Sensible Underground Solutions for Urban Problems

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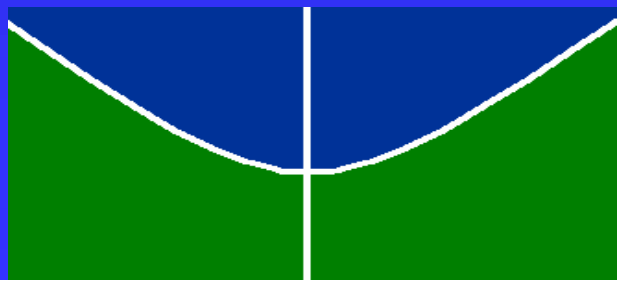


Sensible Underground Solutions for Urban Problems

- **Introduction**
- **Urban Problems and Underground Solutions**
- **Sensibilities of Underground Structures**
- **Final Remarks**

Introduction

World Urbanisation (UN Habitat, 1996)

- 1950: 10% of urban population (BR=38%)
- 2000: 60% of urban population (BR=82%)
- Urban population rate: 60 million / year
- 2015: 10% in 26 mega-cities (18 in Asia)
- Stabilization around 85%
- Investments in infrastructure of cities

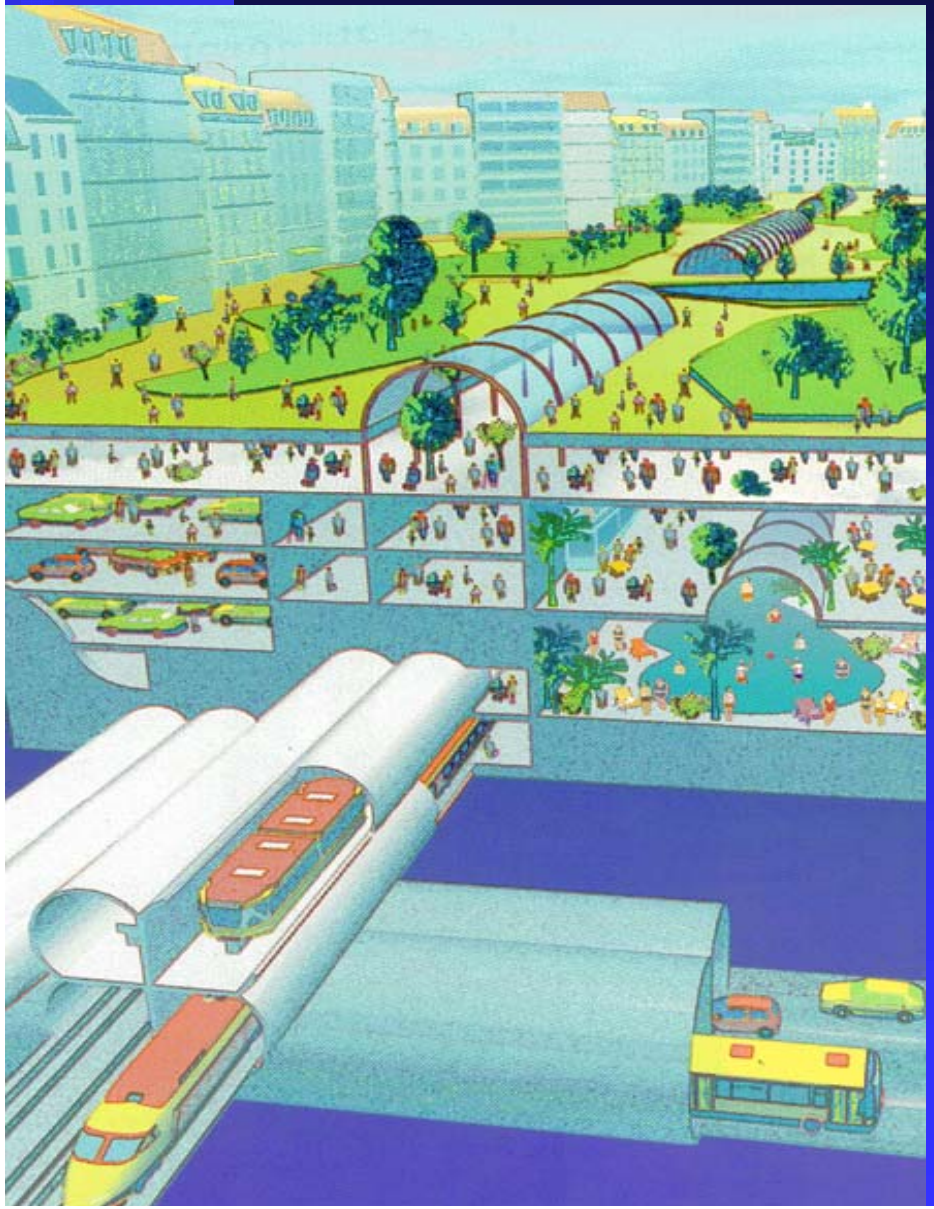
Introduction

Urban Problems

- Allocation of urban space to various urban functions
- Necessity of favouring economic development
- Pressures on the urban environment
- Impacts on global environment

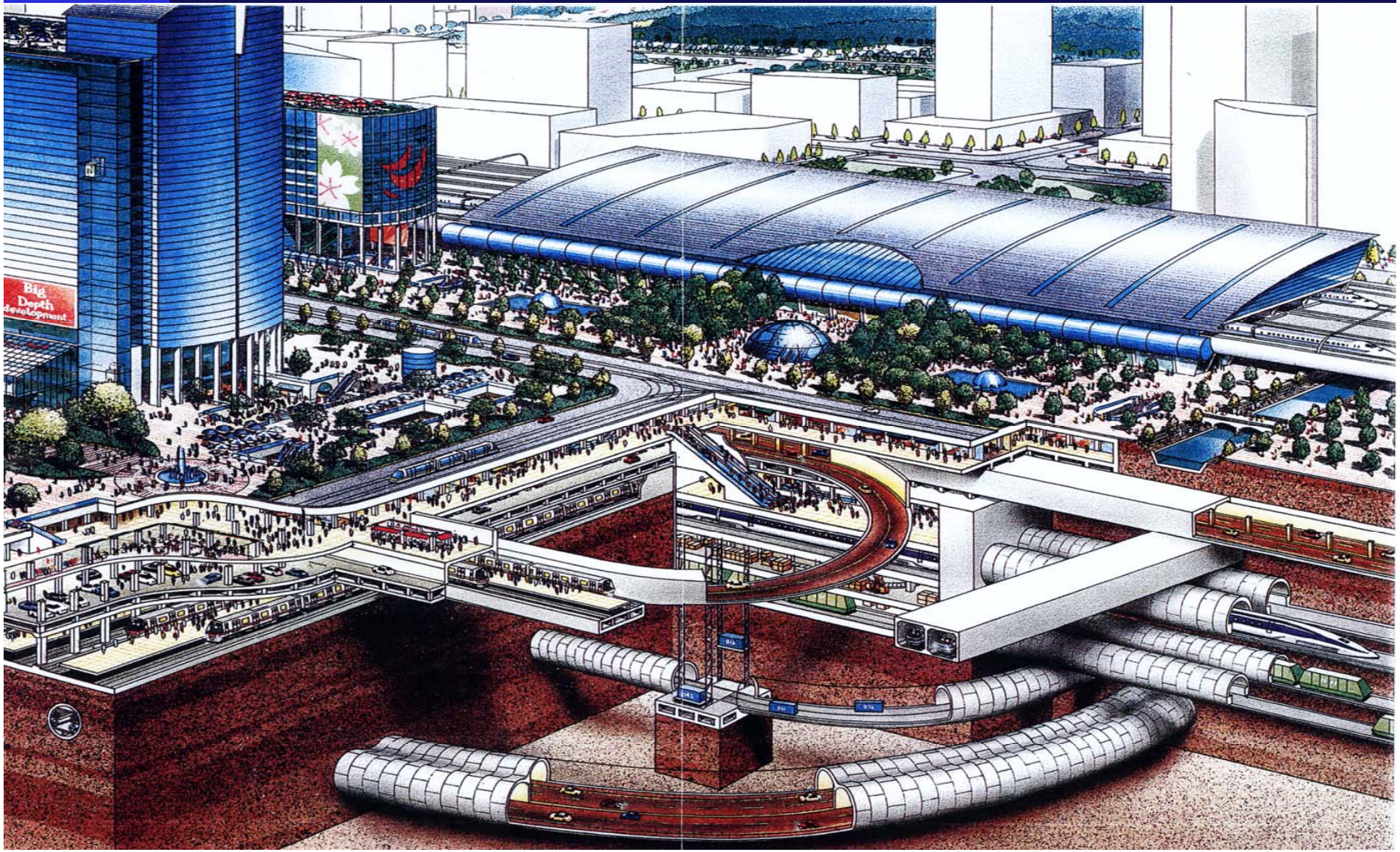
Need for Urban Infrastructure: Productivity →→ Mobility →→ Storage

Environmental Era: Quality of Life



- Better living conditions
- Minimum environmental impacts
- →Use of the surface for more noble needs
- →Use of the underground space for infrastructure

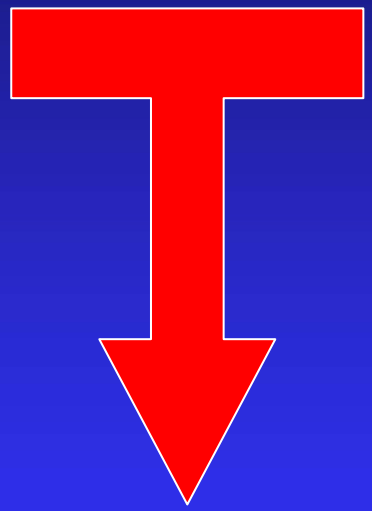
Environmental Era: Urban Trend



Underground Structures in Urban Areas

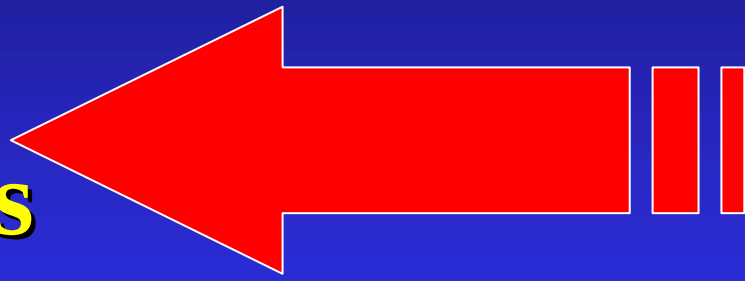
UN Conclusions

Environmental Era



Underground Solutions for Urban Problems: Infrastructure Combining Productivity and Quality of Life

Sensible Underground Solutions for Urban Problems

- Introduction 
- **Urban Problems and Underground Solutions** 
- Sensibilities of Underground Structures
- Final Remarks

Demand of Urban Underground Structures

- Transport
  - Mass Transit Systems
  - Urban Motorways (city rings)
  - Railway Links
- Public Utilities (water supply, sewage and cables)
- City Centre Revitalisation
- Storage (car parking, flood control, goods)
- Public Buildings (leisure, cultural activities)

Tunnels for Transport (next 10 years)	Total
Austria + Switzerland + Germany	800
France + Italy	350
Spain + Portugal	500
Norway + Sweden + Finland	500
UK	250
Netherlands + Belgium	100
North America	650
South America	500
Japan	2500
China (next 20 years)	20000

Mass Transit Systems

- More than 100 cities predominantly underground

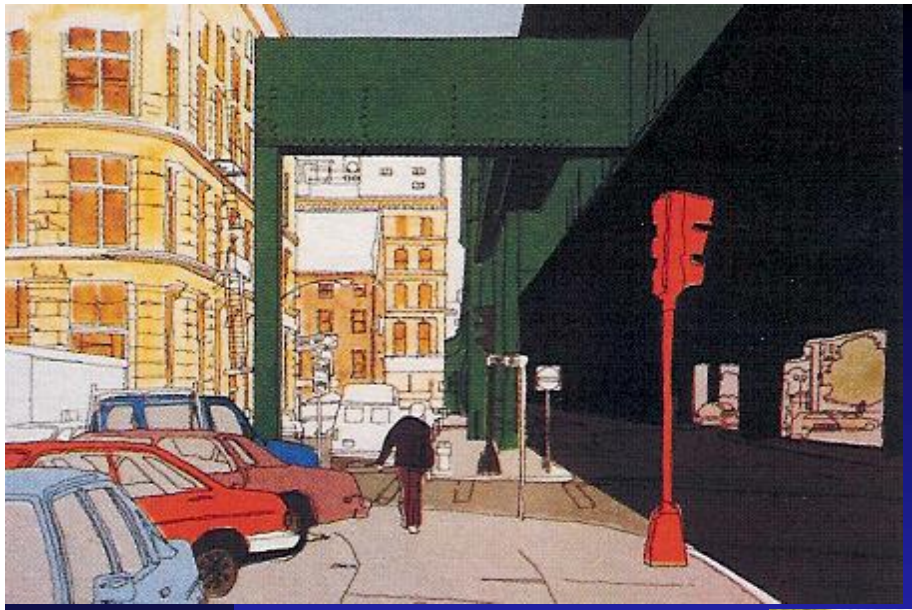
Argentina	Buenos Aires
Brazil	Belo Horizonte, Brasilia, Curitiba, Fortaleza, Goiania, Porto Alegre, Recife, Rio, Salvador, Sao Paulo
Chile	Santiago
Colombia	Bogota, Medellin
Mexico	Guadalajara, Mexico, Monterrey
Peru	Arequipa, Lima
Uruguay	Montevideo
Venezuela	Caracas

Public Utilities

- Water supply
- Flood control
- Sewage
- Cables

Water Supply and Sewage

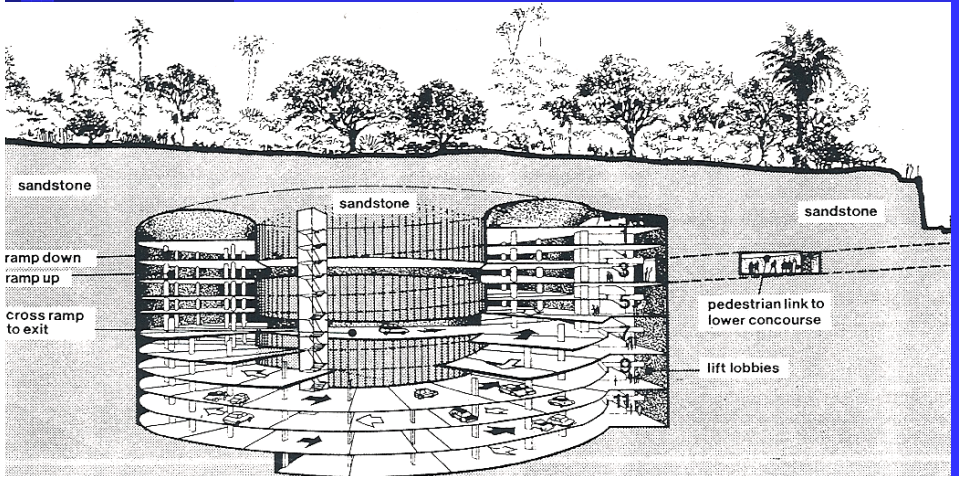
- Water supply
  - Paijanne tunnel, Helsinki, Finland (120 km)
  - Sao Paulo: 1/3 lost by leakage
- Sewage
  - Tokyo: 15,000 km completed in 1995 (100%)
  - Sao Paulo: 1,500 km by 2005 (80%) – 120 km per year (25 pipe jacking machines)

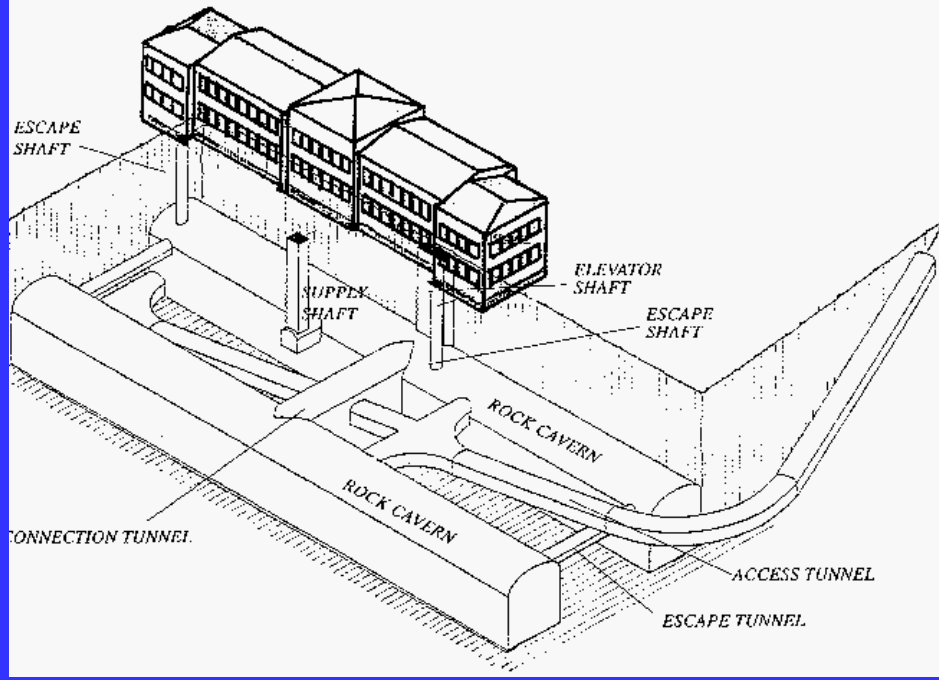


City Centre Revitalisation

- Elevated structures
- Rails and depots
- Car parking

Car Parking & Public Building





Sensible Underground Solutions for Urban Problems

- Introduction
- Urban Problems and Underground Solutions
- **Sensibilities of Underground Structures**
- Final Remarks

Sensibilities of Underground Structures

- Construction Costs
  - Pre-conception that cost is too high
- Work Schedule
  - Pre-conception that work schedule is too long and delays
- Safety and Security
  - Accidents during construction
  - Operation

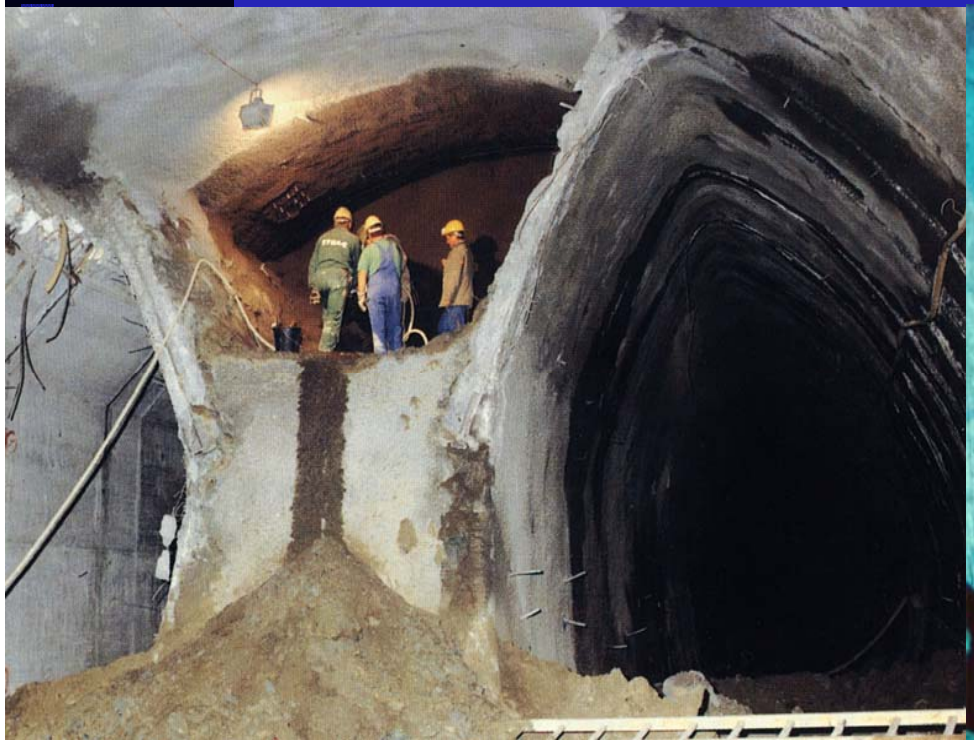
Sensibilities During Construction: → Most Are Related to Geology

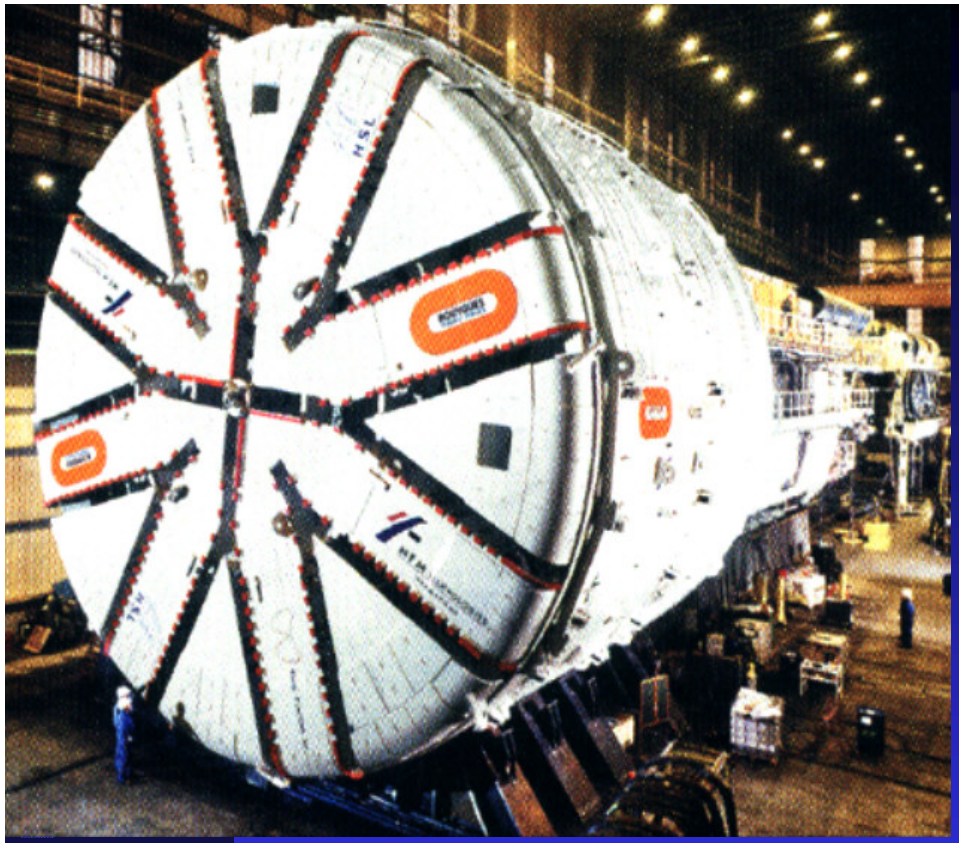
- Cost Difficulties
  - Estimation of support needs
- Work Schedule
- Safety
  - Accidents during construction

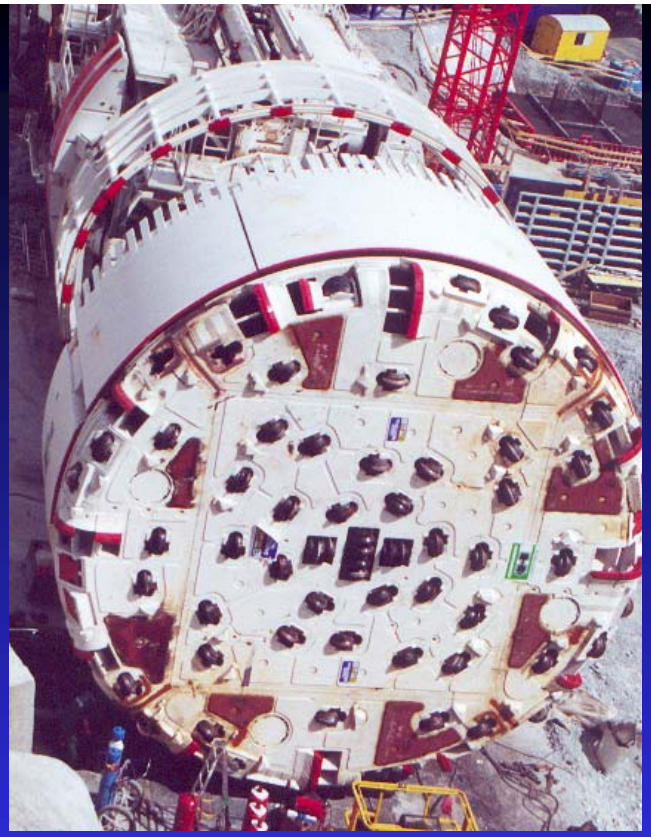
Underground Structures: Favourable Factors

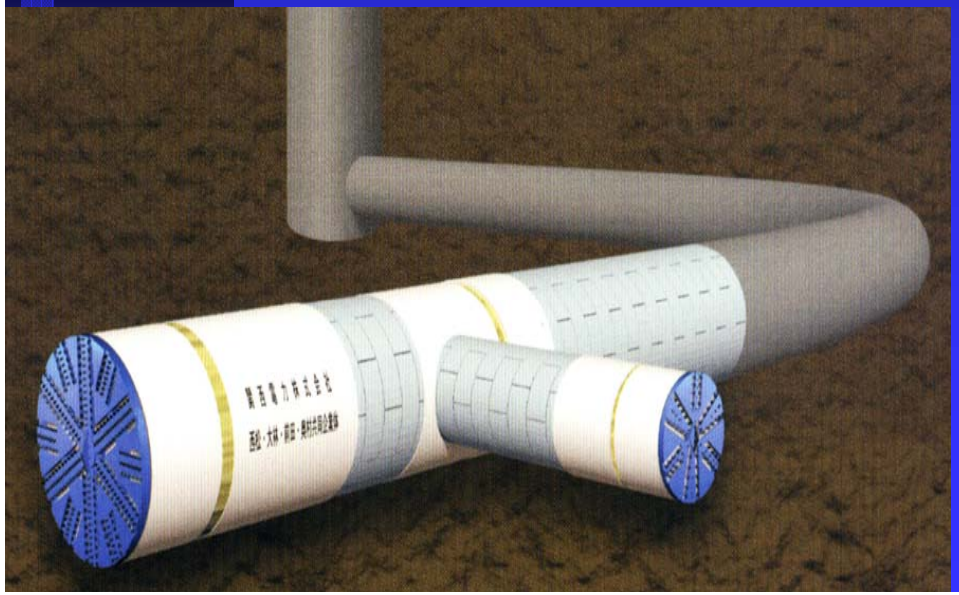
- Improvements of tunnel engineering
  - Tunnelling knowledge
  - Tunnelling technology
- High costs of the surface space
- Difficulties, impacts and disturbances of surface works
- Devaluation of regions surrounding surface infra-structure

Tunnelling Engineering and Technology

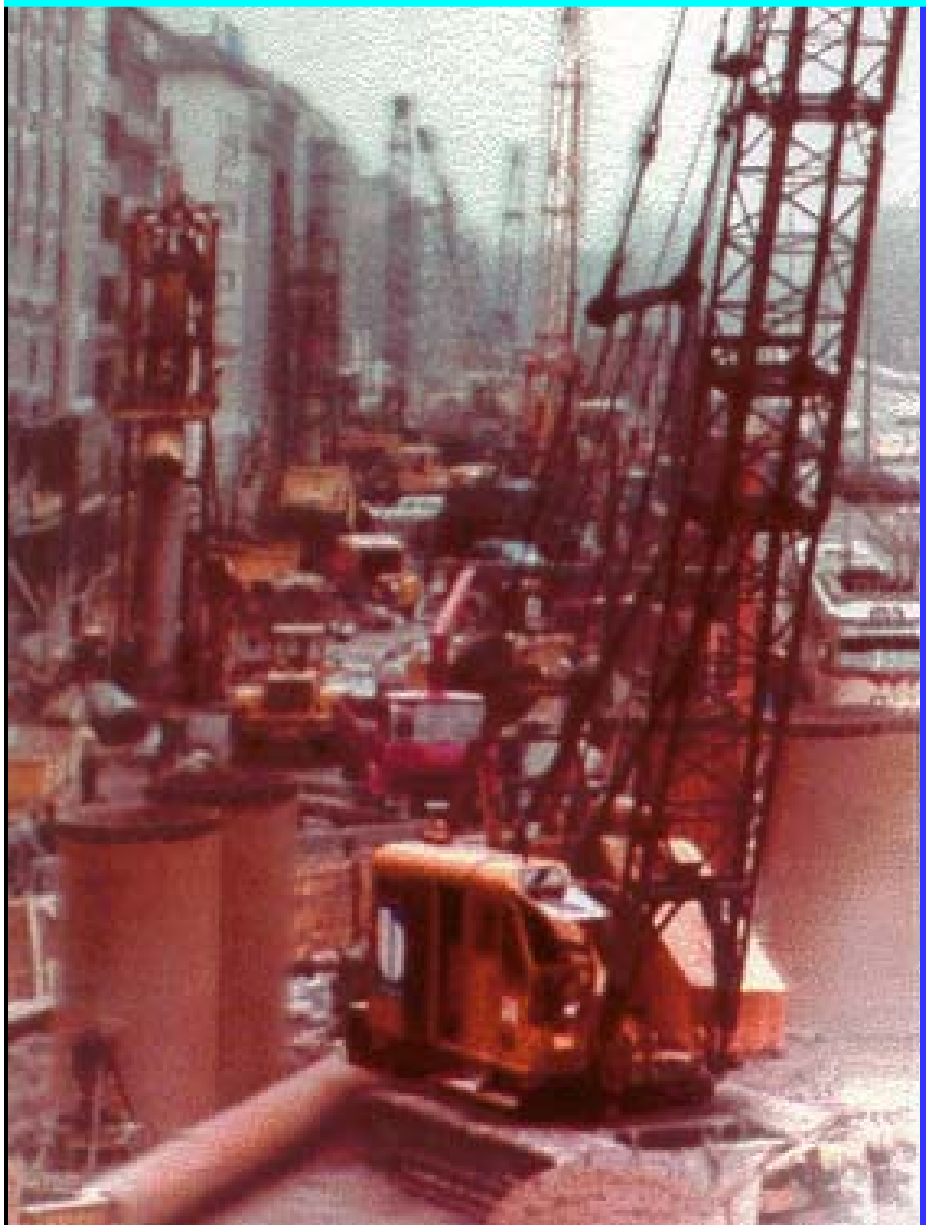


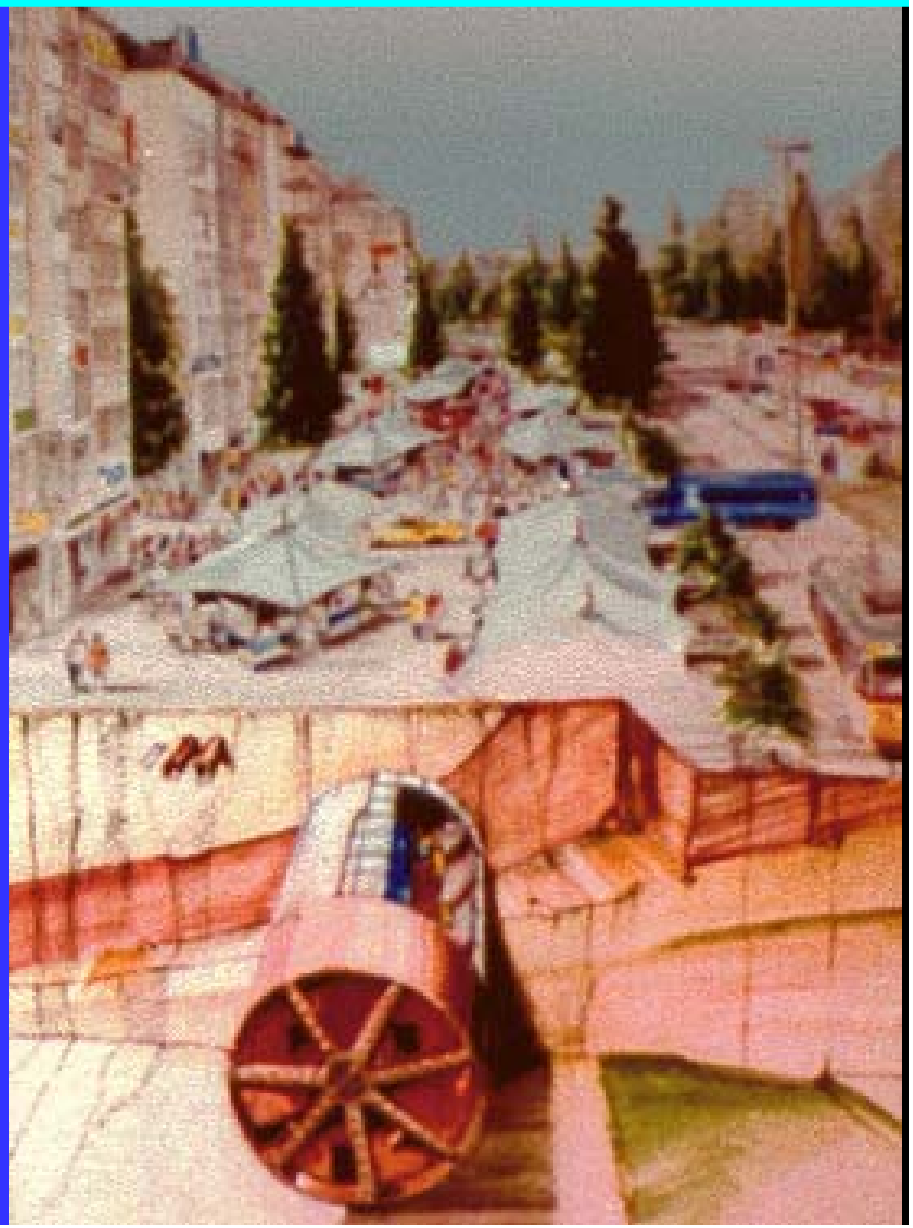




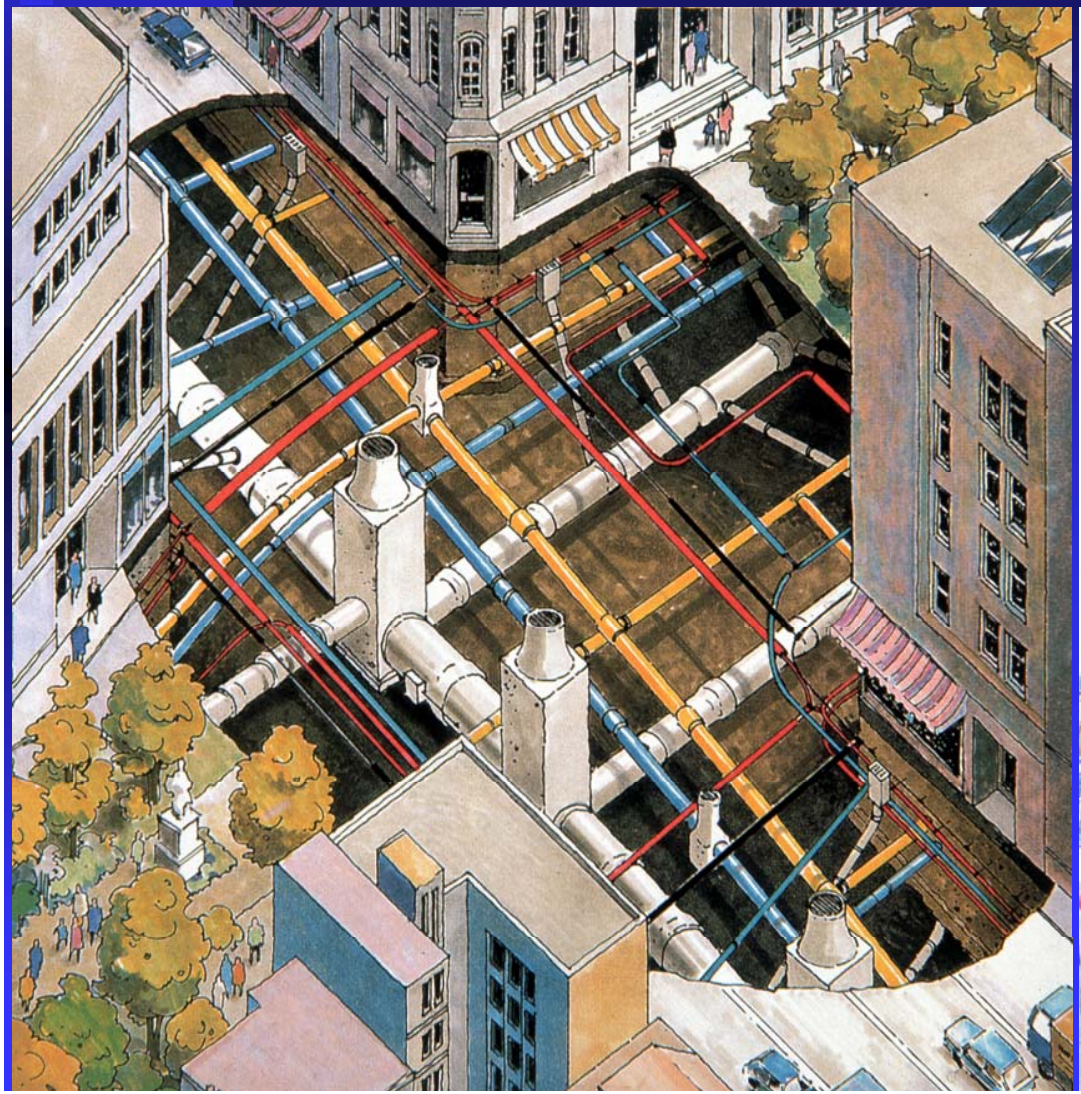


Disturbances During Construction

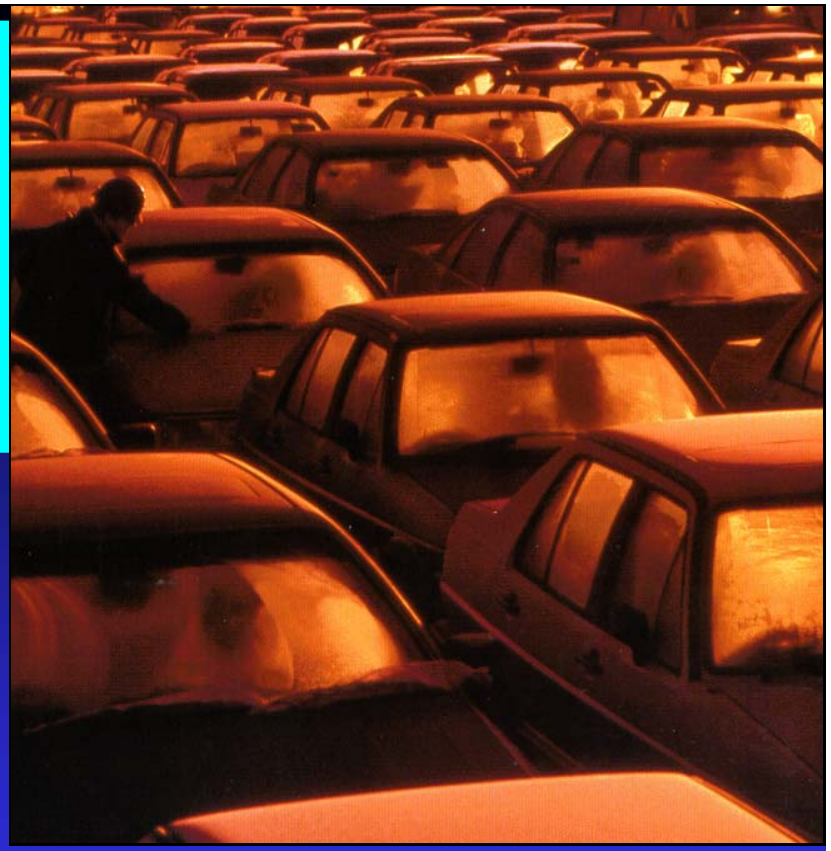




Surface Construction Costs and Neighbourhood Devaluation



Indirect Benefits of Urban Underground Infrastructure



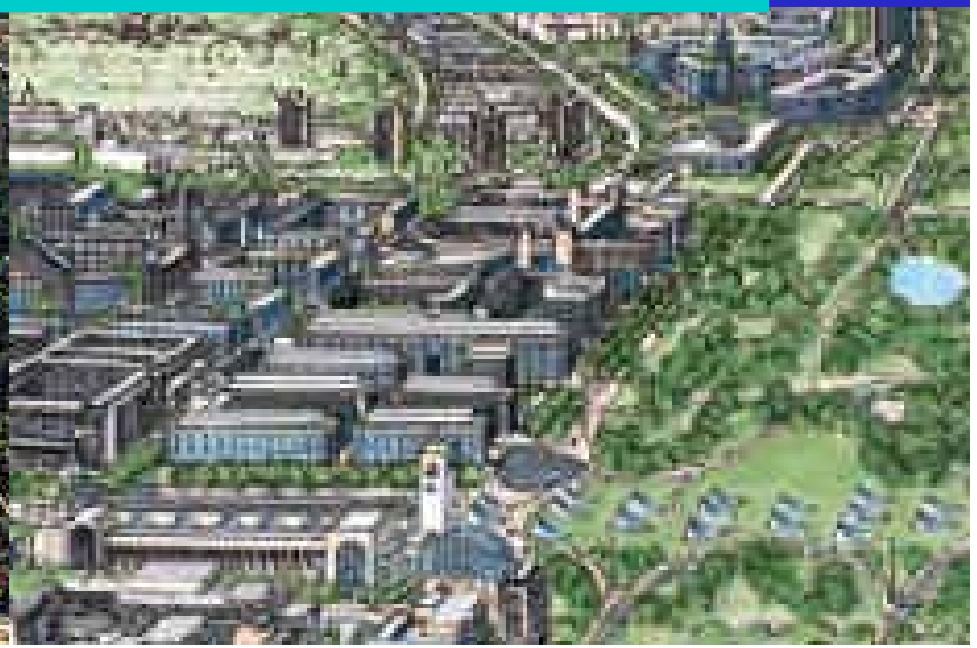
- Time Savings
  - → Time is money
- Energy Savings
  - → Less Environmental Impacts
- Lower Long-Term Maintenance Costs
- Reliability (safety, comfort and time table)
- Priority of the Surface Space Use for more Noble Purposes

Global Cost Assessment

- Construction versus Global cost analyses
  - Indirect benefits
  - Urban reorganisation, revitalisation and revaluation of surroundings

- **Need of a feasibility model → Best cost-benefit investment**

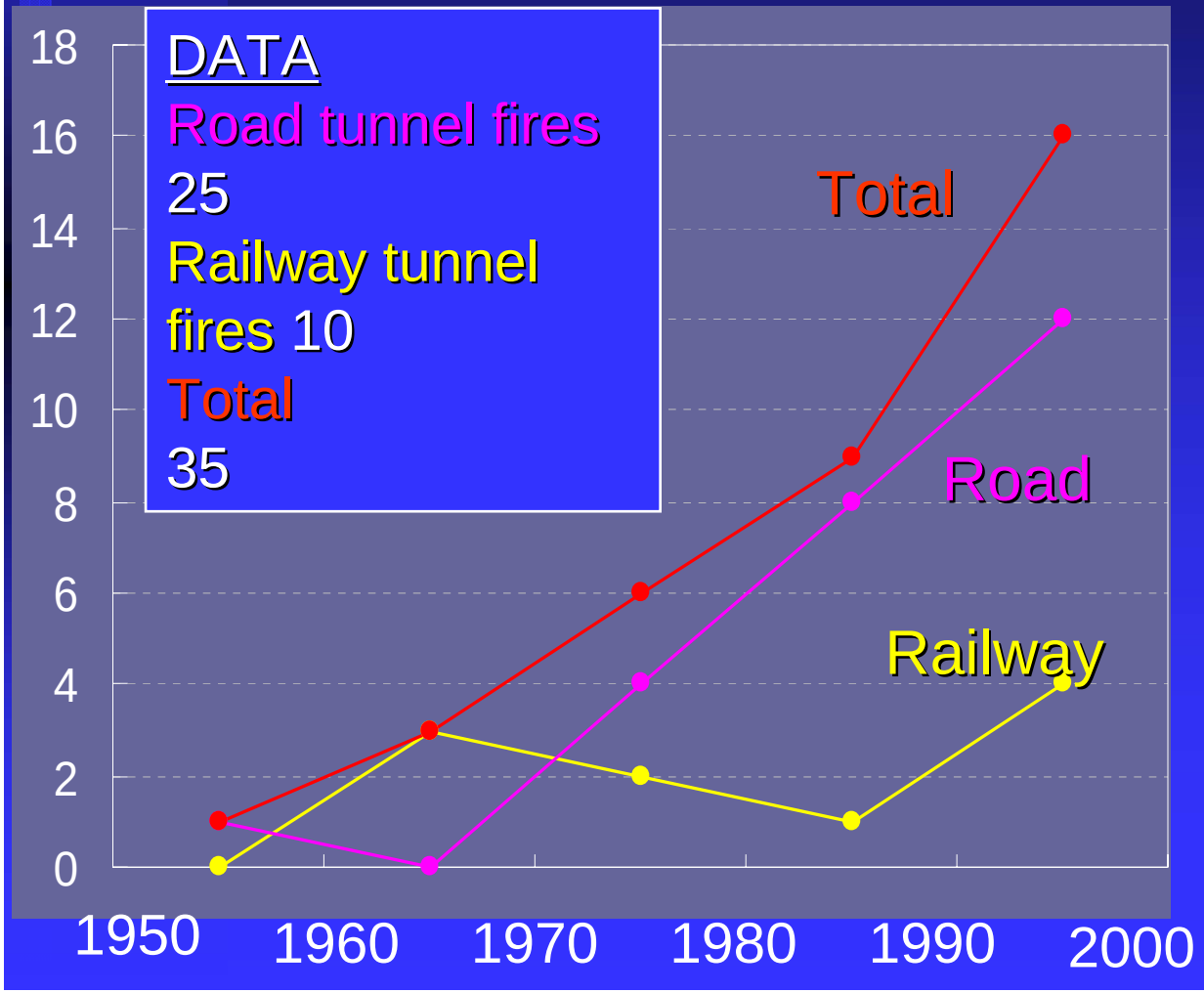
City Centre Revitalisation

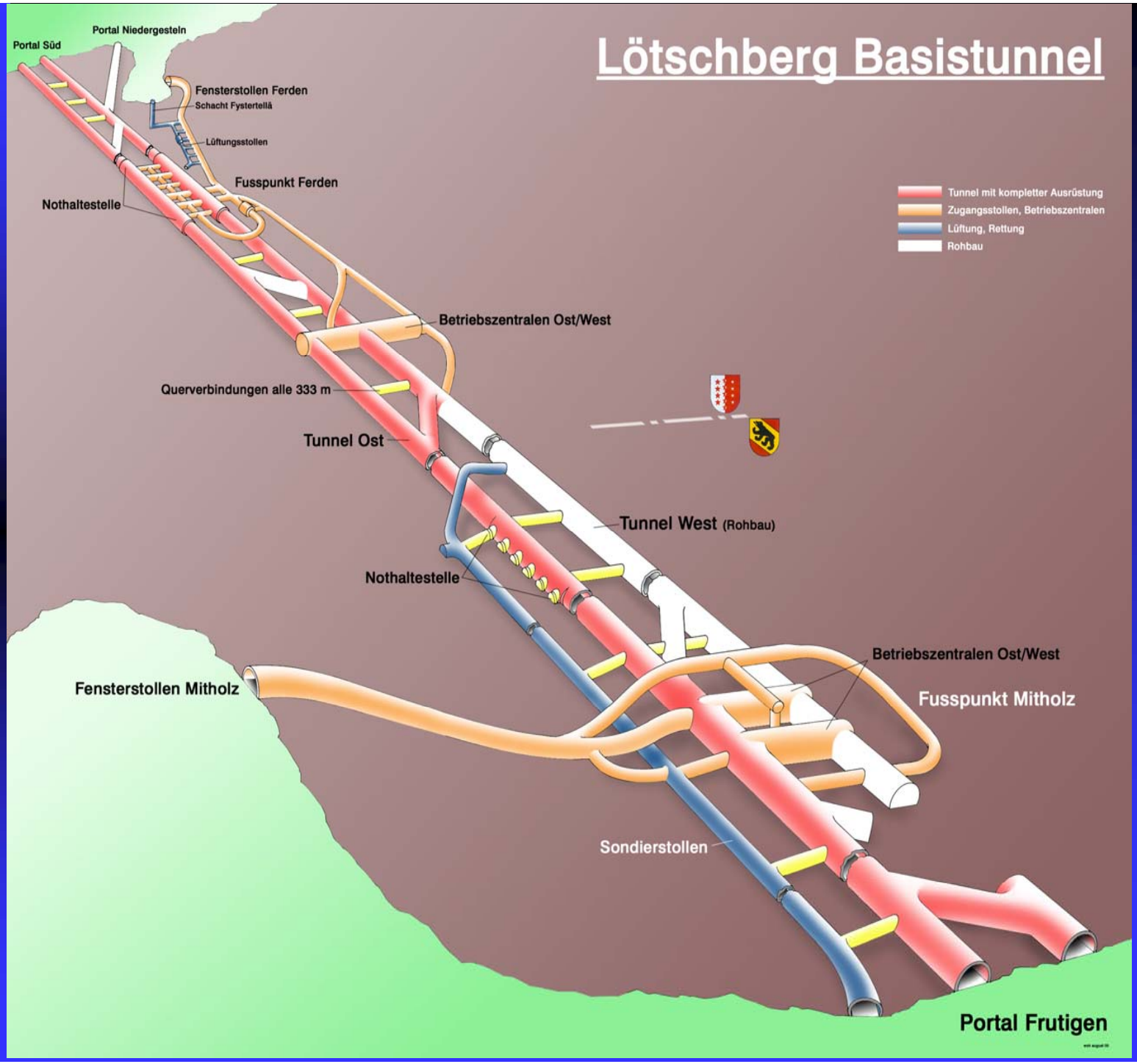


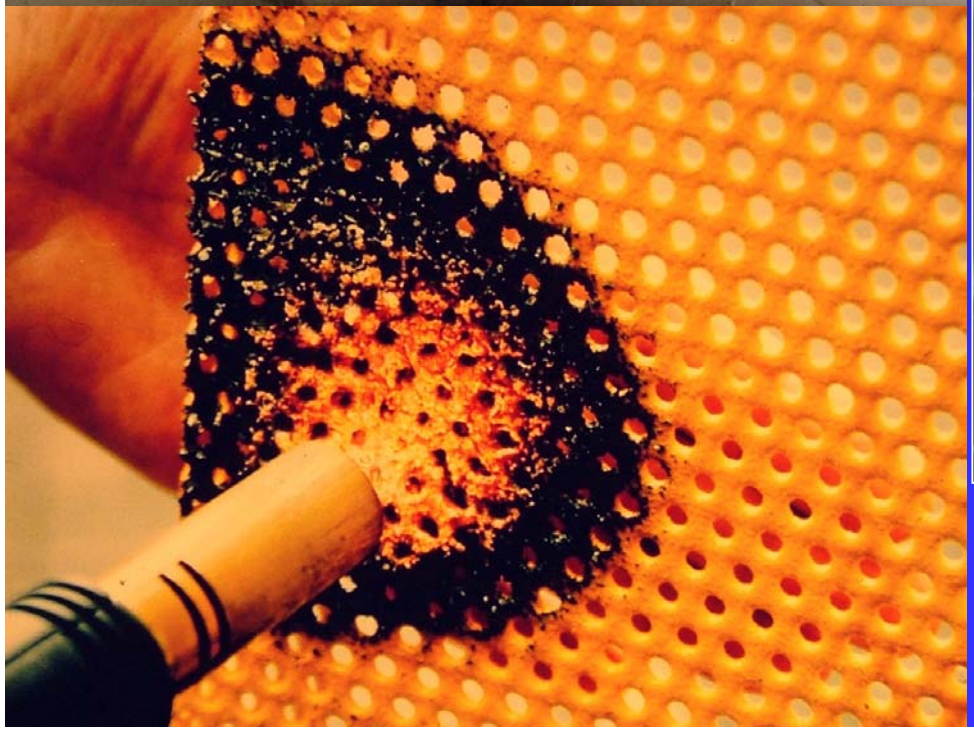
Sensibilities During Operation: Safety for Users

- Architecture
- Psychology
- Illumination
- Finishing
- Signalling
- Training

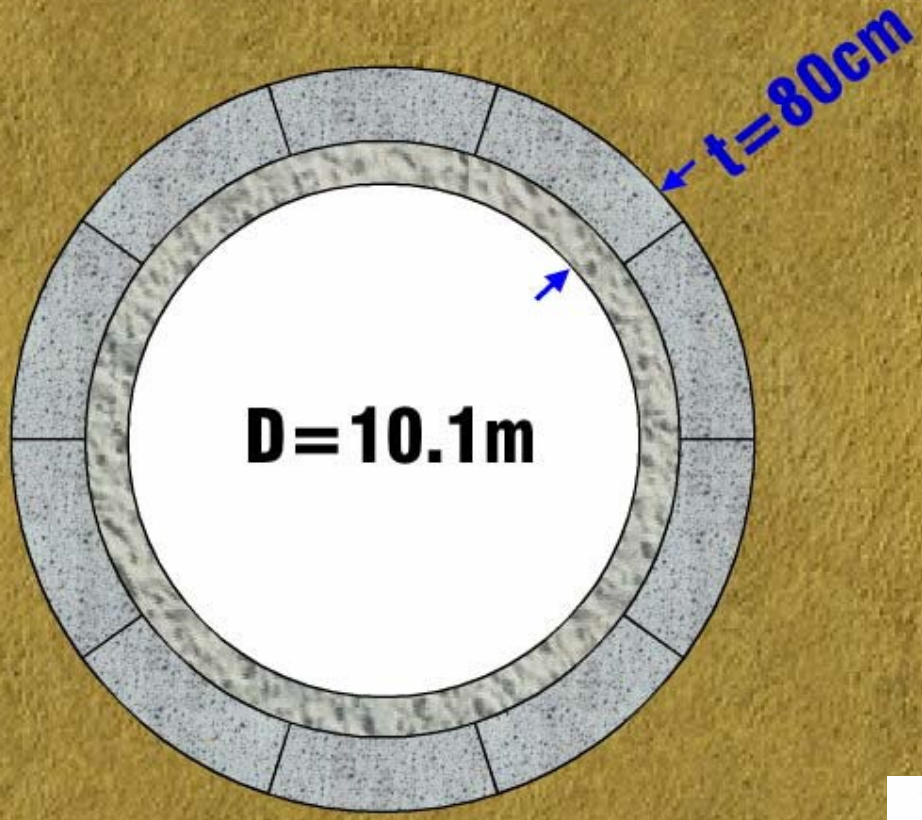
Sensibilities During Operation: Fires




Lötschberg Basistunnel
Portal Süd
Portal Niedergesteln
Fensterstollen Ferden
Schacht Fystertellä
Lüftungsstollen
Fusspunkt Ferden
Nothaltestelle
Tunnel mit kompletter Ausrüstung
Zugangsstollen, Betriebszentralen
Lüftung, Rettung
Rohbau
Betriebszentralen Ost/West
Querverbindungen alle 333 m
Tunnel Ost
Tunnel West (Rohbau)
Nothaltestelle
Betriebszentralen Ost/West
Fusspunkt Mitholz
Fensterstollen Mitholz
Sondierstollen
Portal Frutigen

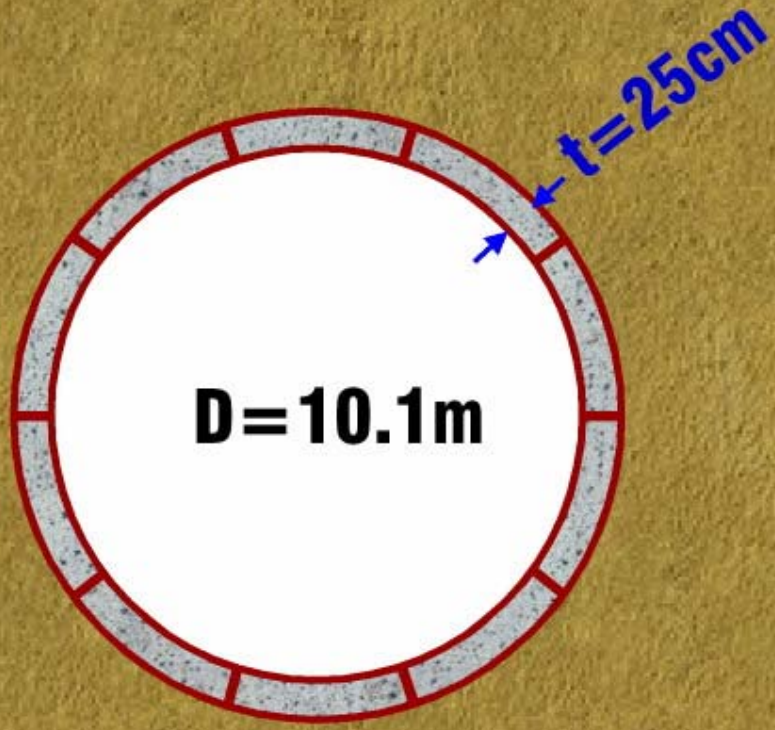


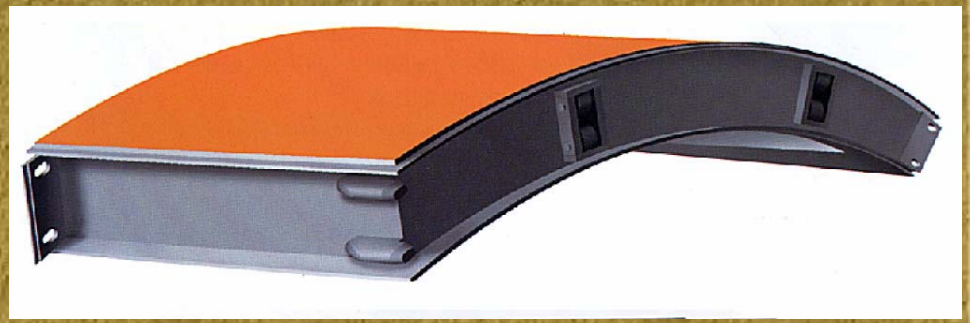
Original design



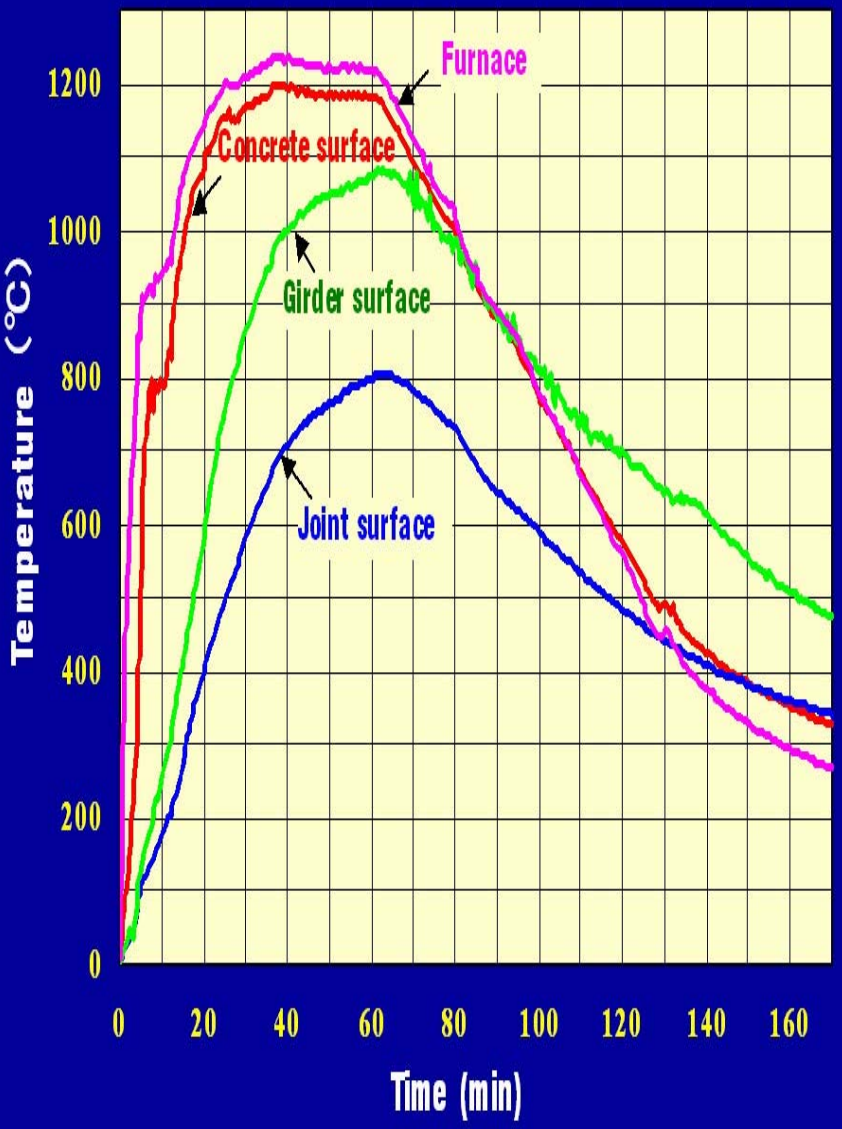
RC segment

Design change

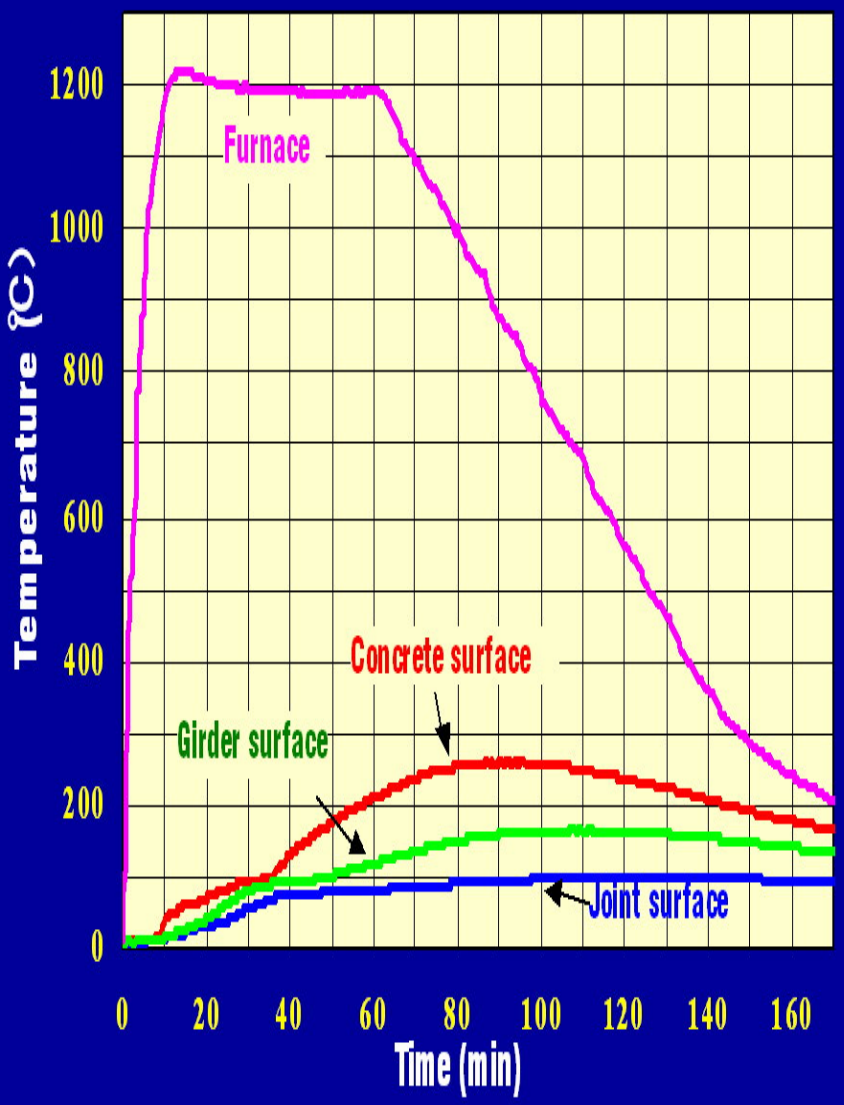




Excavation volume can be reduced by 19m³/m



Surface temperature of unprotected specimen



Surface temperature of board type protection

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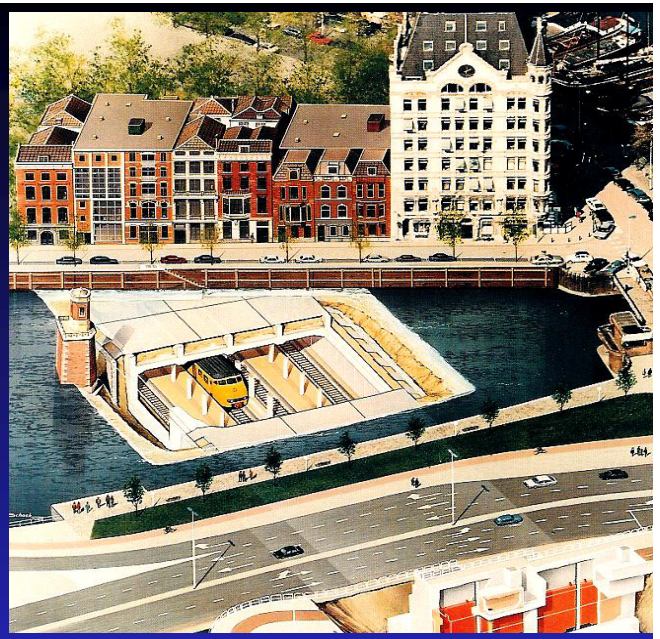
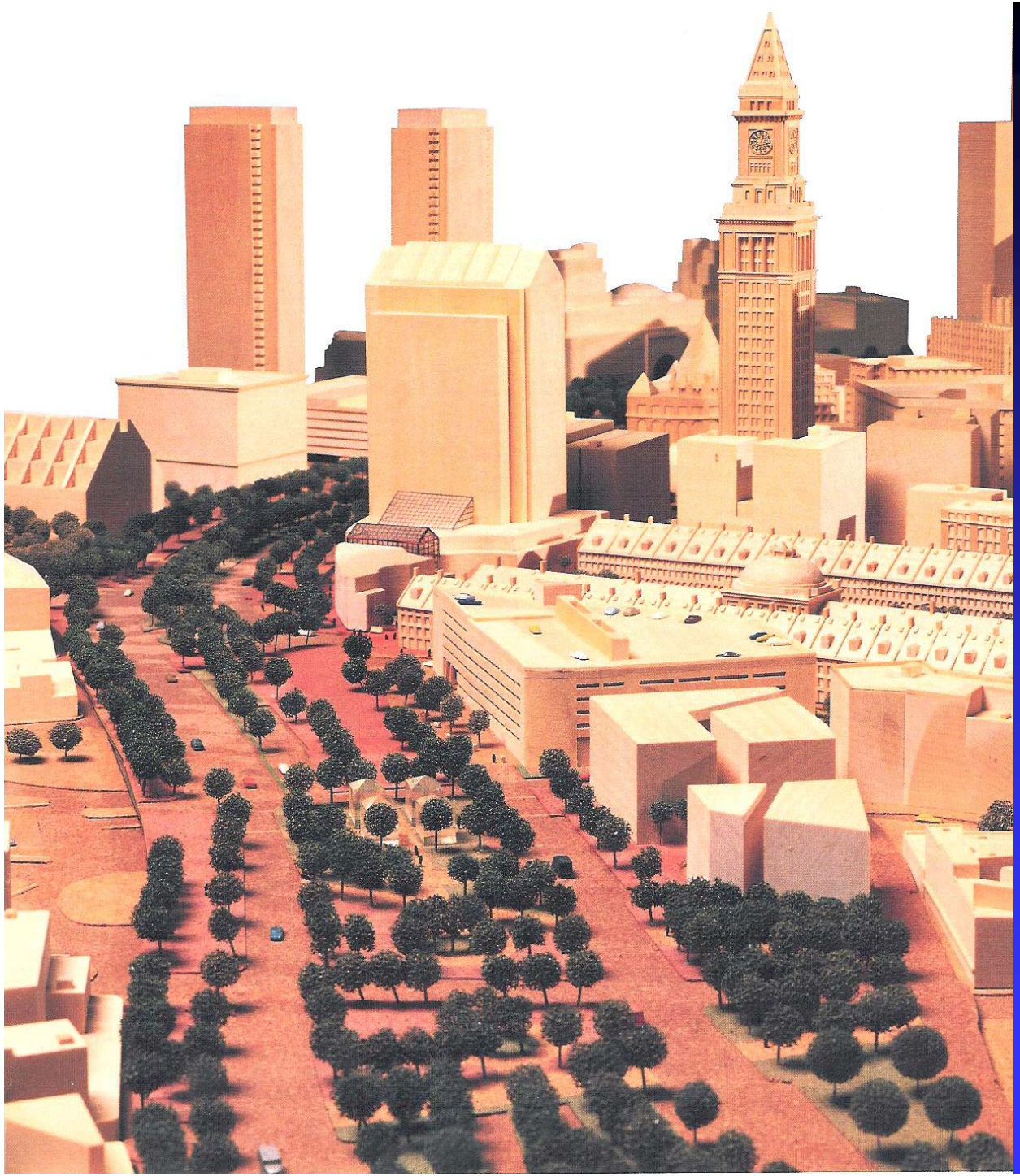
Final Remarks on Urban Underground Infrastructure



- Increasing demand
- Feasibility depends on global cost analyses
- Construction methods and technology vary depending on geology, tunnel location, length and geometry, local tradition etc.
- Tunnel engineering and technology allow construction in any kind of environment
- Safety and security concerns during operation



Acknowledgements:

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