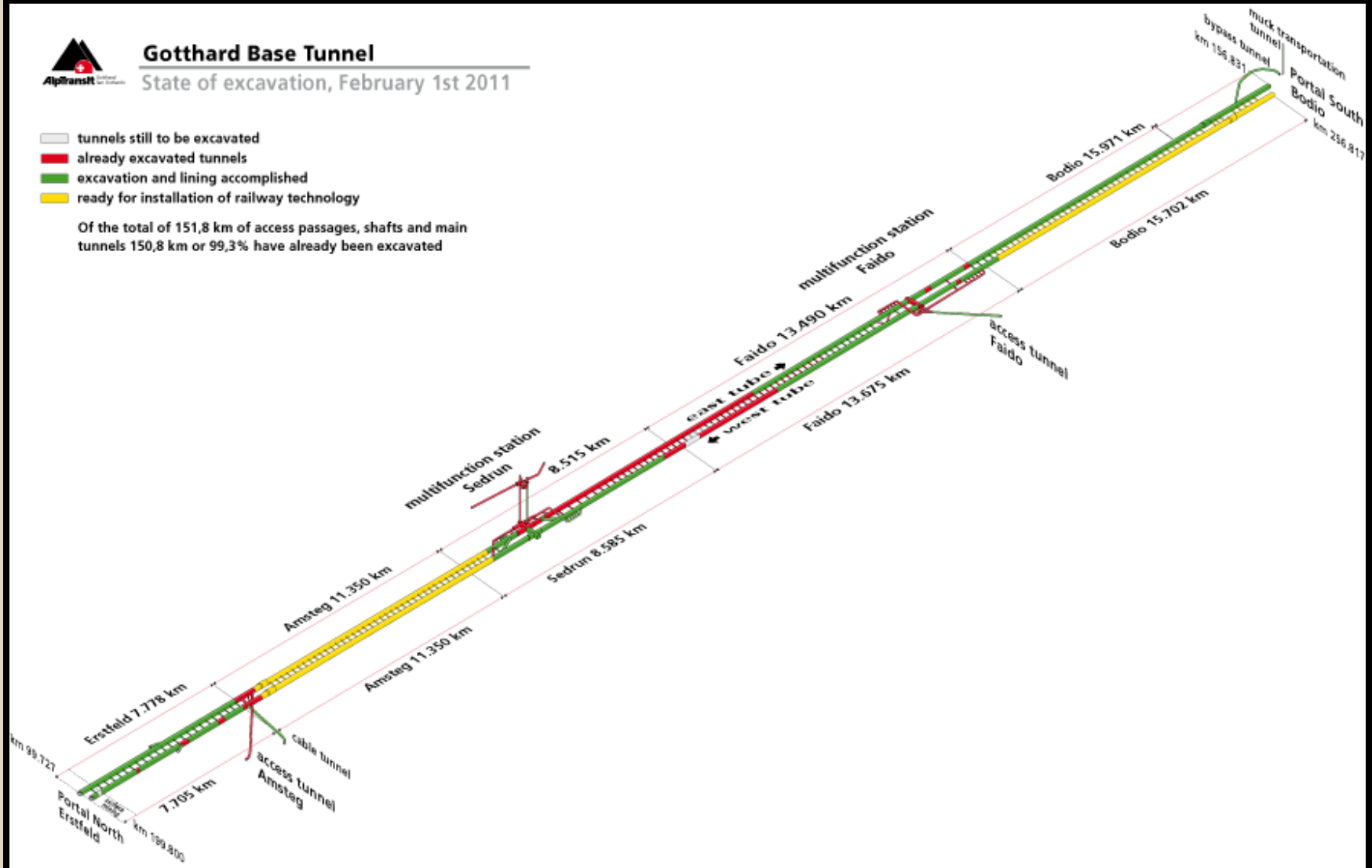


Gotthard Base Tunnel

State of excavation, February 1st 2011

- tunnels still to be excavated
- already excavated tunnels
- excavation and lining accomplished
- ready for installation of railway technology

Of the total of 151,8 km of access passages, shafts and main tunnels 150,8 km or 99,3% have already been excavated



Current State

As of February 1, 2011

- 99.3% of Excavation Complete
- Amsted & Bodio ready for railway
- Erstfield, Sedrun & Faido in concrete lining process



Road Ahead

- Planned opening in 2017
- Environmental Protection
- Incident management
 - Eliminate human element as much as possible
 - Preventative maintenance vs. reactive maintenance
- Railway of the Future
 - Branch Extension
 - Continuous Advancement



References

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