



North/South-line: The connection with tomorrow





The north/south line

1. Introduction

2. Tecnics

3. Organisation

Break

4. Risk management

5. Current status

6. Questions and possible answers



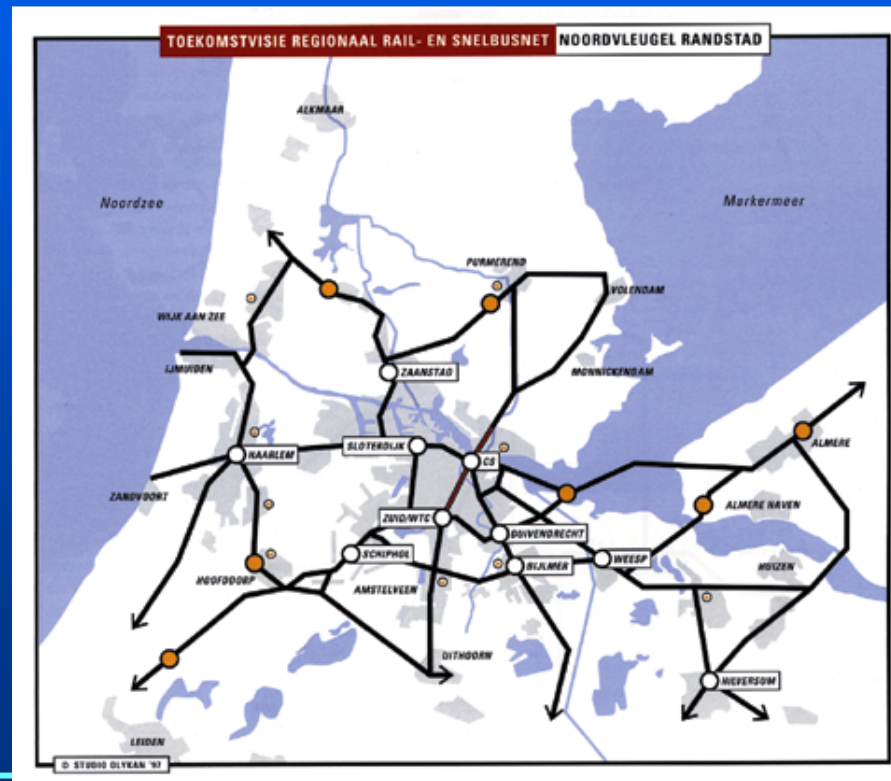
North/south line

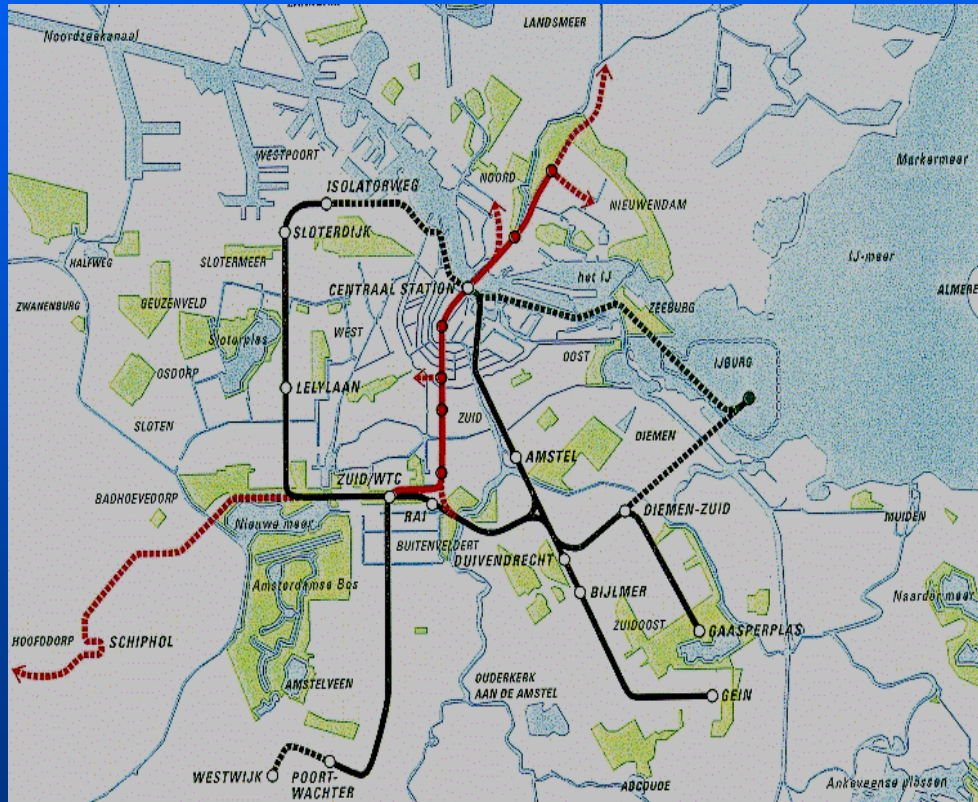
2. Tecnics

- **Why a North/South-line**
- **The city**
- **Alignement**
- **construction techniques**
- **Stations**
- **Monitoring**
- **Safety sytems**



North South line: part of a regional system



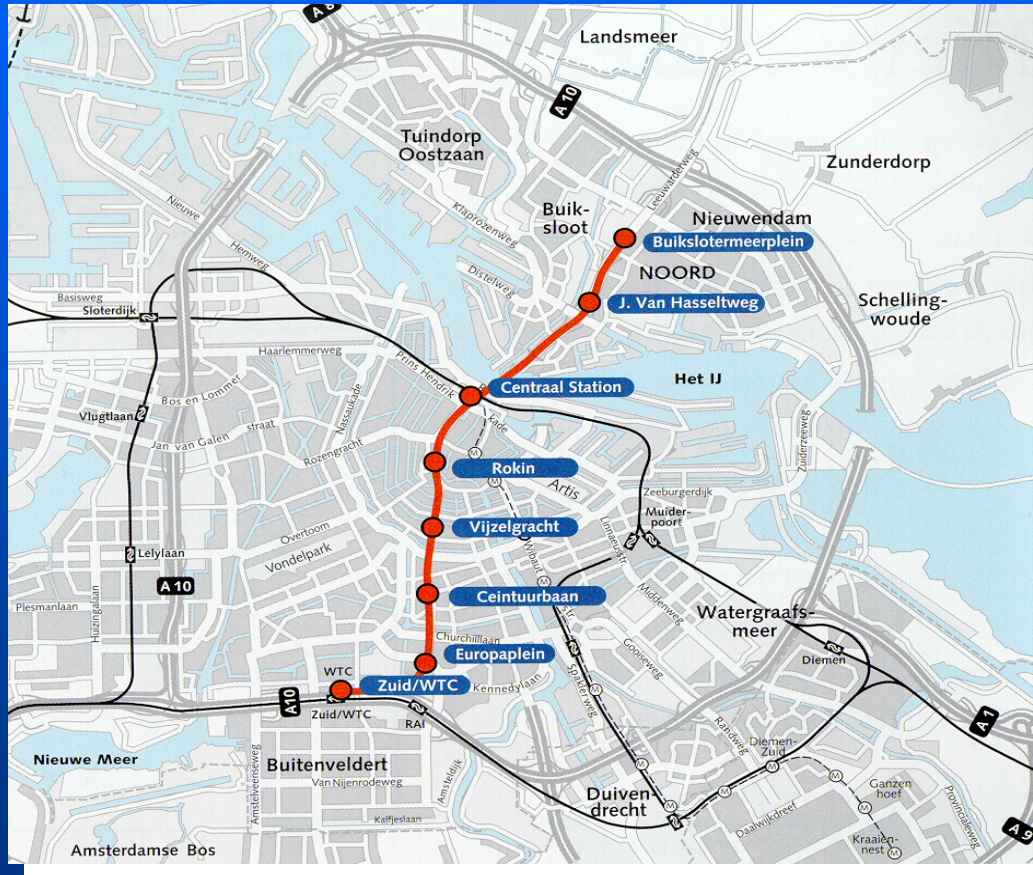


North/South-
line:
Part of the
local public
transport
system

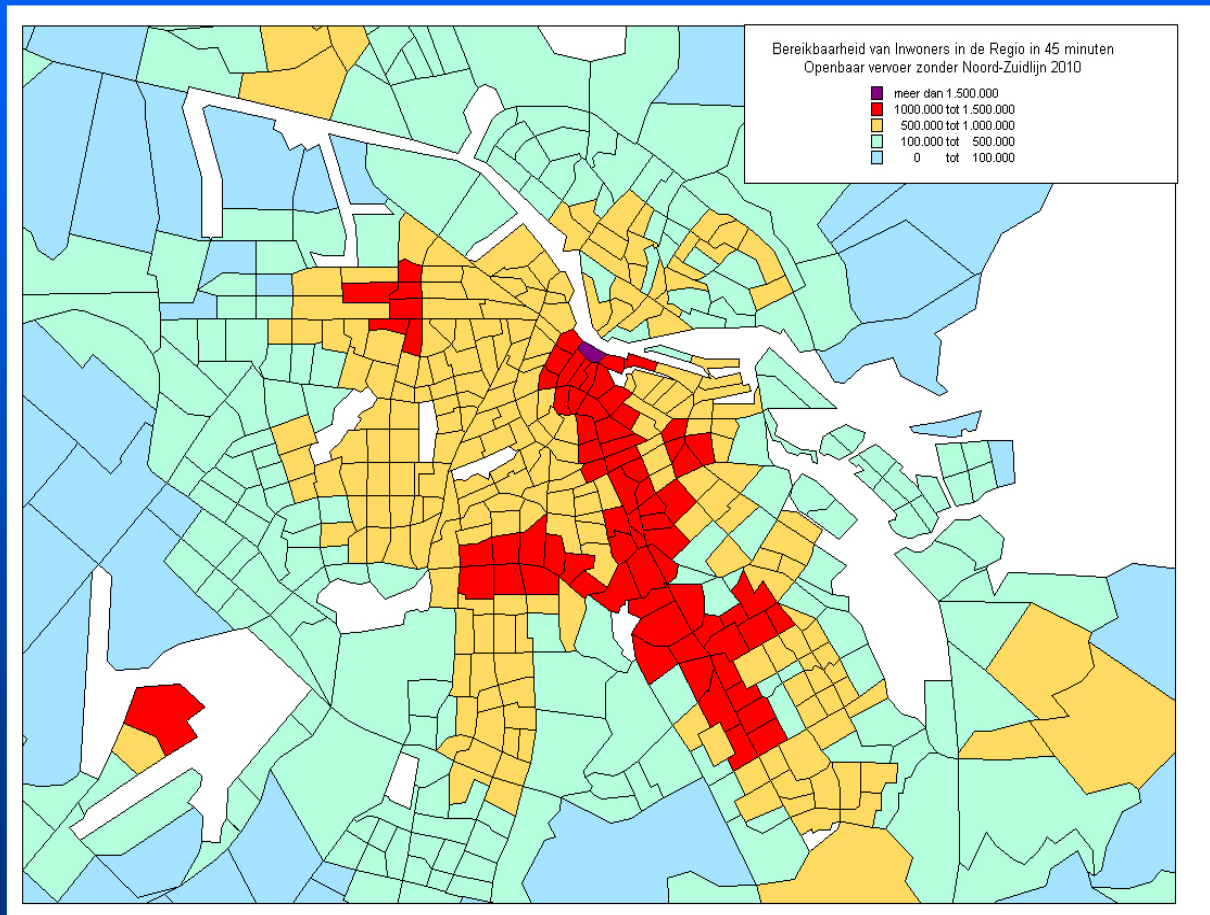


Travelling speed of public transport systems

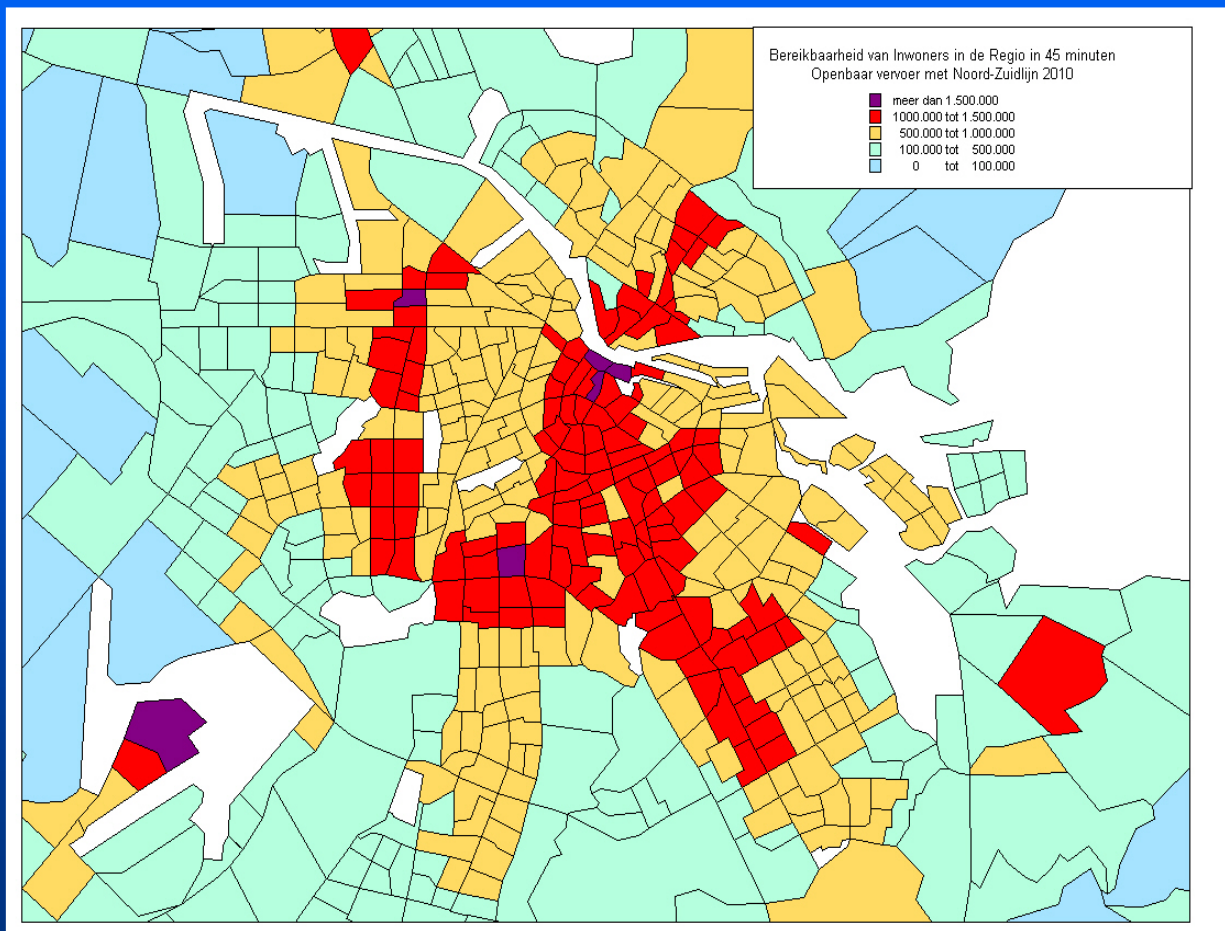
	V(traveler) [km/hour]
CITY (dense grid) Busses & streetcars	12 – 18
REGION City environment : metro	35
Region : bus	> 35
PROVINCE Train	50 – 60
LAND Intercity trains	> 60



North/South- line: stations



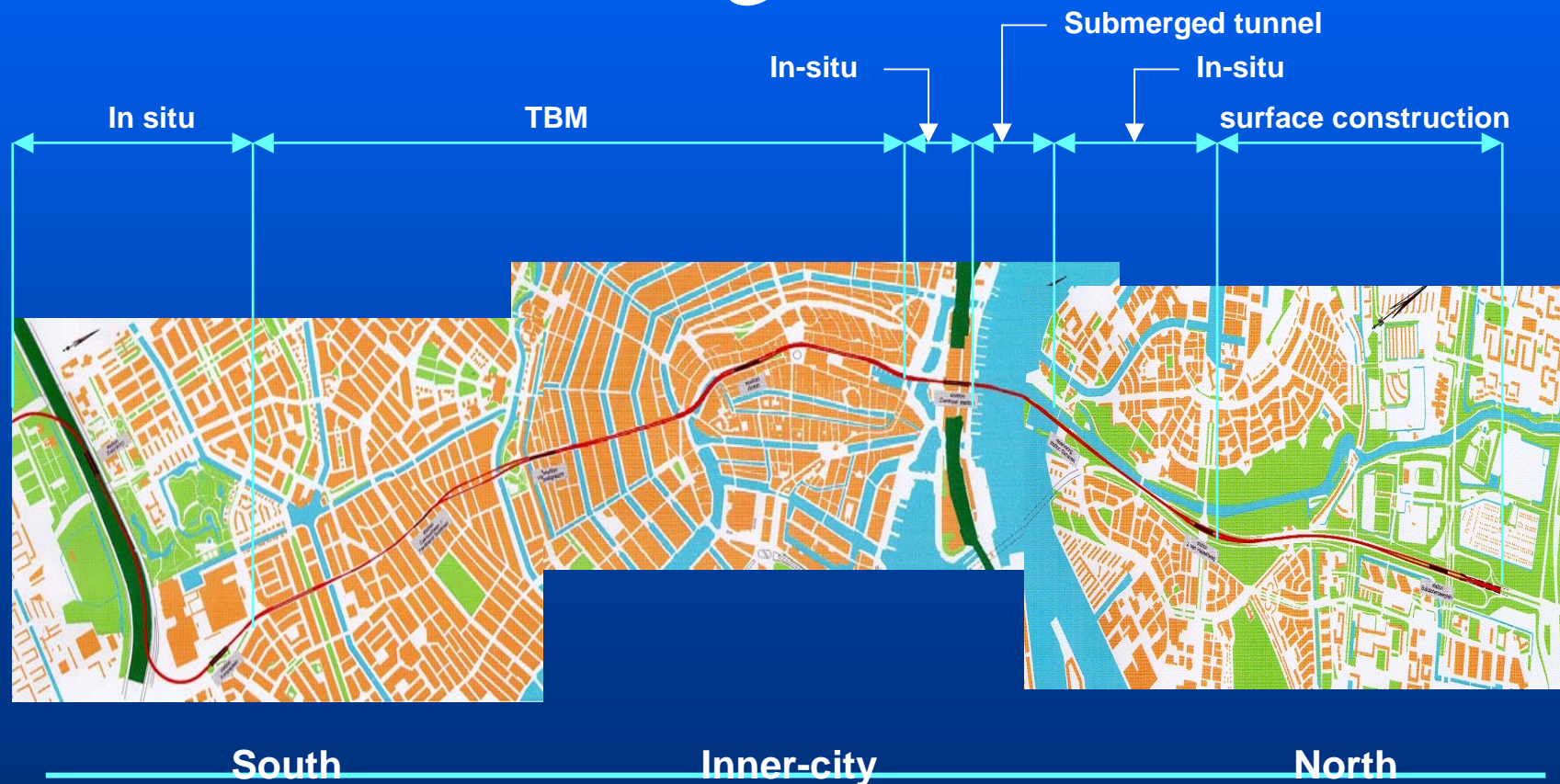
2011
without
North/South
line

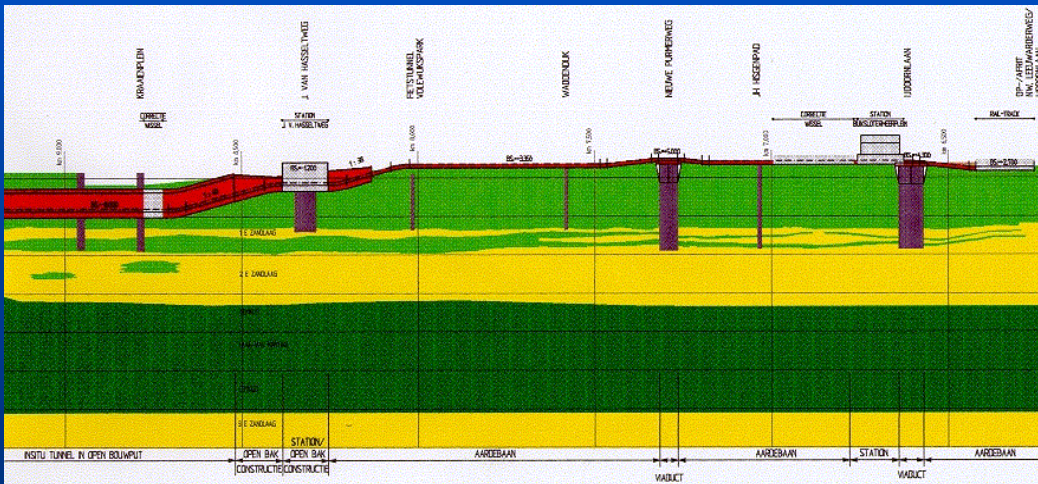


2011 with
North/South
line



The North/South-line: horizontal alignment

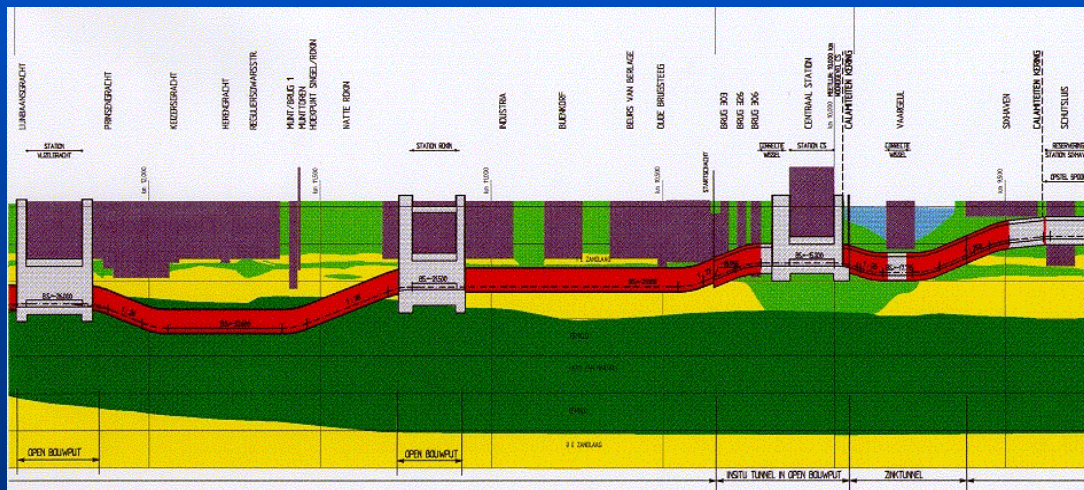
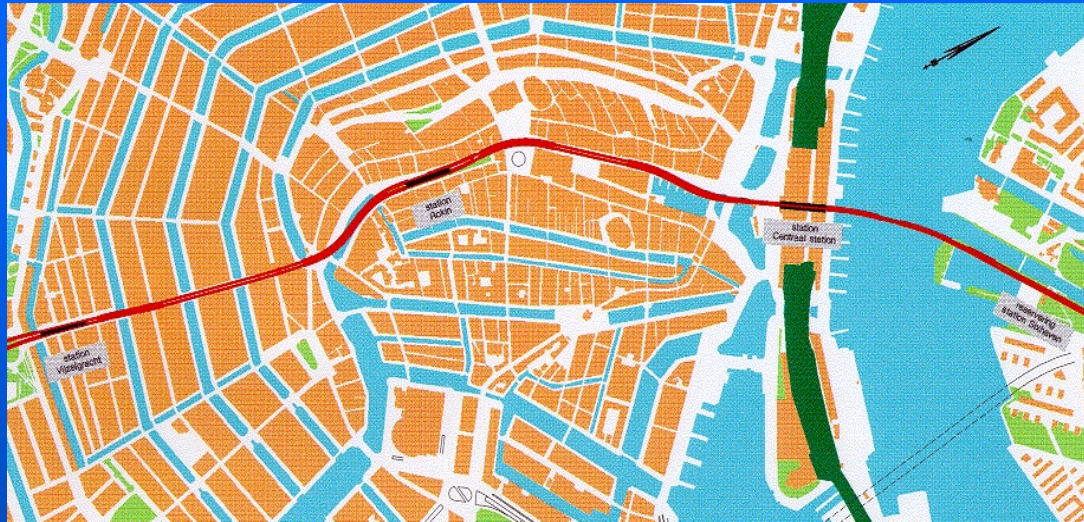




North

Construction:
Tracks &
Stations at
surface level.

Shallow in-
situ built
tunnel



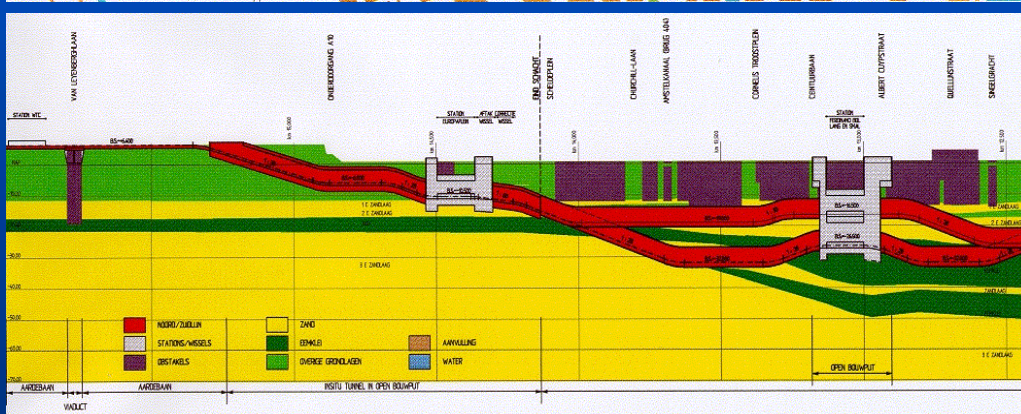
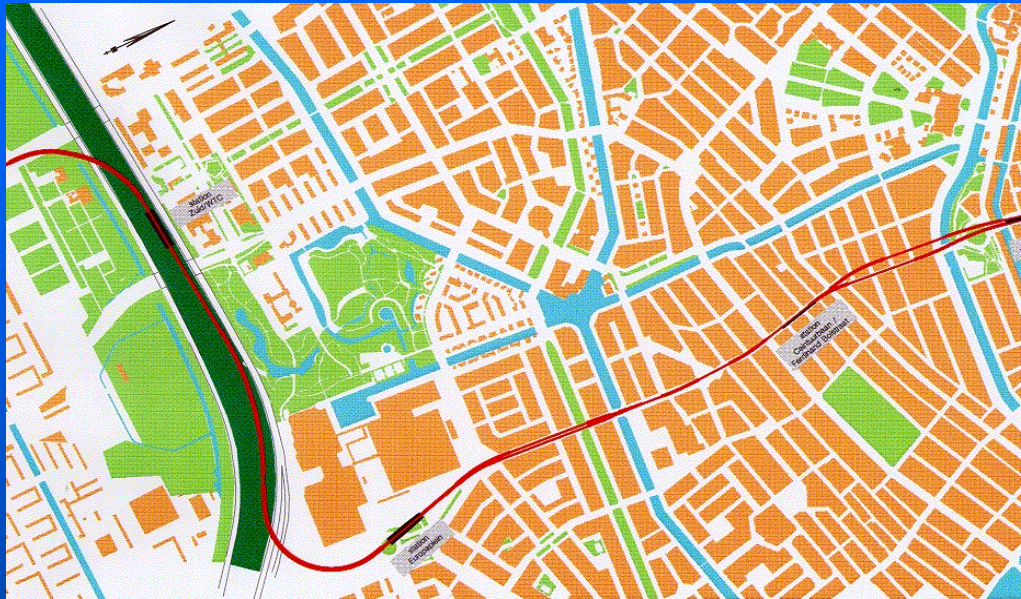
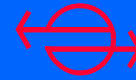
Inner city

Submerged
tunnel

Caissons

Twin bored
tunnels

Deep stations
(cut & cover)



South

Twin bored tunnels

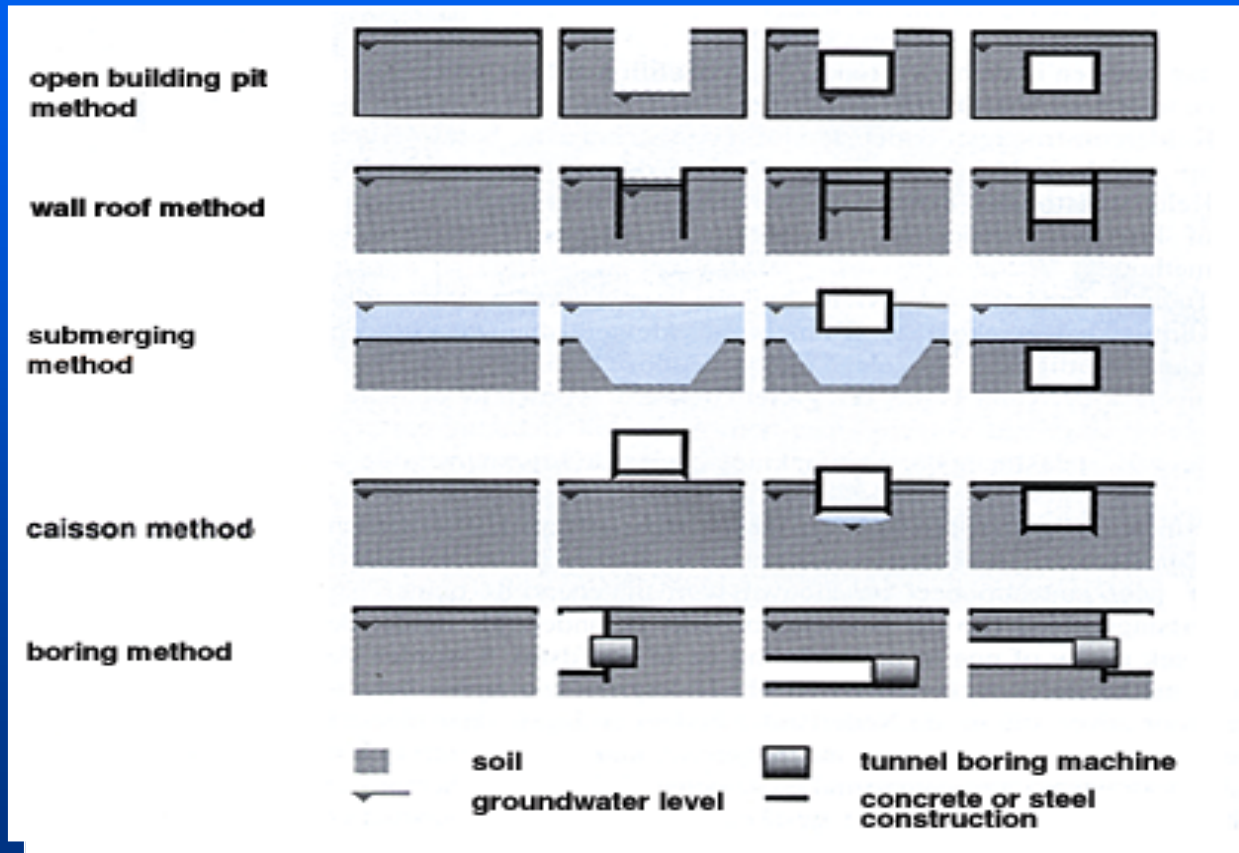
Deep station (cut & cover)

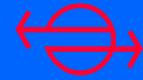
Shallow station (cut & cover)

In-situ tunnels



Construction methods





Central Station : 1890



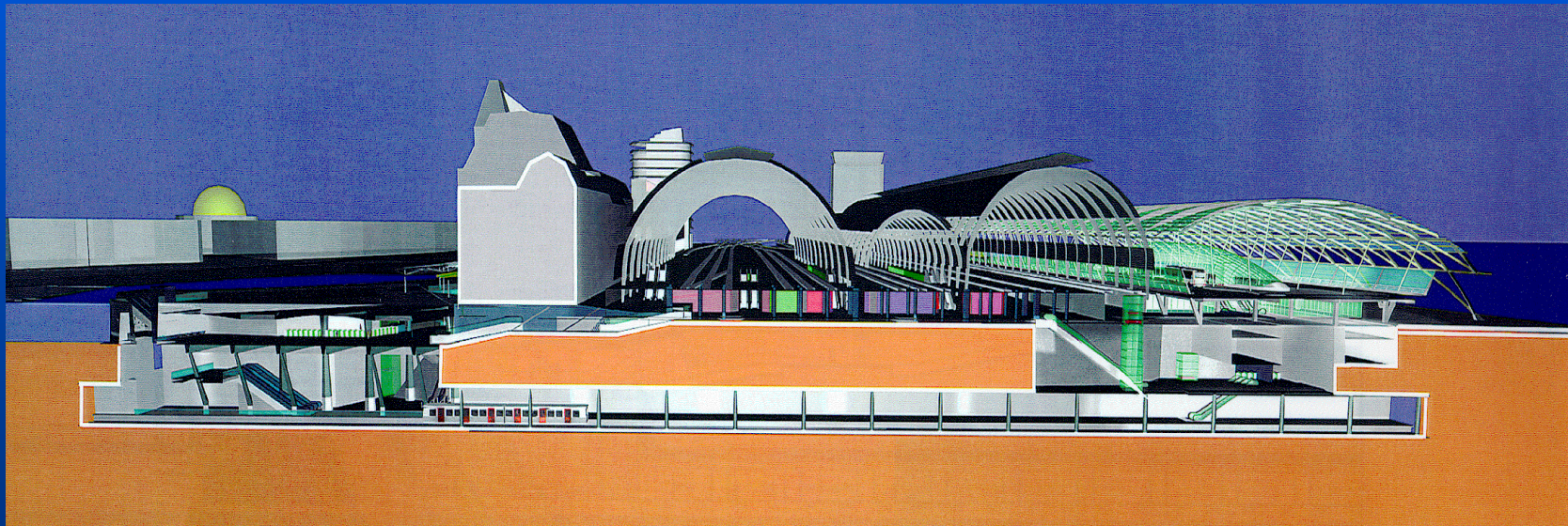


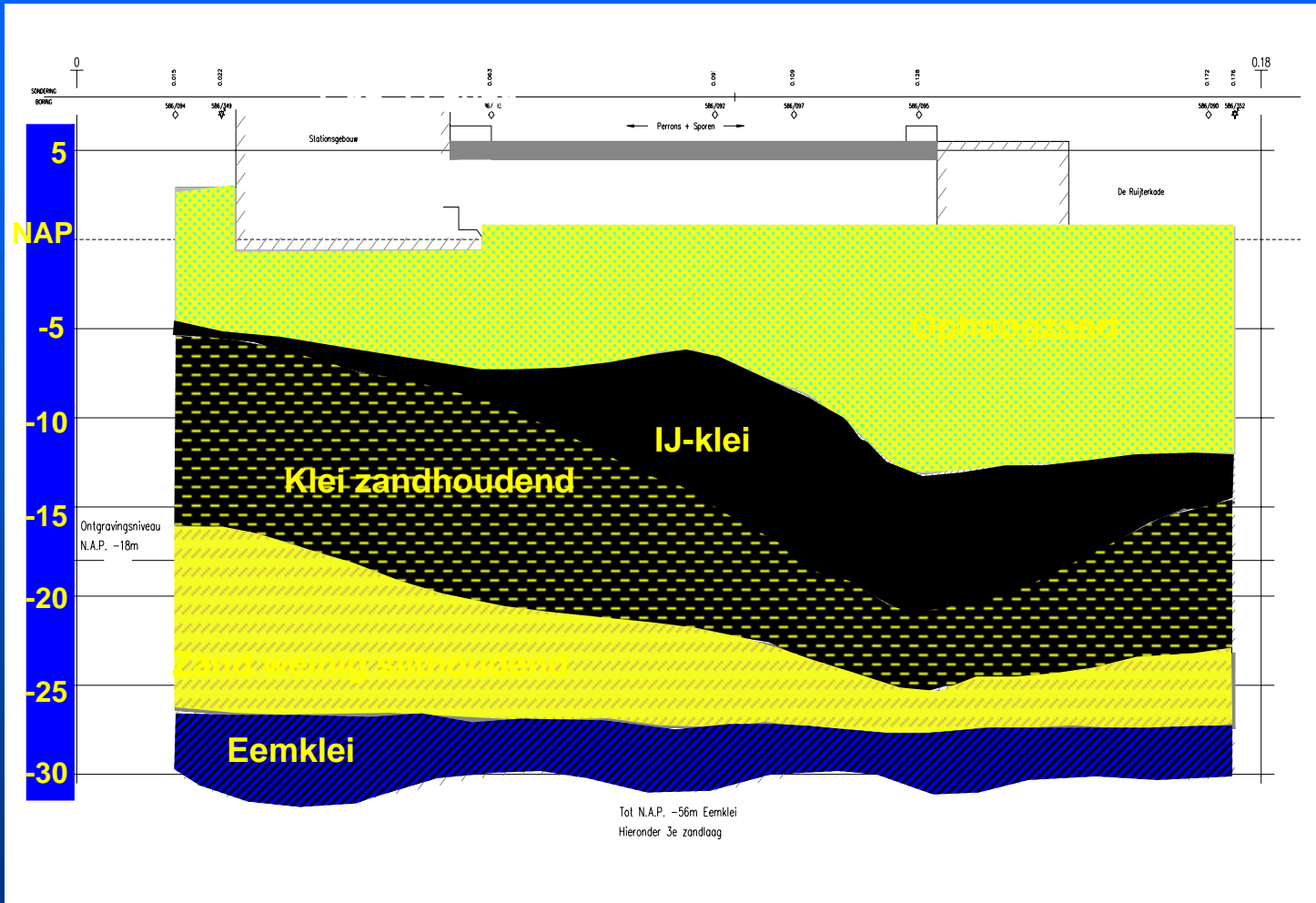
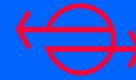
Central Station : actual situation

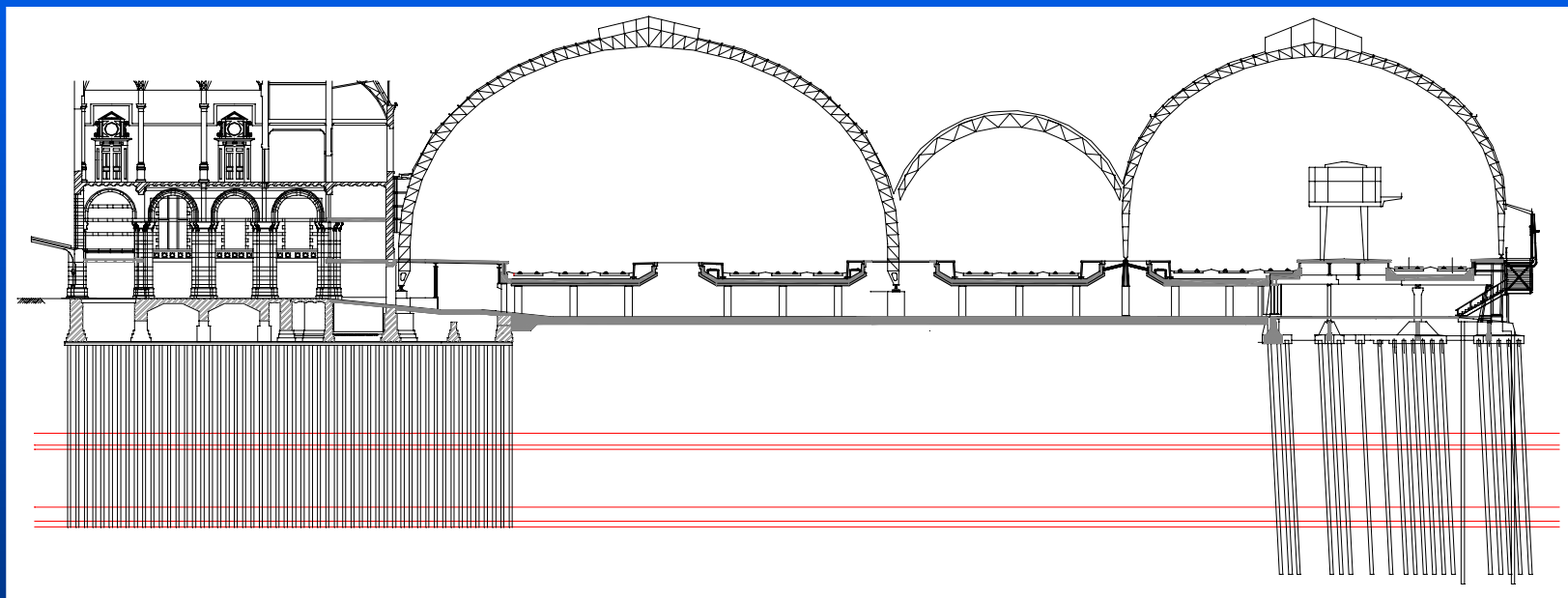




Central Station: 2011

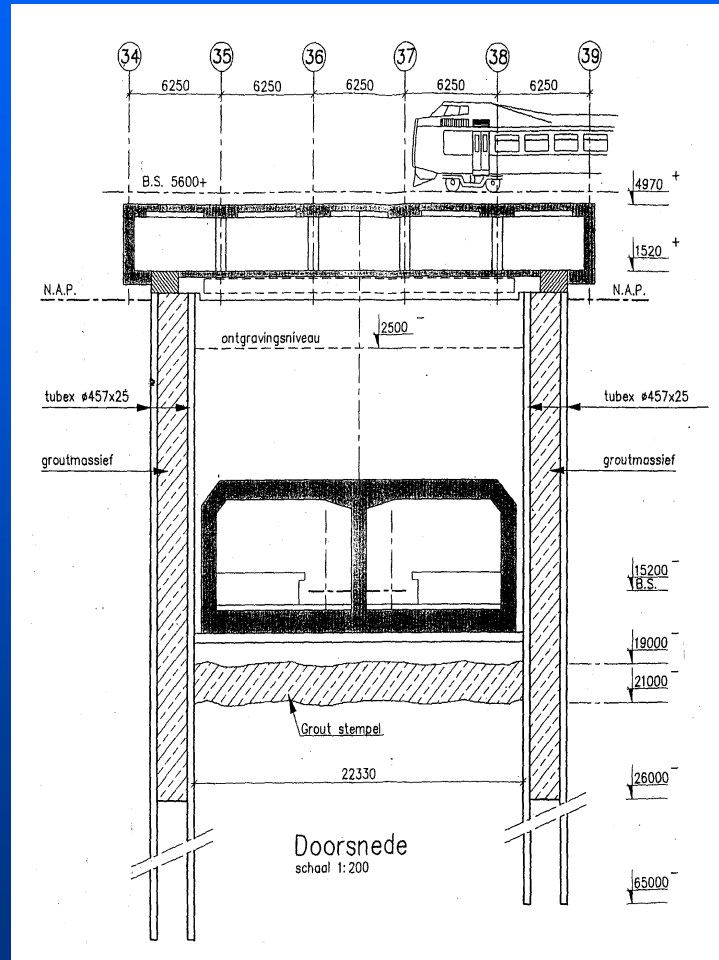


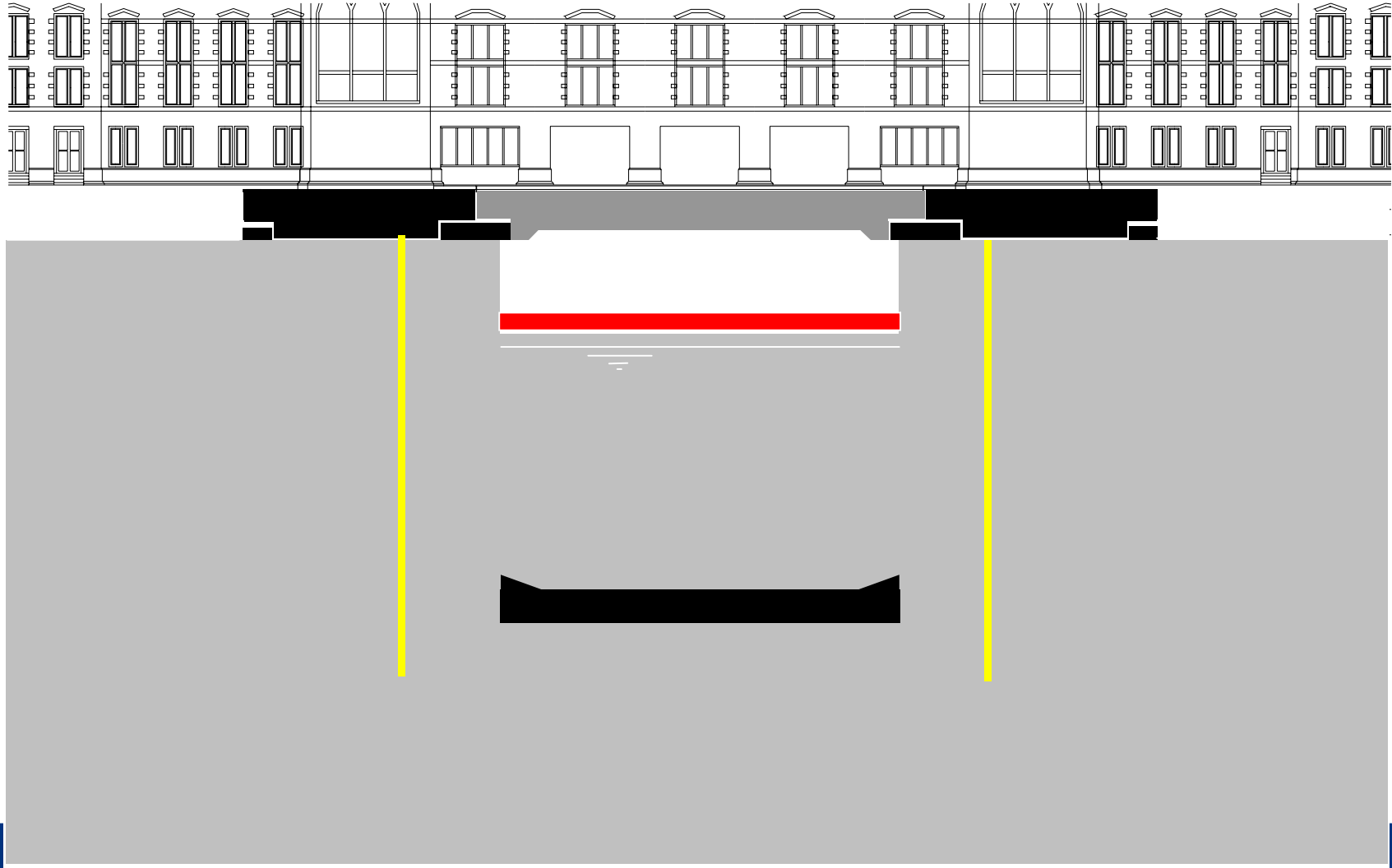


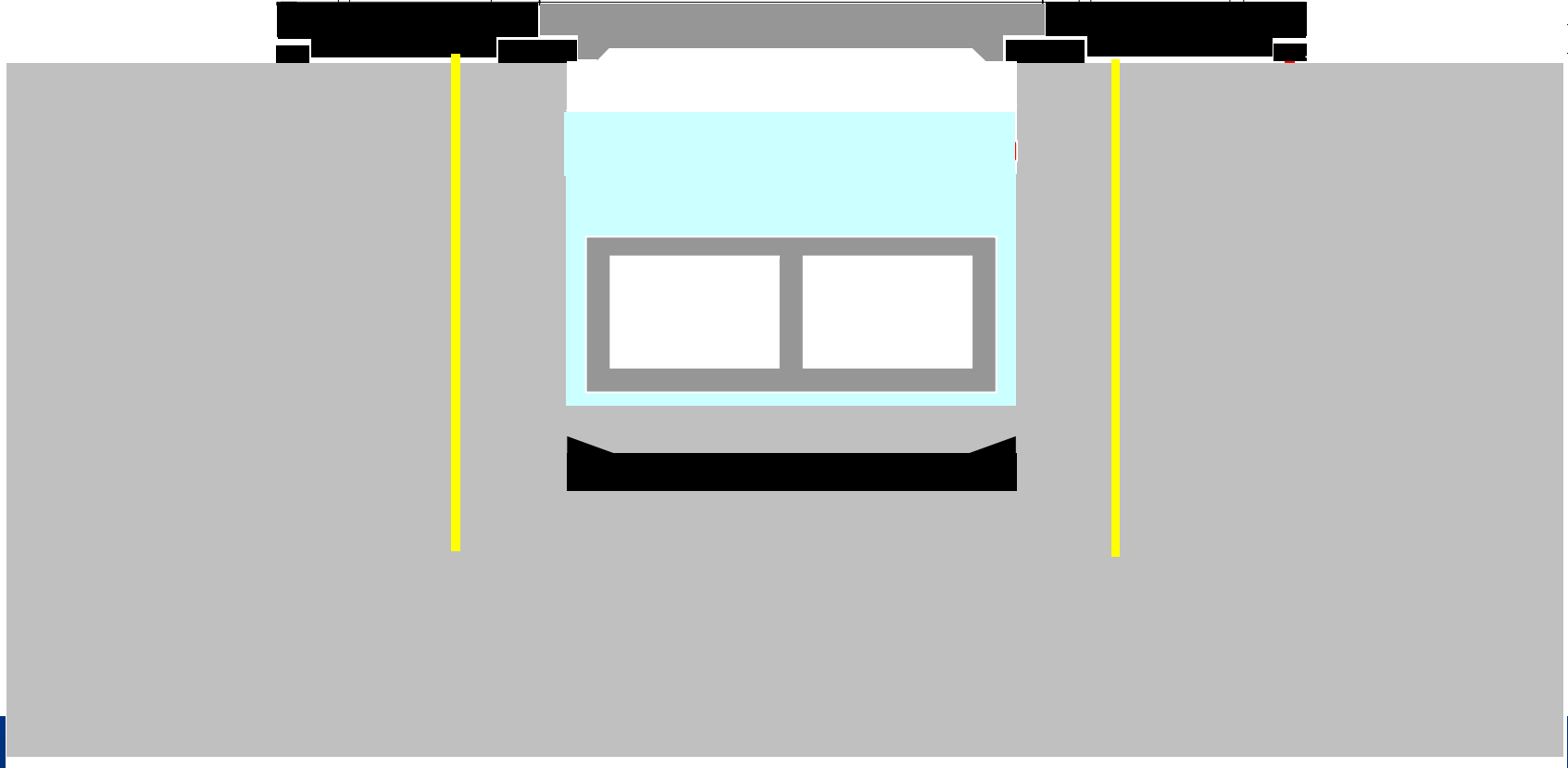
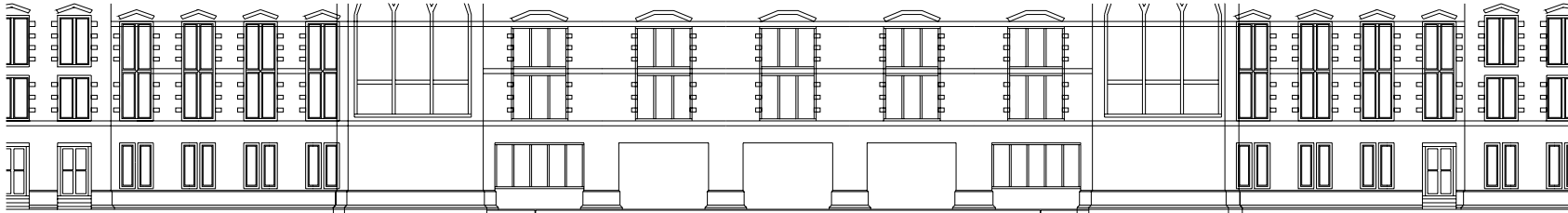


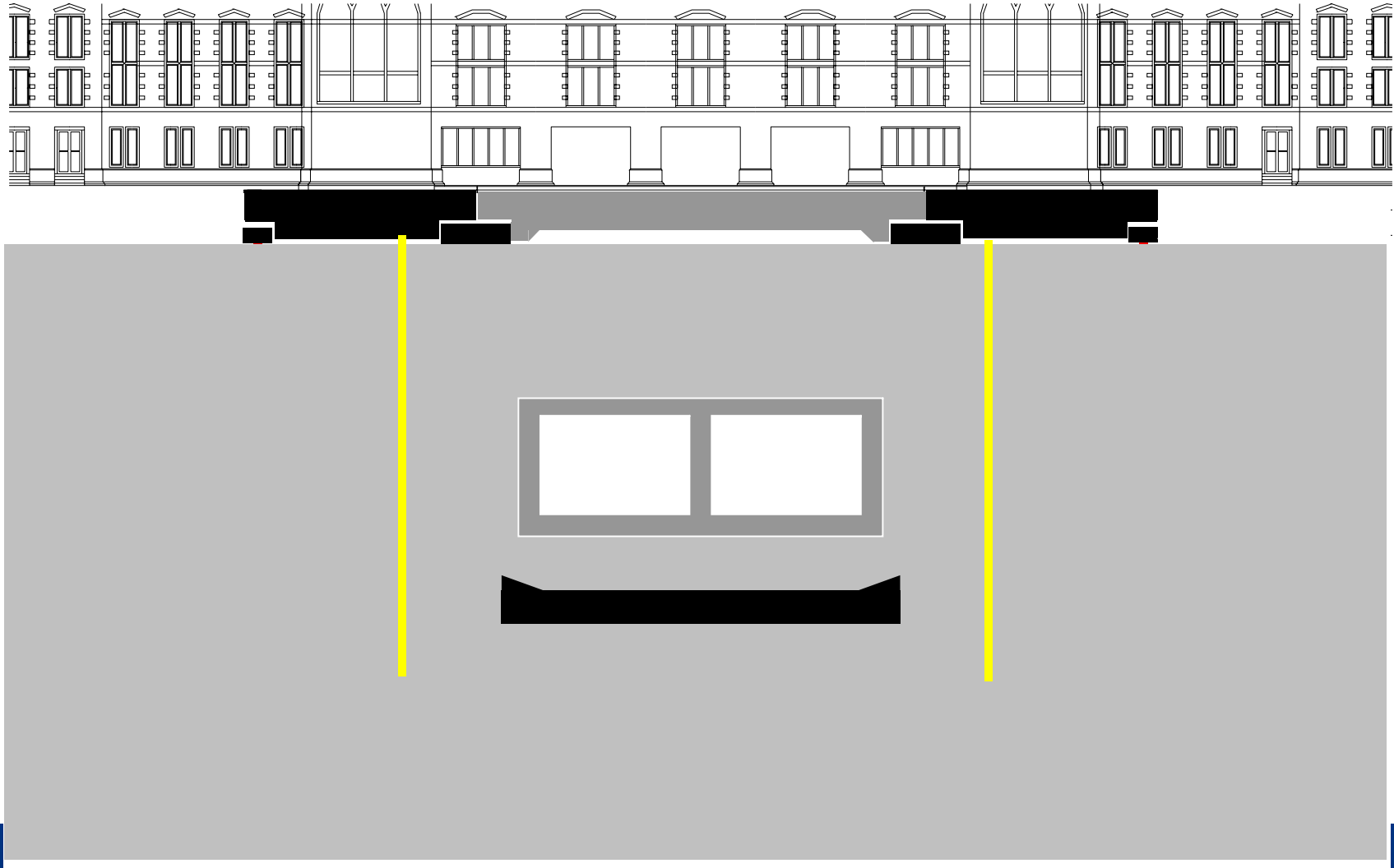


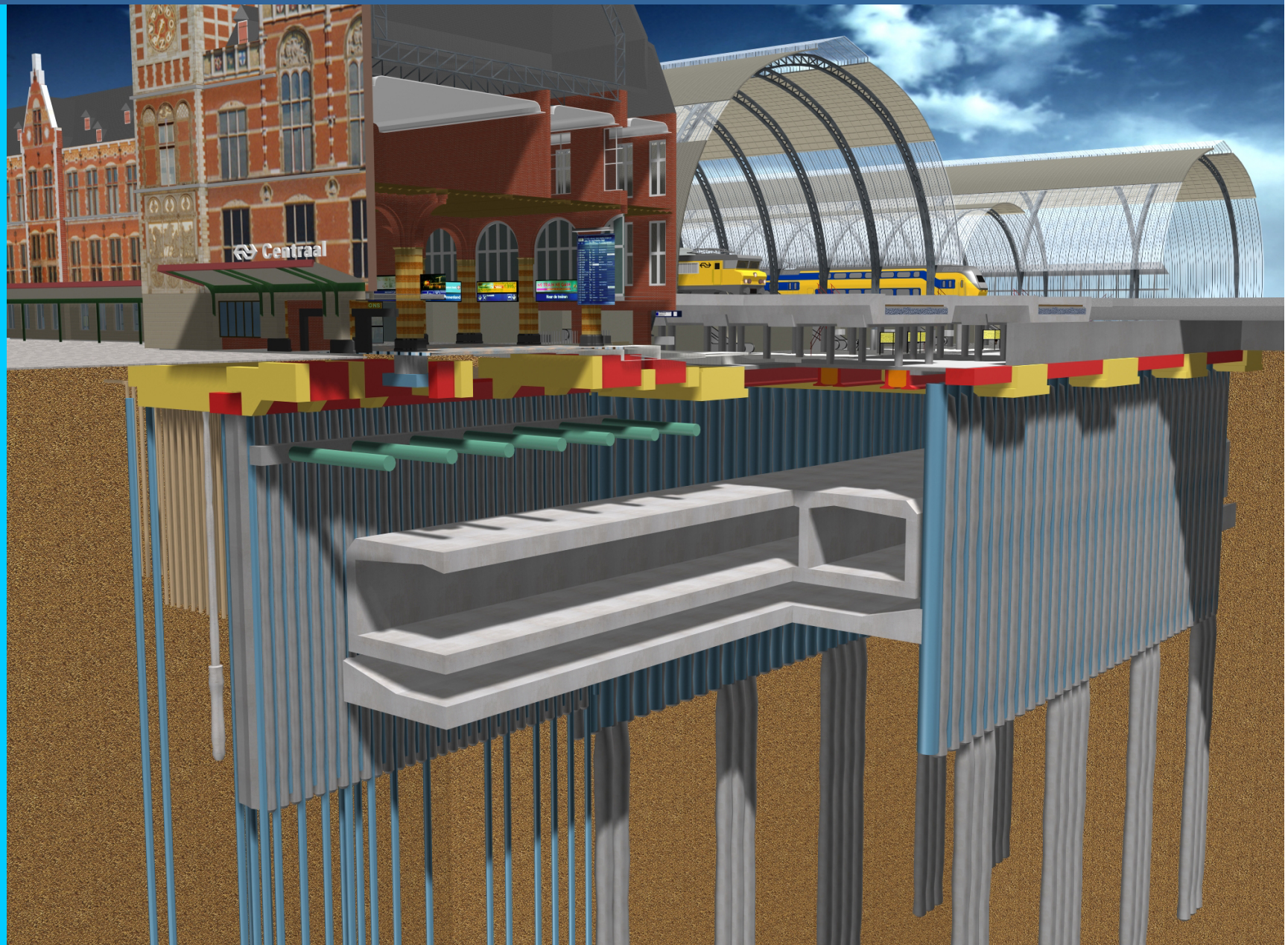
Central Station: submerged tunnel

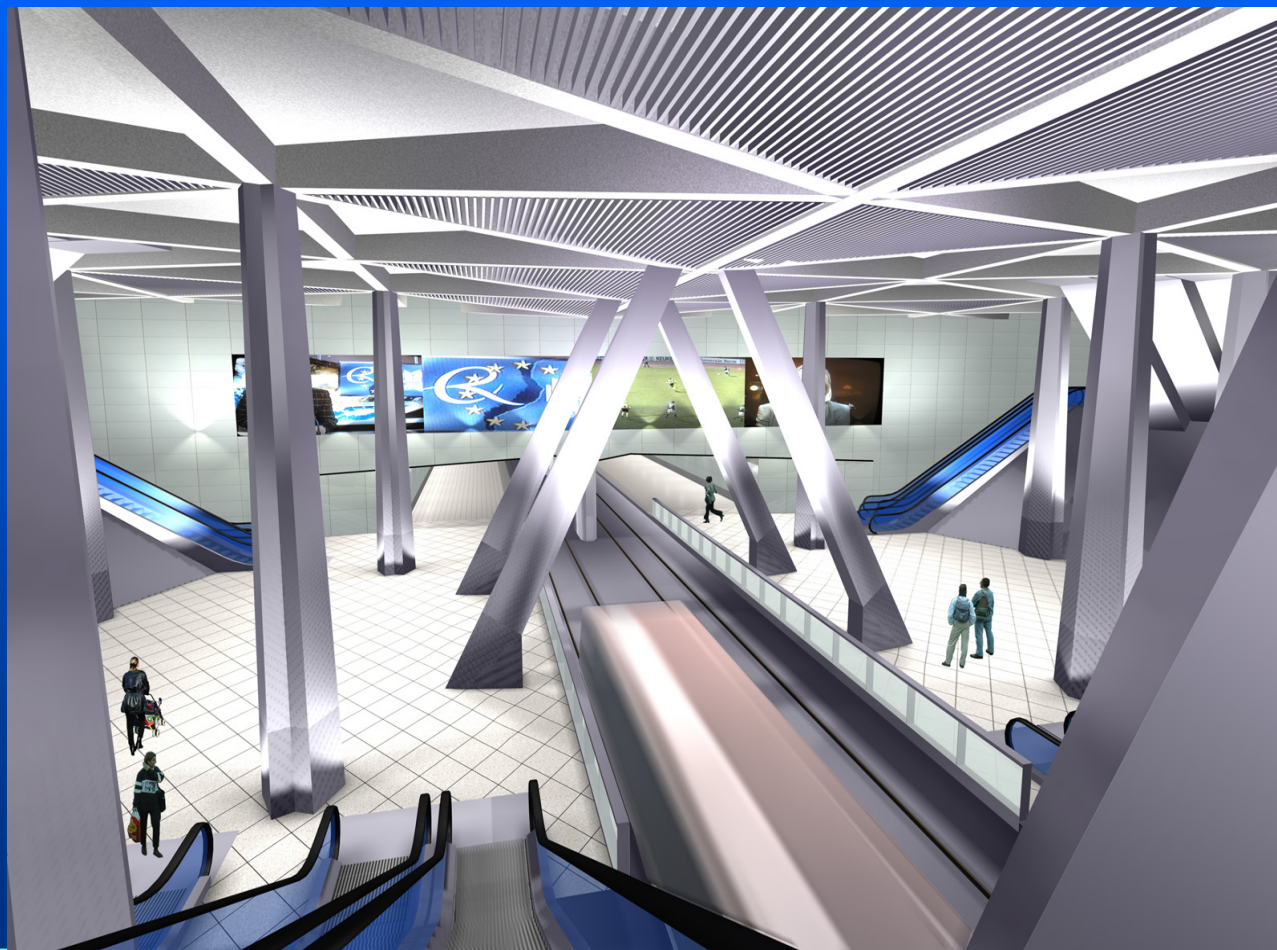


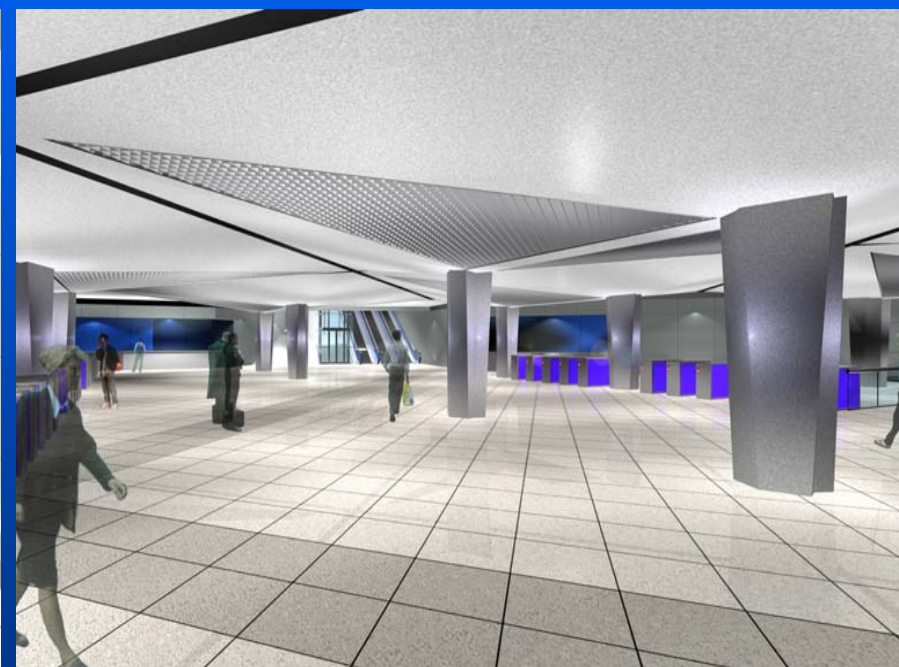


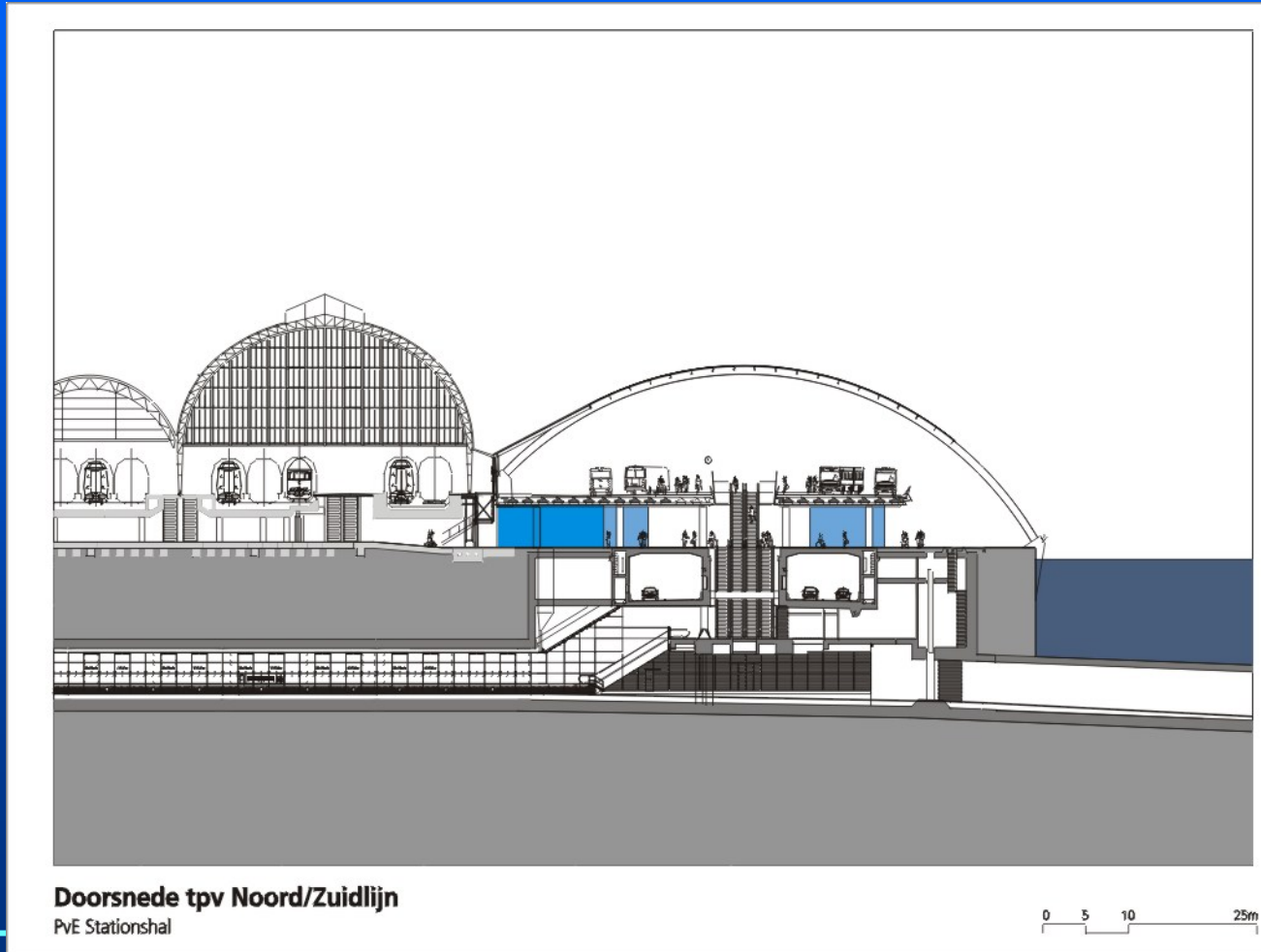






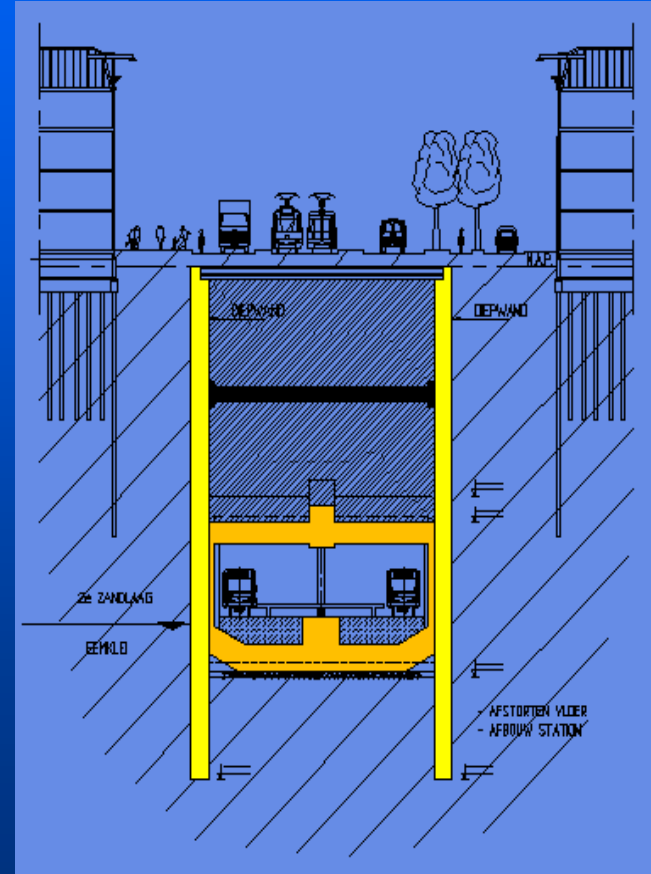
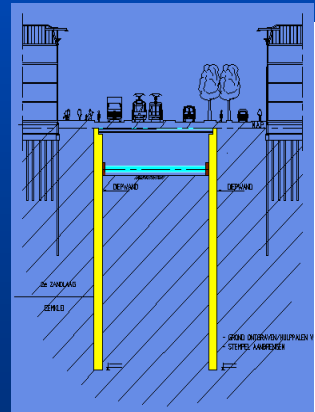
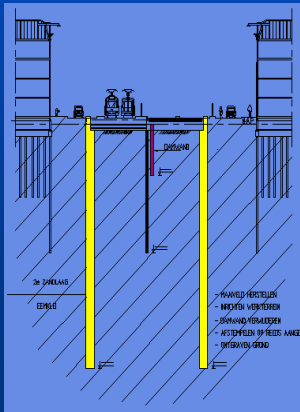
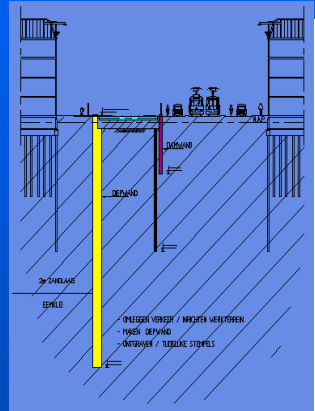
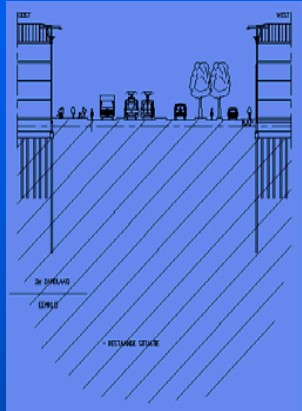


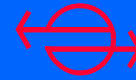




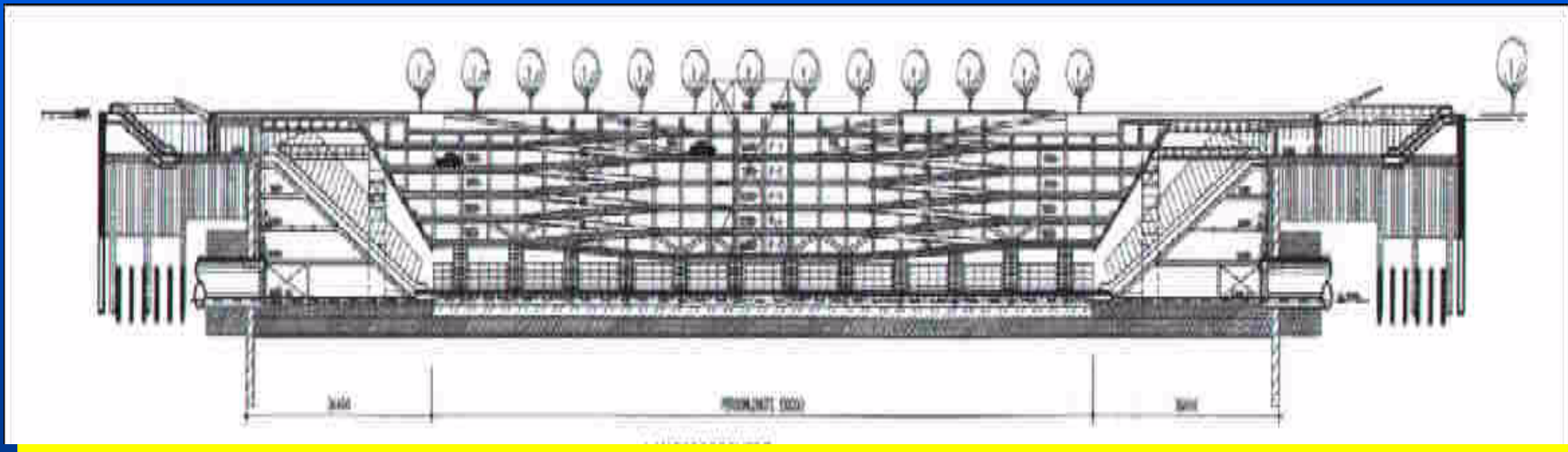


Cut & Cover building pits



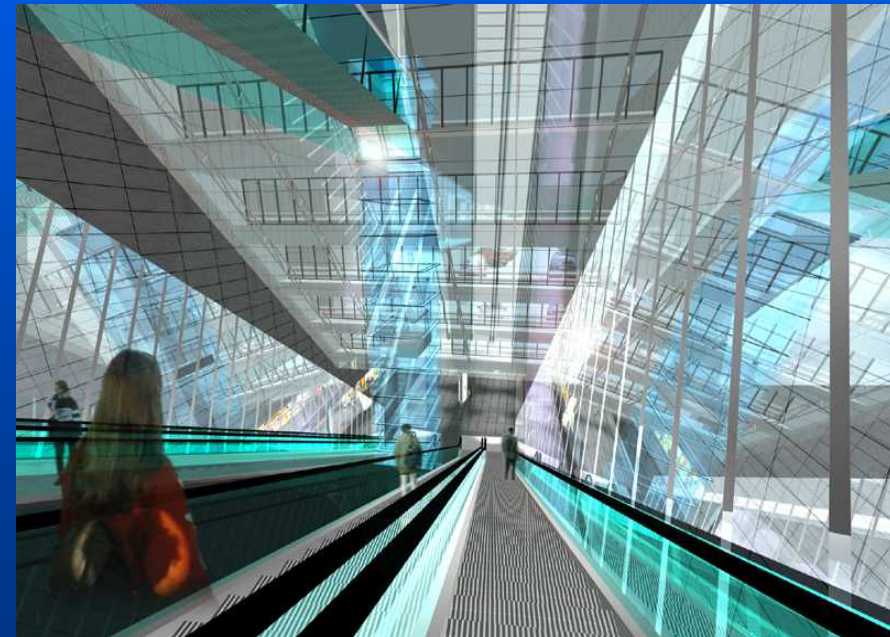
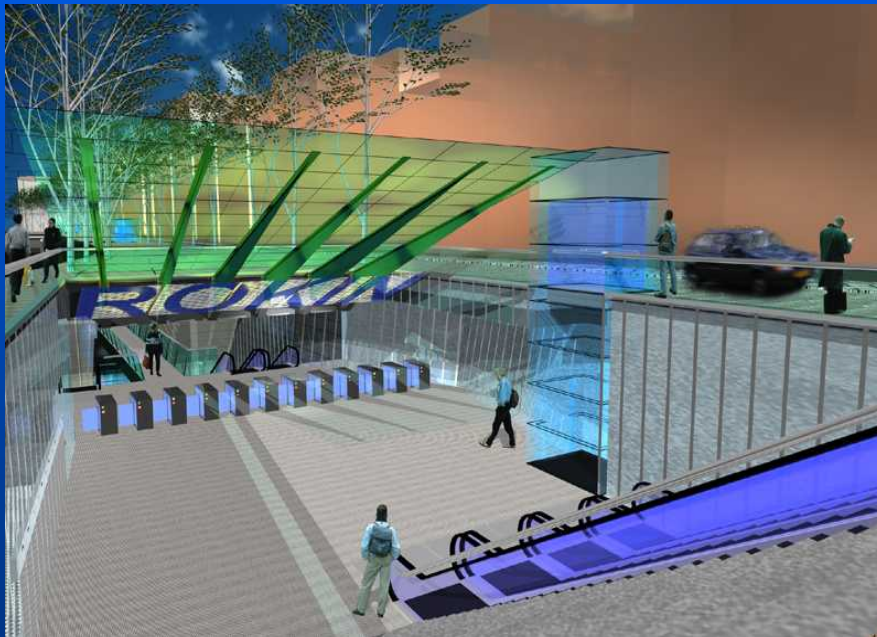


Station Rokin





Station Rokin : entrances



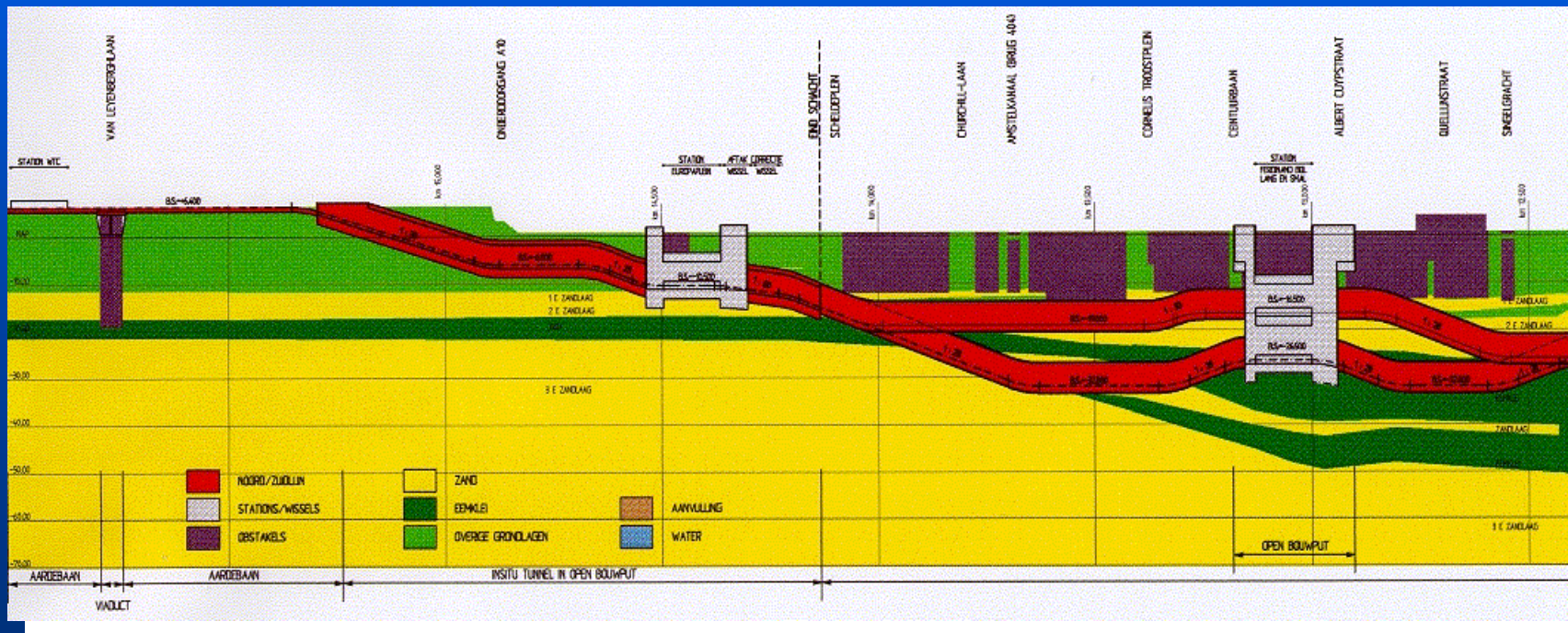


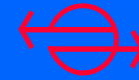
Station Rokin: platform





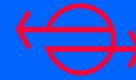
South, vertical alignment





Ferdinand Bolstraat





Station Ceintuurbaan



Station Ceintuurbaan





Environment: monitoring (early warning)

Monitoring prisma's
op de gebouwen
(x,y,z meting)

meetbouten
als backup

Installatie

"Total station"
Computergestuurd
meetinstrument

Secured
220V

Computer +
power supply

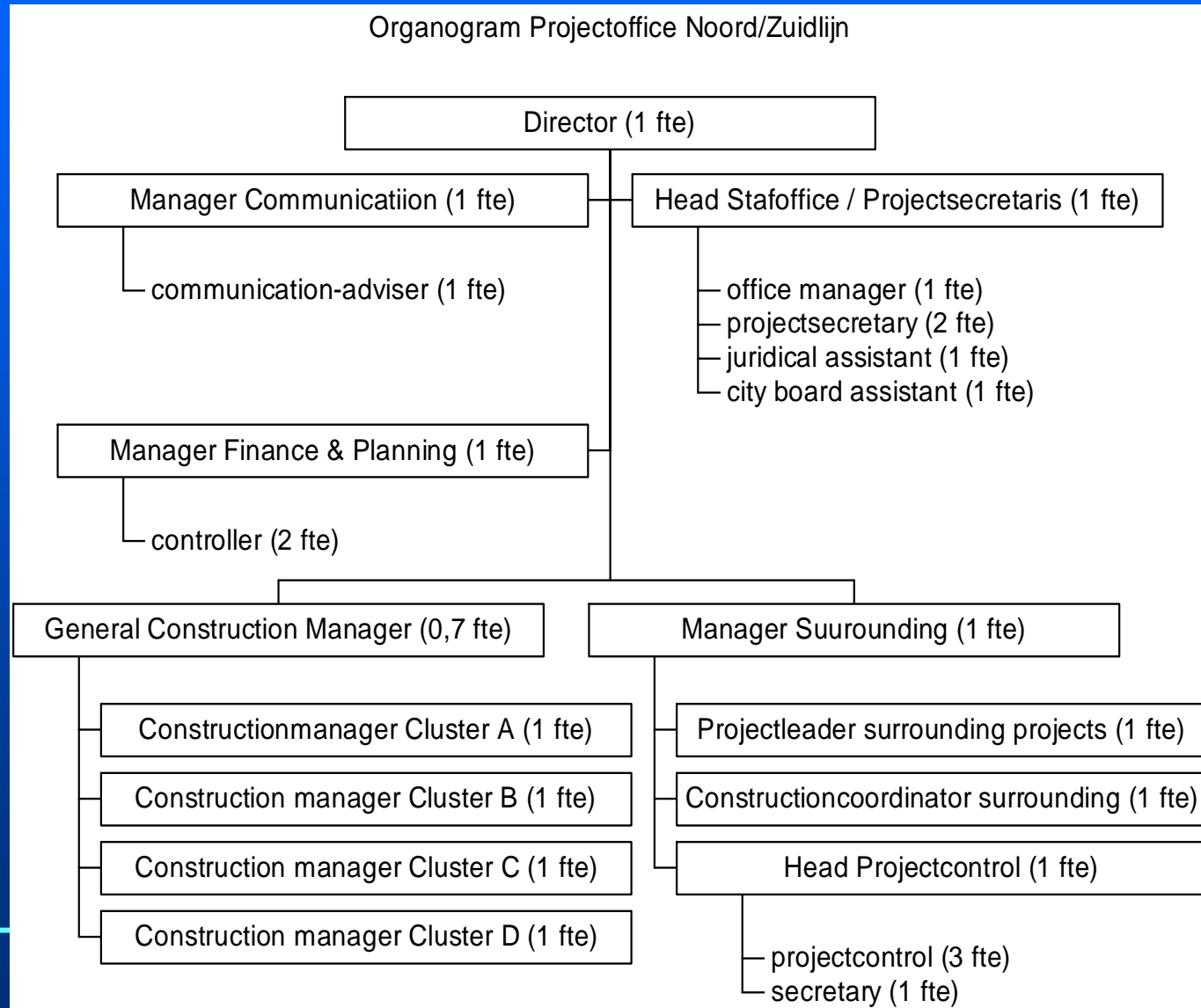
Radio
Antenna



The North/South-line Amsterdam

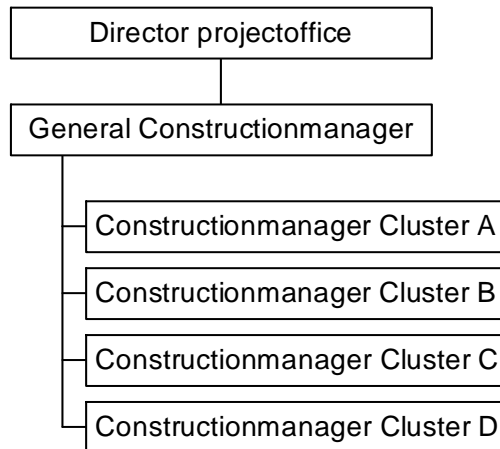
- ## 3. Organisation
- Project organisation

Organisation

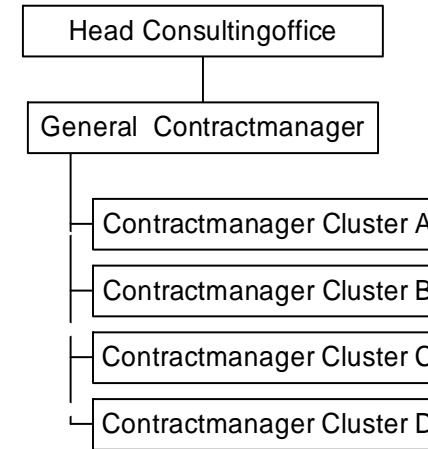


Organisation

Constructionmanagement Projectoffice Noord/Zuidlijn

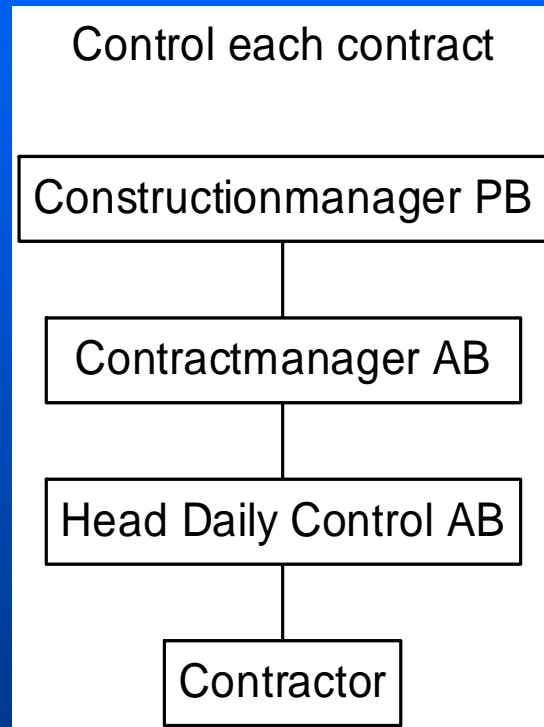


Contractmanagement Consultantoffice Noord/Zuidlijn



Relatie Projectbureau - Adviesbureau

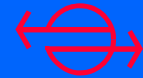
Organisation



Organisation

Structure of organisation:

- Board <-> PO:
 - alderman staff
 - board team
- PO <-> Consultant office:
 - general contract meetings
 - Construction Manager<->Contract Manager
- Consultant Office <-> contractor
 - construction meeting



The North/South-line Amsterdam

Break



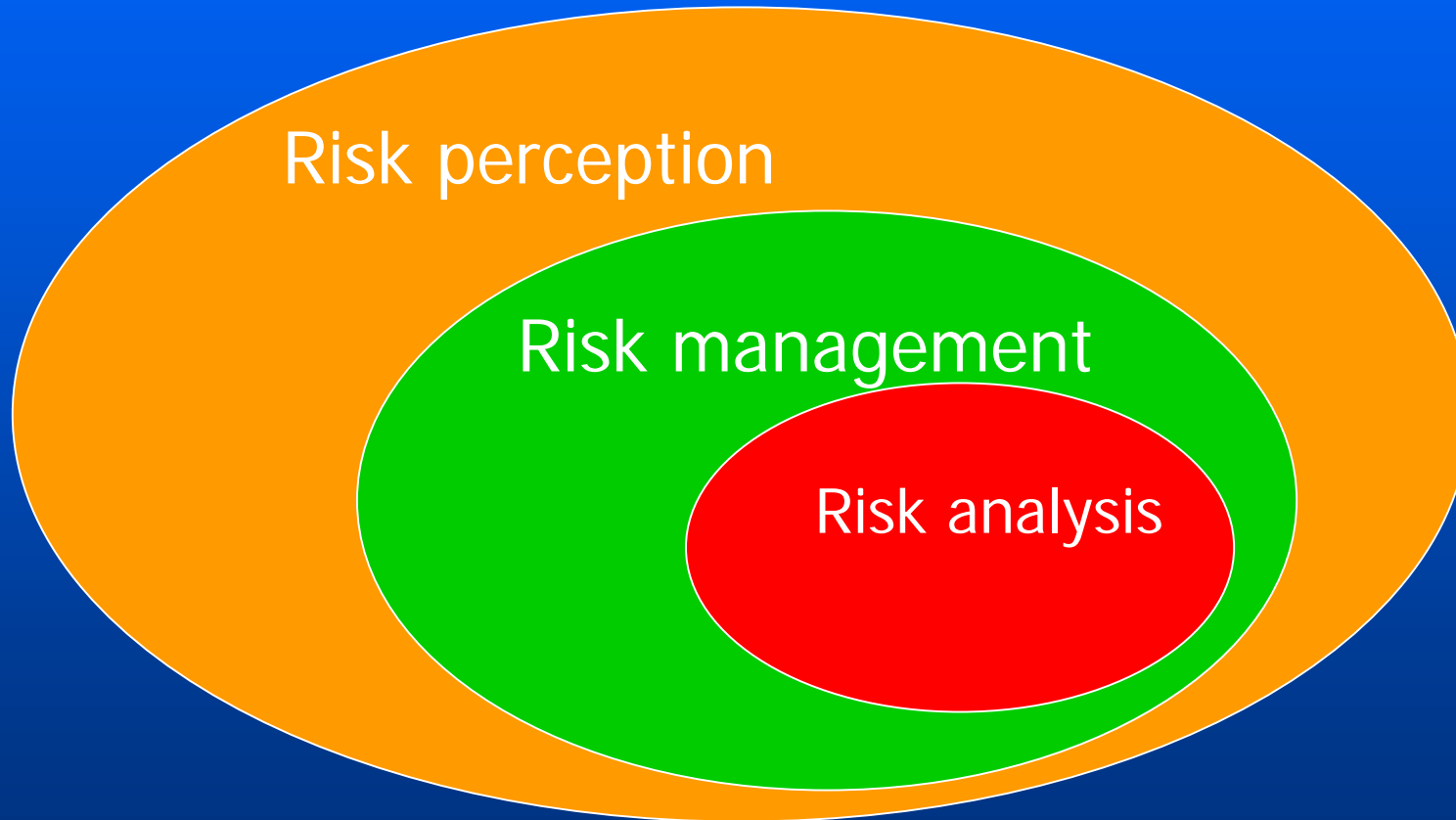
The North/South-line Amsterdam

4. Risk management

- Topics
- Analyzing risks
- Reducing risks
- Testing
- Contract filosofy TBM
- Environment
- Monitoring
- No insurance CAR



The North/South metroline Amsterdam





The North/South metroline Amsterdam

Topics:

- The project
- The start: analyzing the risk profile
- Reducing the risk profile
- Environment (surroundings)
- Actual situation (contractors)

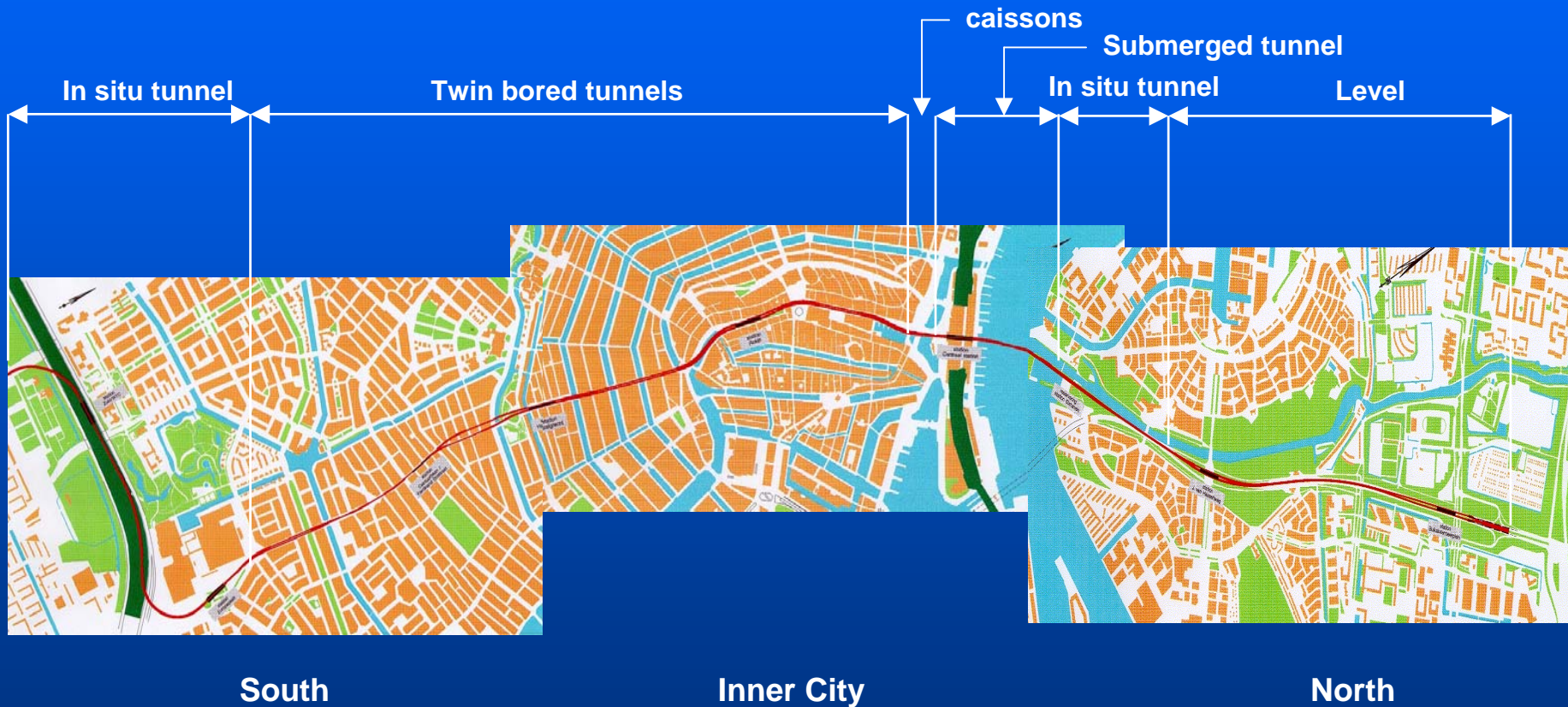


The Project:

- 200.000 passengers / day
- 9 km long new infrastructure
- 6 km subsurface
- 4 complex deep stations
- 2x4 km single track twin bored tunnels
- in operation: 2011



Overview of the construction methods





ANALYZING THE RISK PROFILE

Focus on Inner city.

- Use of TBM in the city of Amsterdam
- Deep stations
- Passage of the Central Station



REDUCING THE RISK PROFILE

Goal (1994):

“The risk profile of the construction of the North/South metro line should be less or equal to a substantial traditional project”

Actual situation (2003):

“General consensus that this goal is achieved”



REDUCING THE RISK PROFILE

Risk analysis & management:

- Design
- Organization
- Contracts

**Investing > € 100 million in risk
reducing measures**



REDUCING THE RISK PROFILE

Design:

- Horizontal alignment follows street pattern.
- Vertical alignment bored tunnels determined to avoid obstacles.
- Carefull choice of station location.



REDUCING THE RISK PROFILE

Design:

- Development of design tools
- Design by testing
- Investigations (soil & buildings)
- Mitigating measures



REDUCING THE RISK PROFILE

Investing [million]

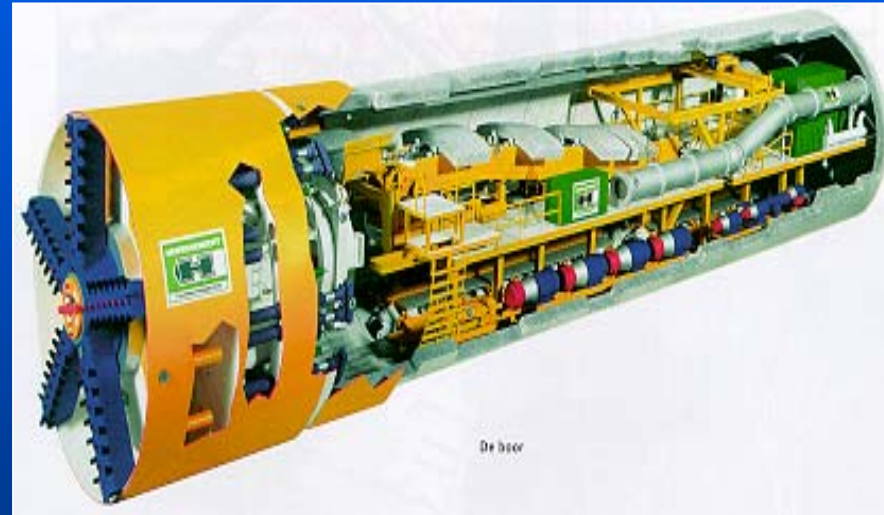
Soil investigation	€ 3
Building investigation	€ 3
Foundation reconstruction	€ 20 (30%)
Monitoring system	€ 15
Mitigating measures	€ 40
Research & design by testing	€ 15

etc.

- Deep stations
- Passage of the Central Station

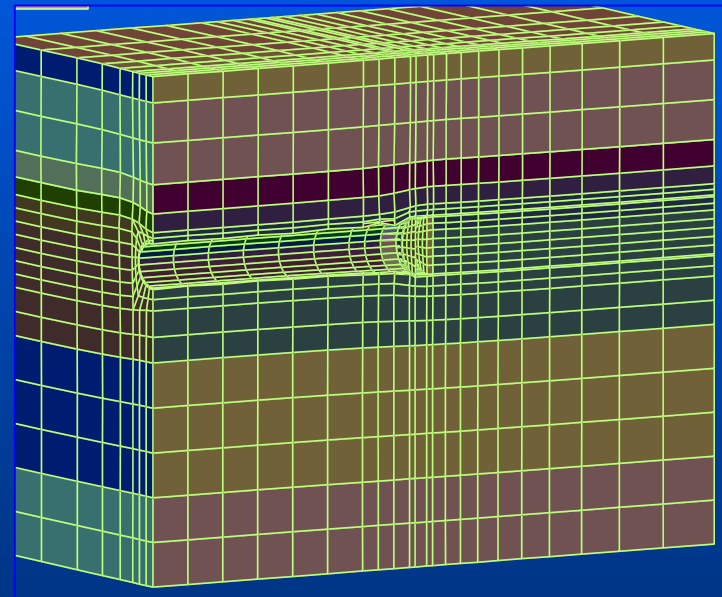
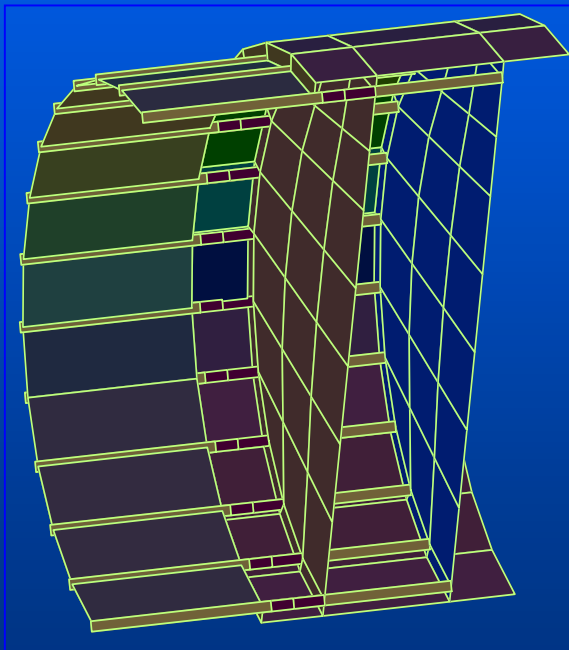


Design by testing: why ?



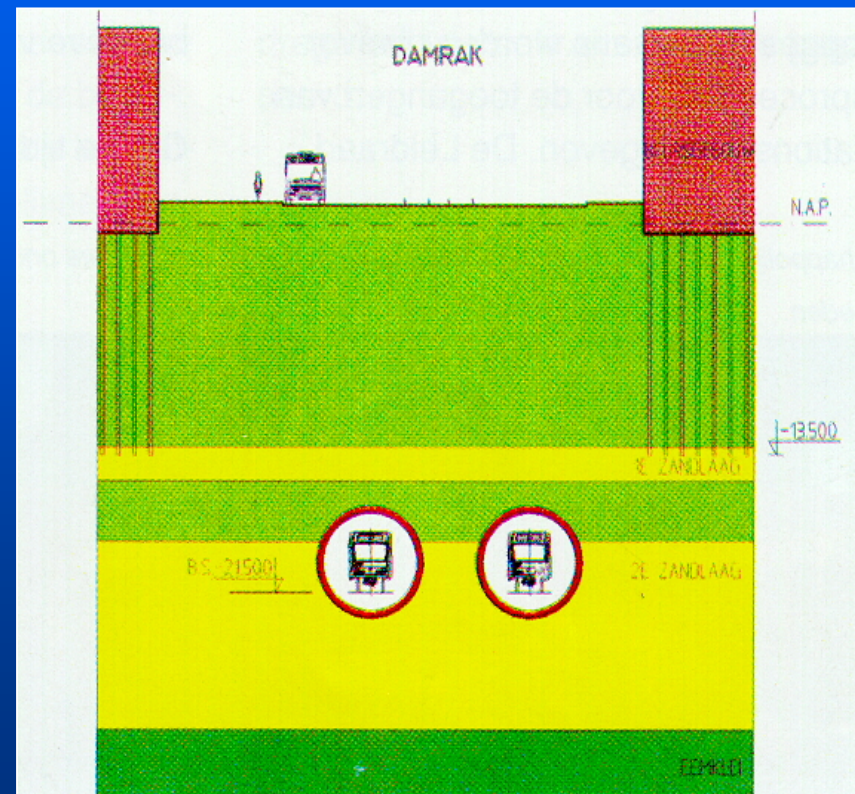


4D FEM model TBM & subsurface





TBM driven track tunnels & pile foundations





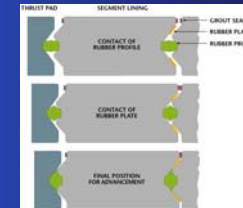
FSPT

FSIT

GEO-GIs



Lining test



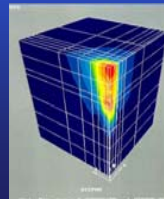
Design by testing (Full scale tests)



TBM / TVIT



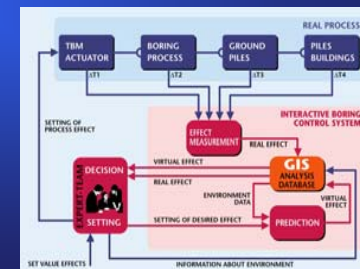
3D-EEM



Monitoring



IBCS



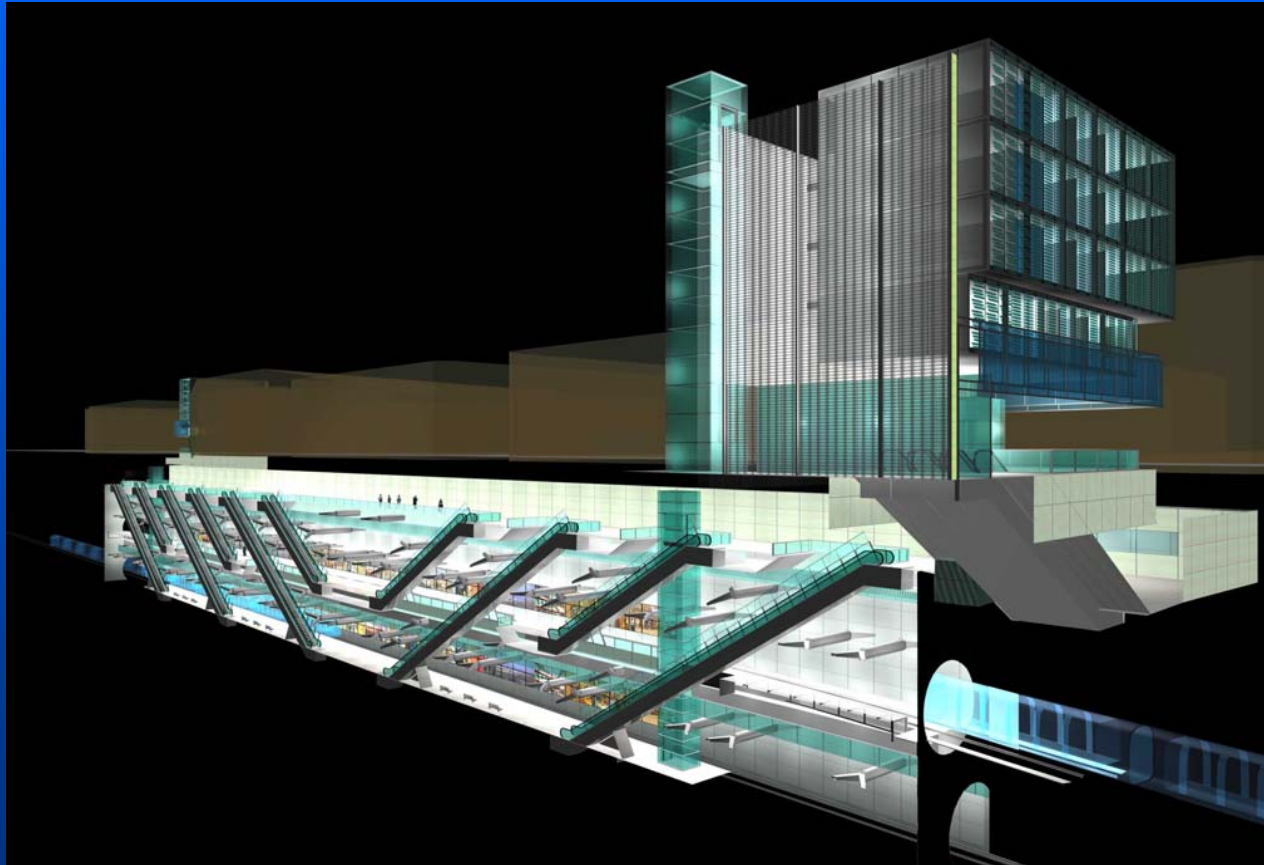


OVERVIEW FULL SCALE TESTS

- Influence TBM on pile foundations
- Vibration behavior tunnelling & pile foundations
- Slurry wall
- Tail void injection [1:5]
- Soil treatment tests
- Use of drilled steel piles to large depths
- Use of large diameter steel piles in limited space
- Compensating Grouting trail



DEEP STATIONS : Ceintuurbaan





FULL SCALE SLURRY WALL TEST

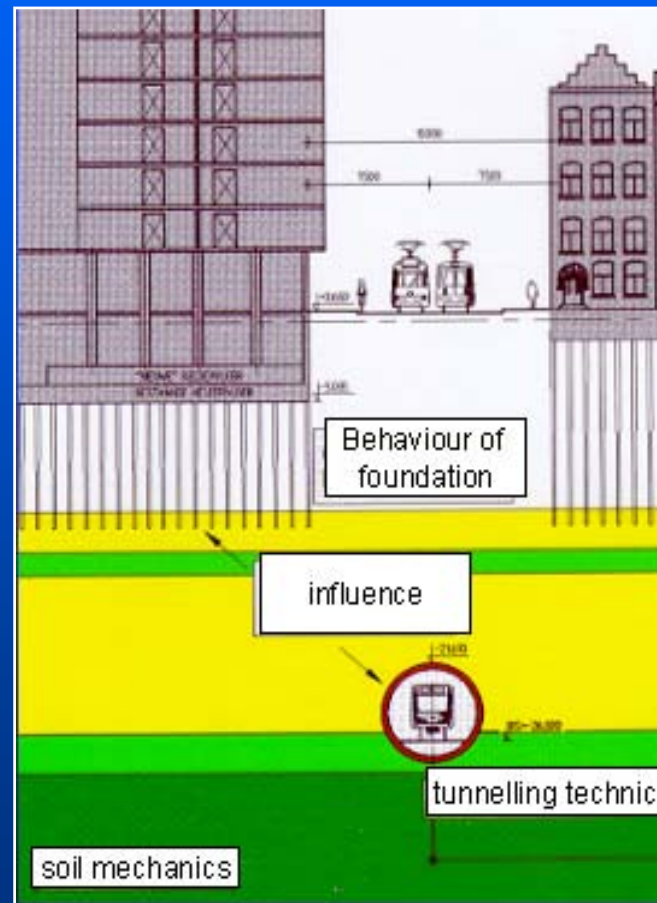




CONSTRUCTION TECHNOLOGY

Generating knowledge:

- Buildings
- Pile foundations
- Soil
- TBM process





FULL SCALE PILE TEST





FULL SCALE PILE TEST

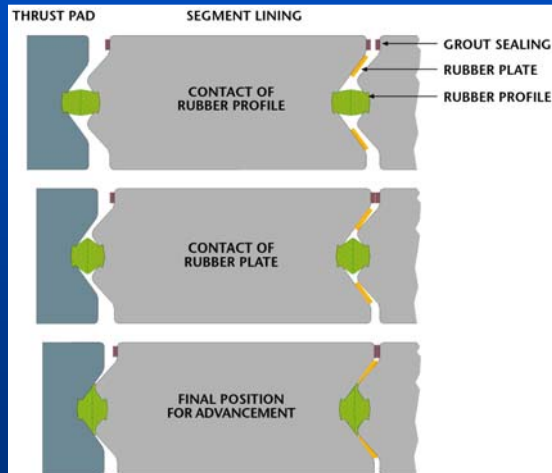


© Ton Borsboom



Full scale tests.

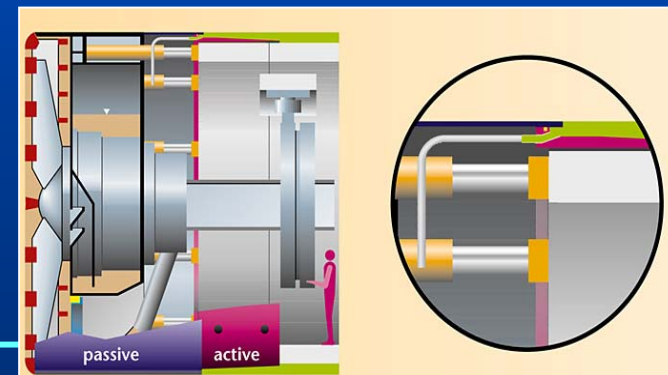
- Lining test
- Soil freezing





Full scale tests.

- Tail void injection
- Tubexpile test
- Large diameter pile test
- Compensating Grouting Trail
- Soil treatment tests



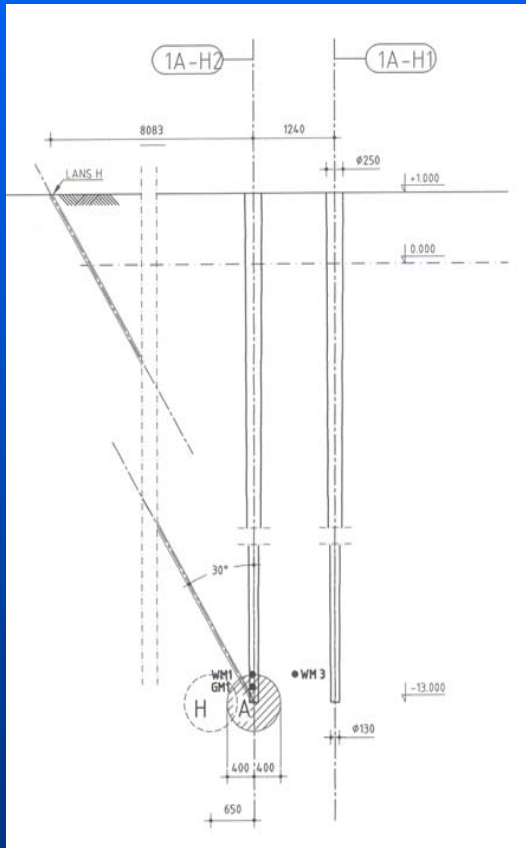


FULL SCALE SOIL TREATEMENT TEST



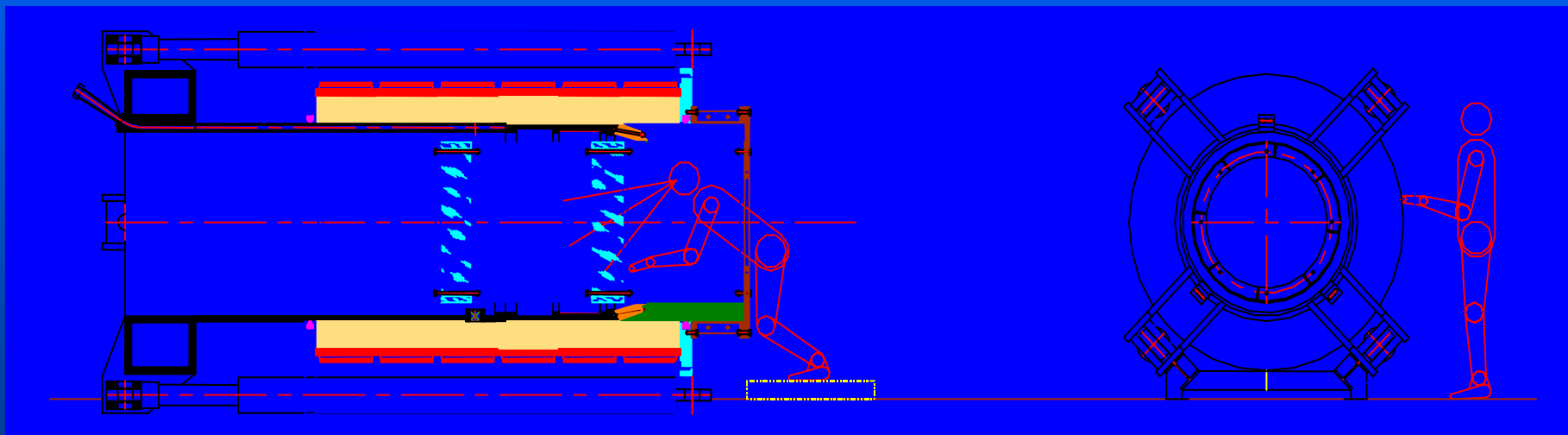


FULL SCALE SOIL TREATEMENT TEST



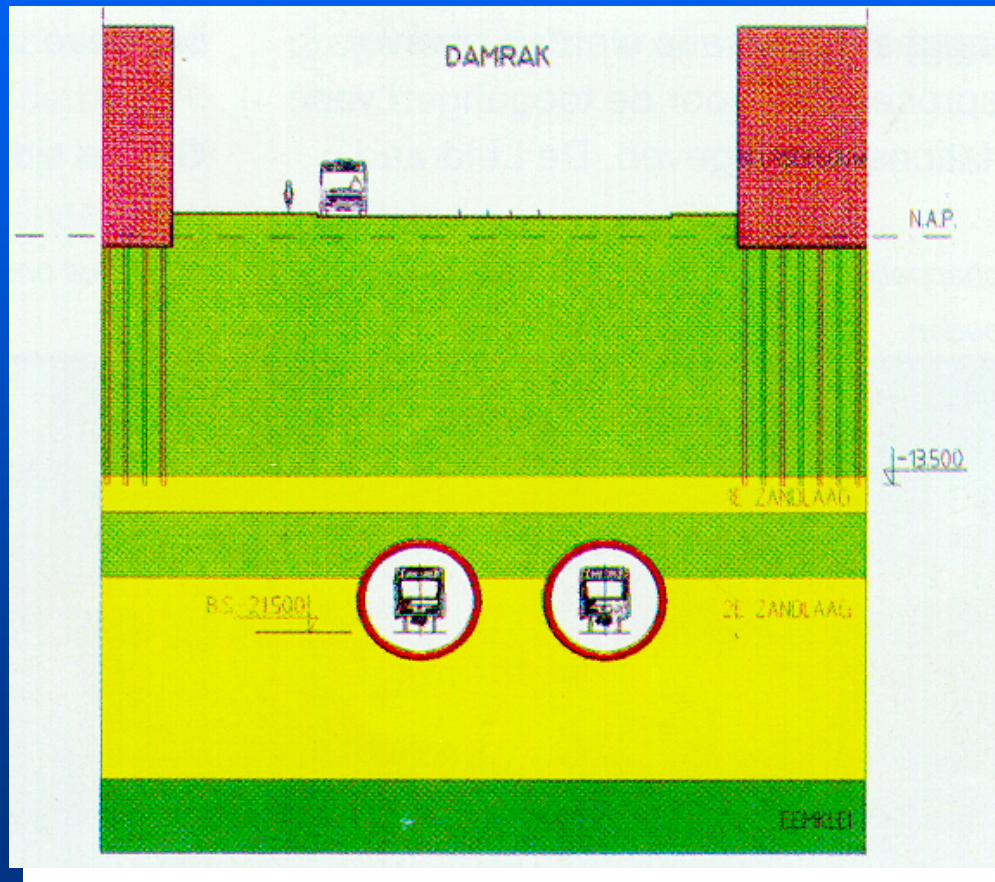


TAIL VIOD INJECTION TEST [1:5]

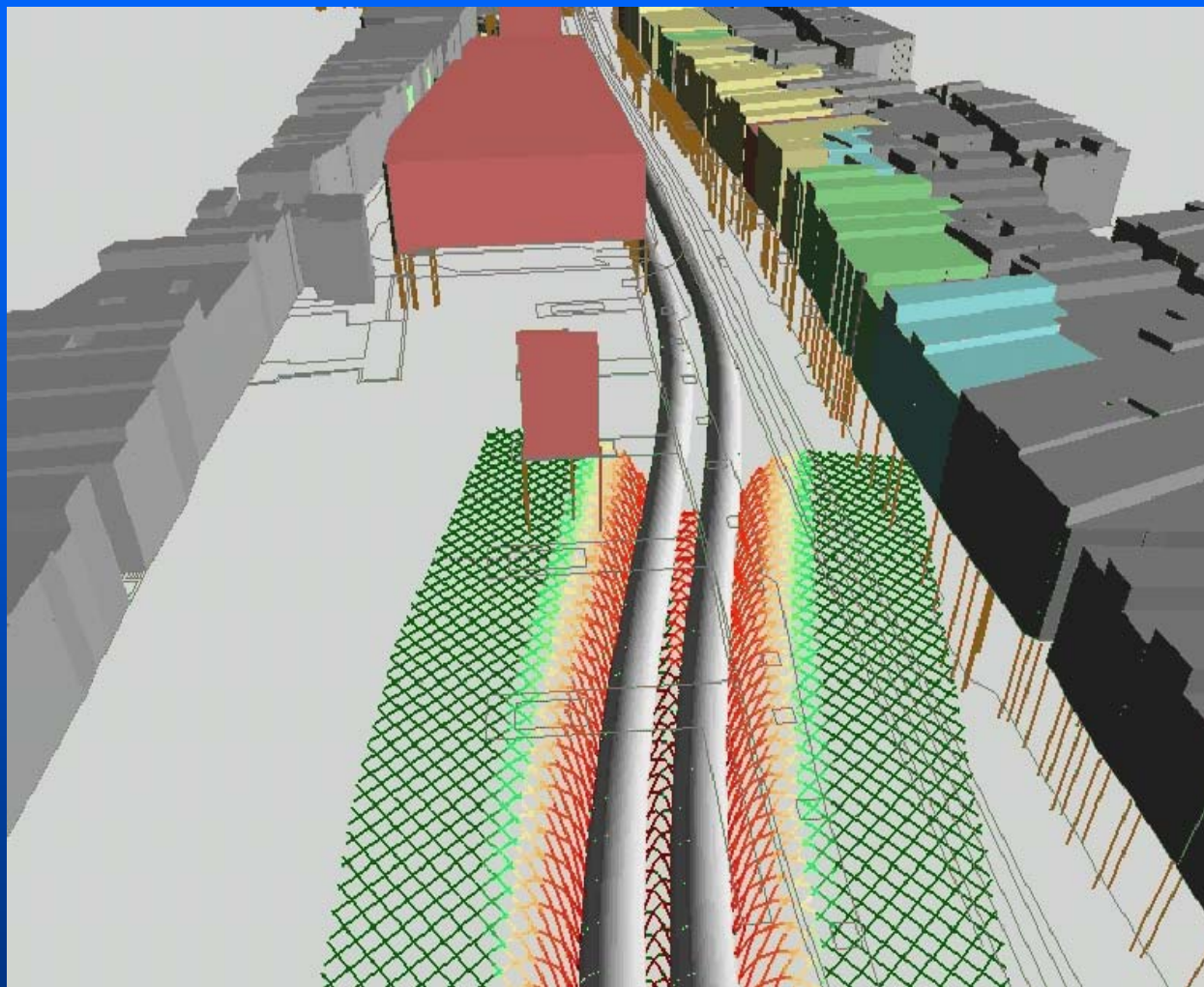


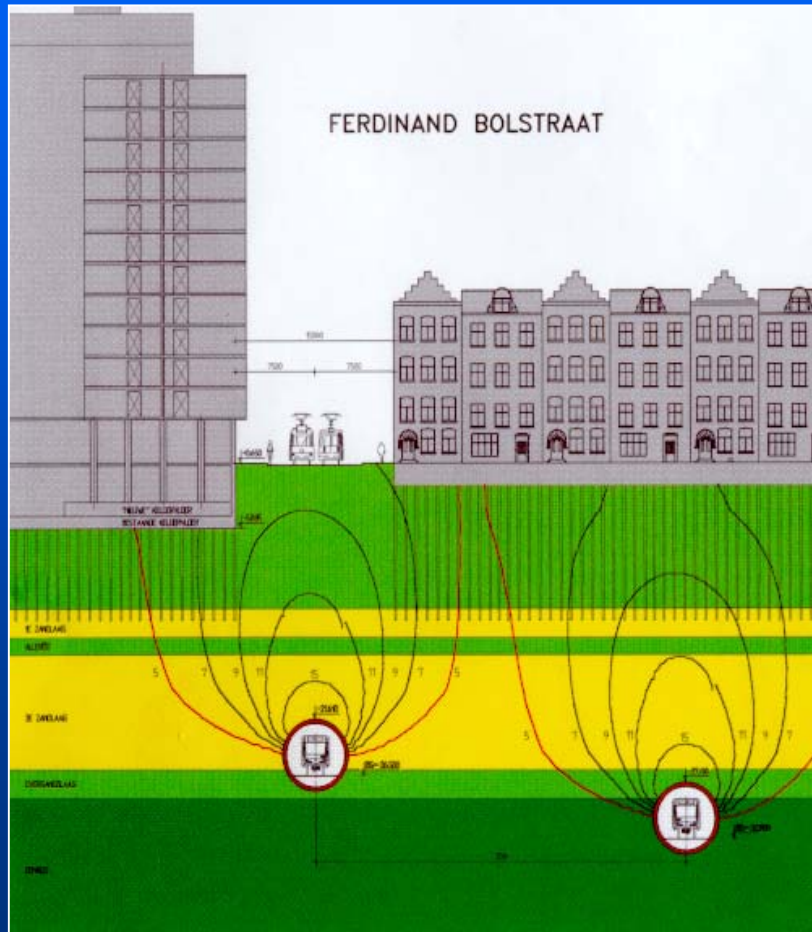


SINGLE TRACK BORED TUNNELS



- Diameter 7 [m]
- Second sand layer
- Street pattern





Application of results.



REDUCING THE RISK PROFILE

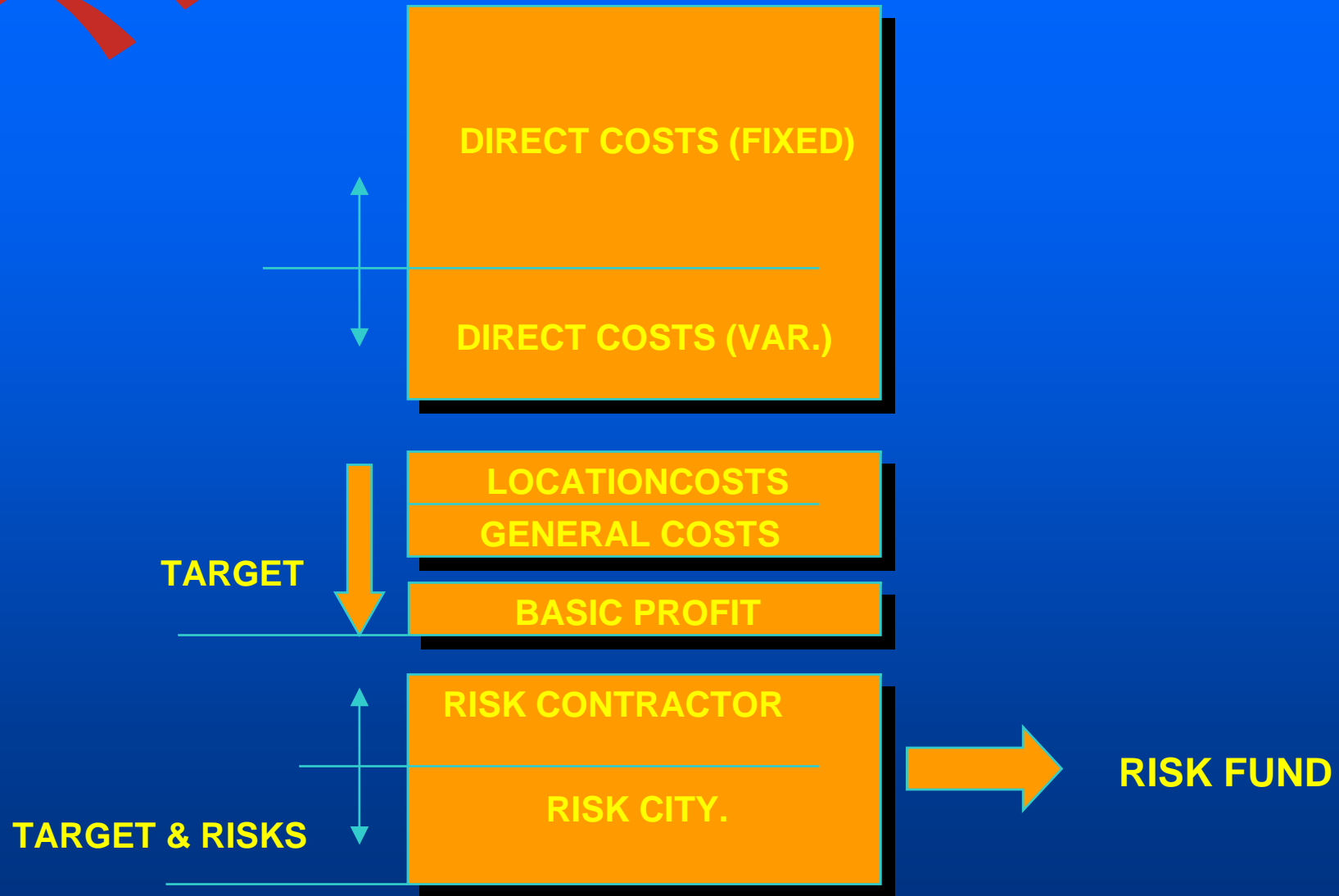
Organization.

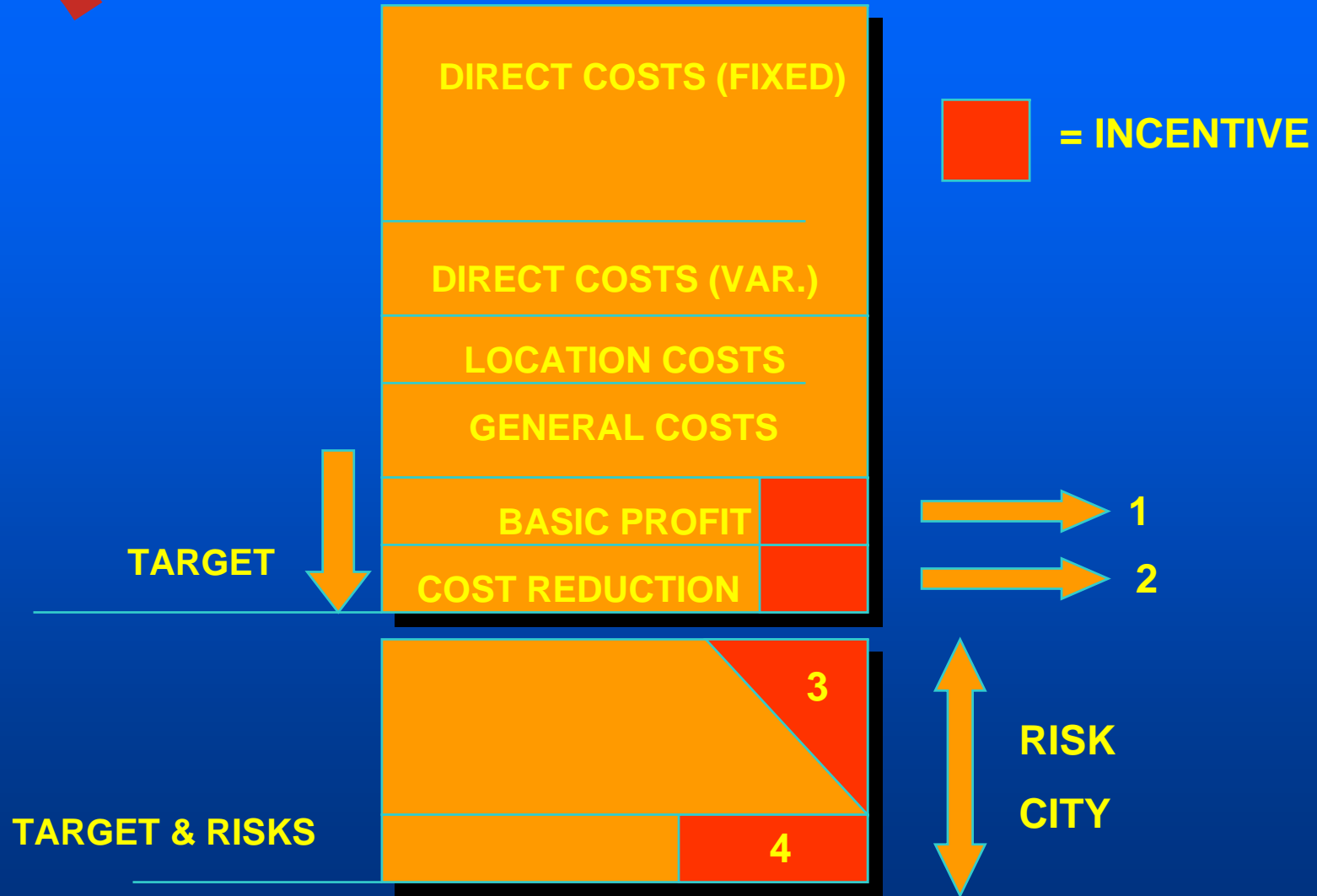
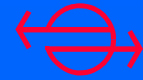
- Fit for purpose (flexible)
- Management with technical expertise
- First, second & third opinions
- Making use of experience generated at other projects (site visits, trails)



Contractfilosofy TBM

- E/C- contract:
 - Detail design of lining
 - Detail mitigating measures
 - design TBM
- Target price:
 - Contractor price: part fixed, part variable
 - Incentives
- Basic risk spread (BRT)







REDUCING THE RISK PROFILE

Contracts.

- Philosophy: 13 main contract clusters
- Contract form: E/C & (modified) RAW
- Contract attitude:
 - Risk sharing & risk bearing
 - Responsibility
 - Trust



ENVIRONMENT

- Historical buildings:
 - Assessment of condition
 - Developement of settlement limits
 - Mittigation measures
 - Early warning system (monitoring)



ENVIRONMENT

- Lack of (public) space:
 - Choice of construction methods
 - Phased construction
 - Construction of additional space



ENVIRONMENT

- Inhabitants:
 - Communication
 - Central claim office



MONITORING SYSTEM



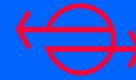
Base monitoring

Early warning
system

Contract control

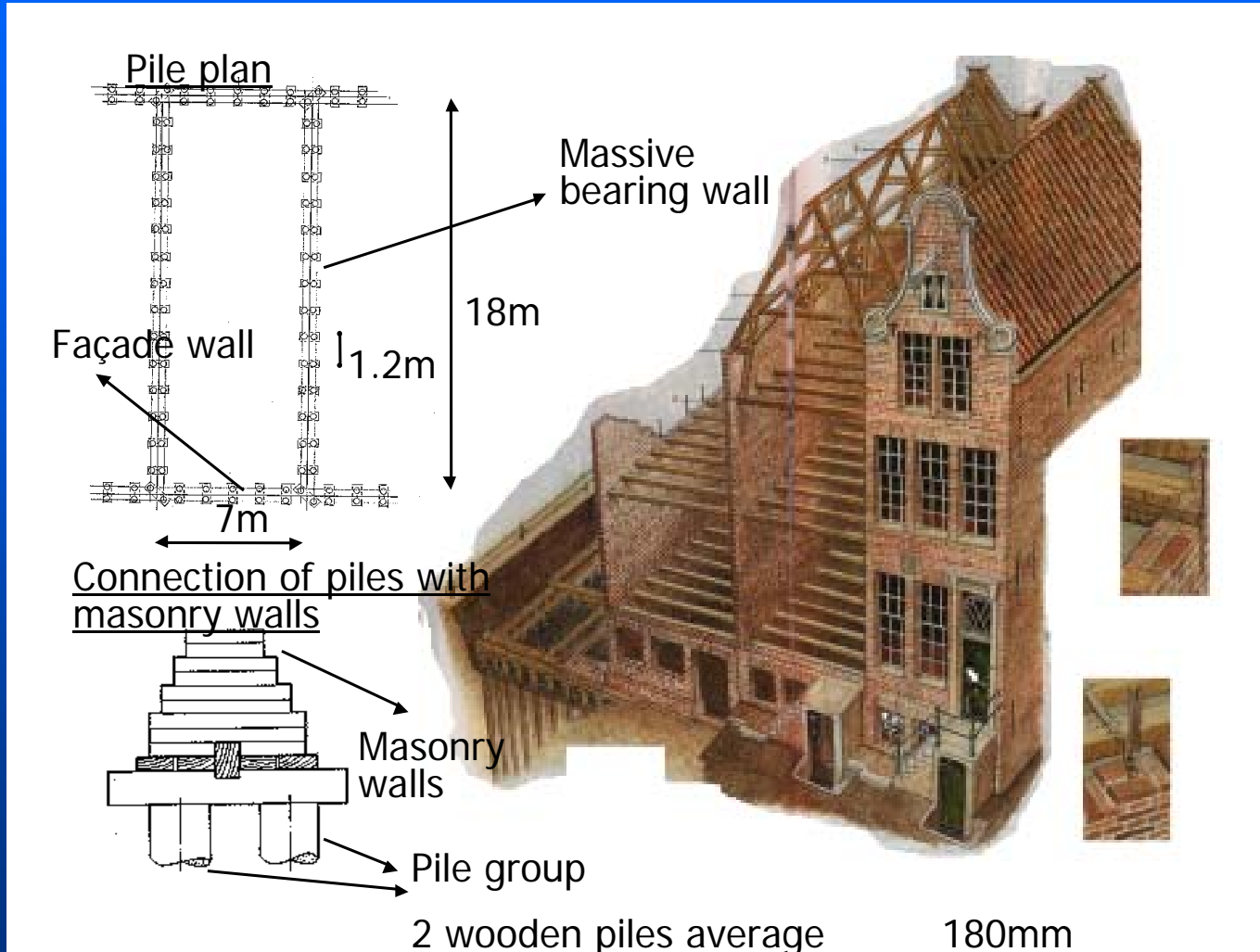
Assurance

Civil law



FOUNDATION INSPECTION







FOUNDATION INSPECTION

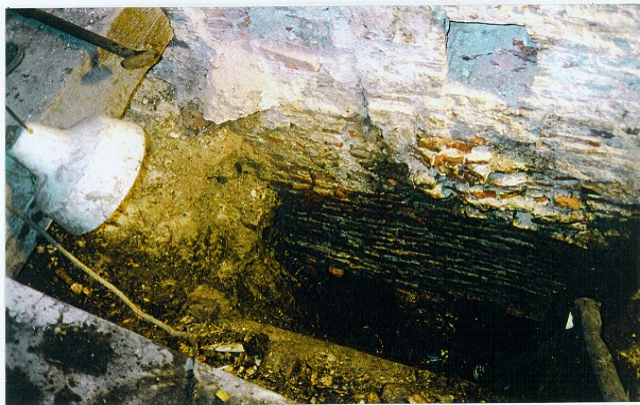


Foto nummer 2



Foto nummer 6





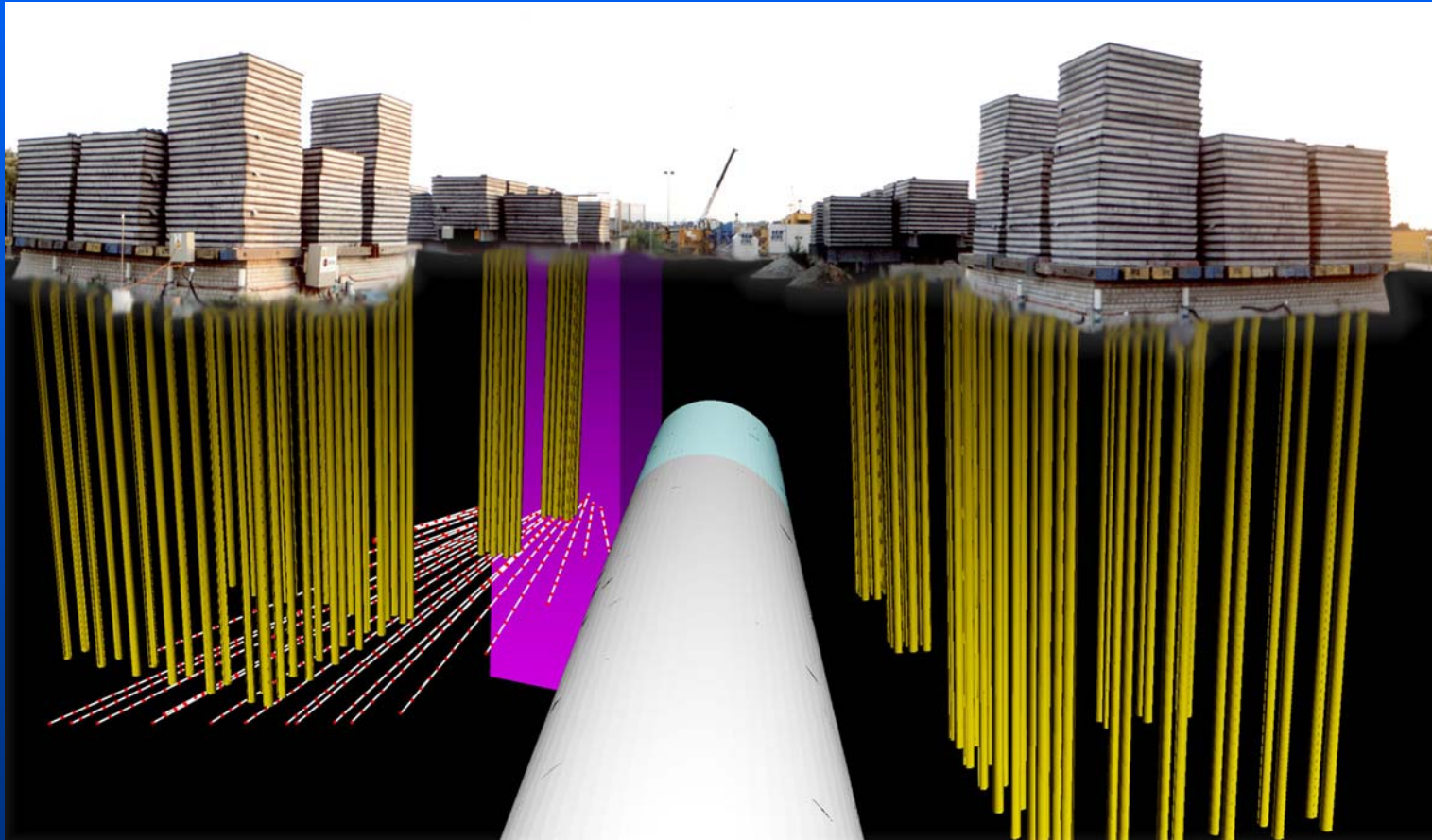
MITIGATING MEASURES

Three types of mitigating measures:

- Foundation renovation
- Real time compensating grouting
- Compensating settlements by hydraulic jacks



COMPENSATING GROUTING





ACTUAL SITUATION

- Most complex parts tendered
- 6 out of 7 contracts awarded:
 - Contractors are known
 - Participation of the contractors in detailed design started
- Foundation renewal in progress
- Monitoringsystem working



Q & A:
After the break