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Design Concept and Financing of the Light Rail Zagreb Project

2. CCC Symposium on
Concrete Engineering

Hradec Kralove,
September 21-22, 2006

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- 1. Introduction : concept of development
- 2. Structures on light-rail lines
- 3. Bill of quantities and cost estimation
- 4. Construction time schedules
- 5. Financing models
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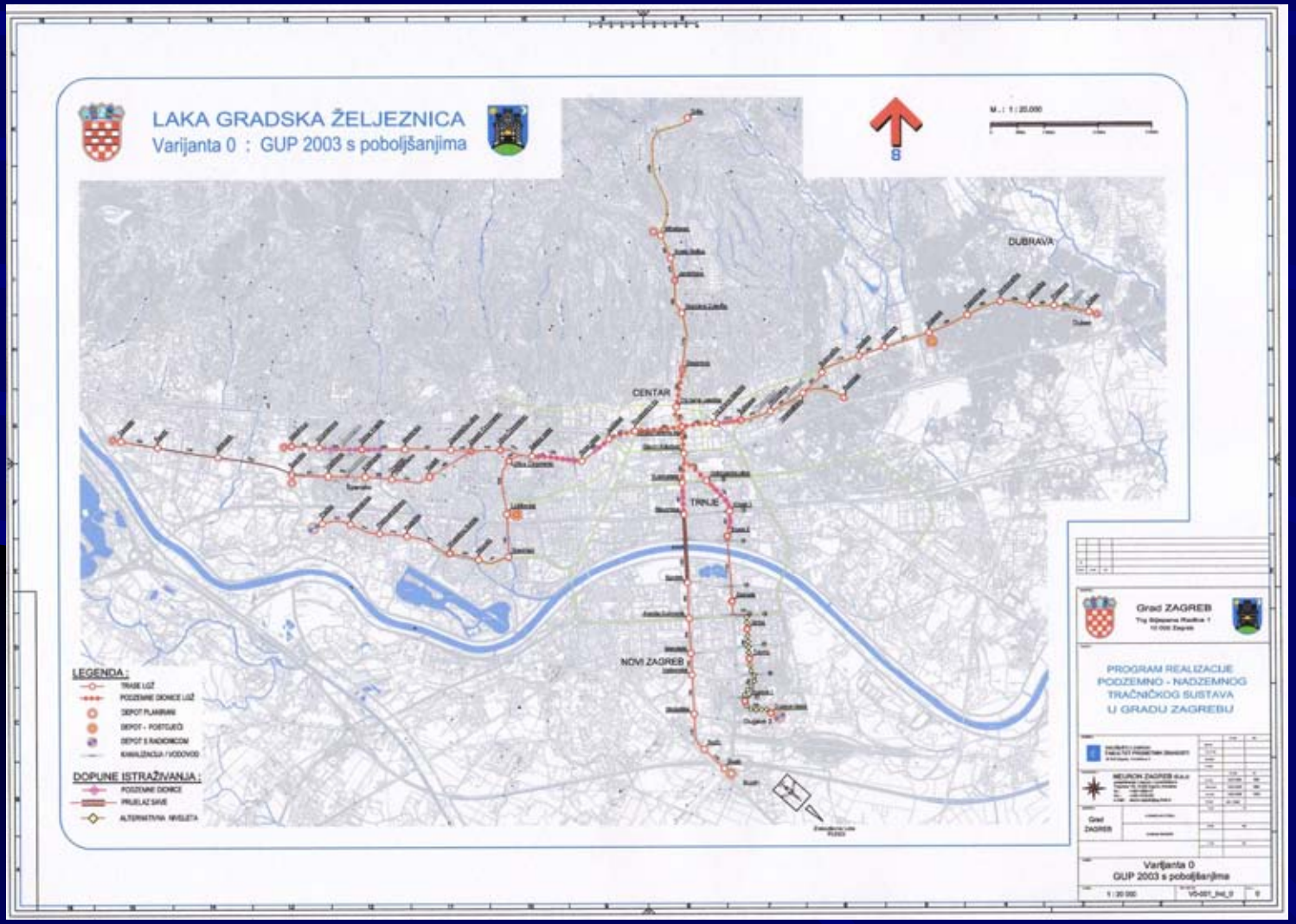
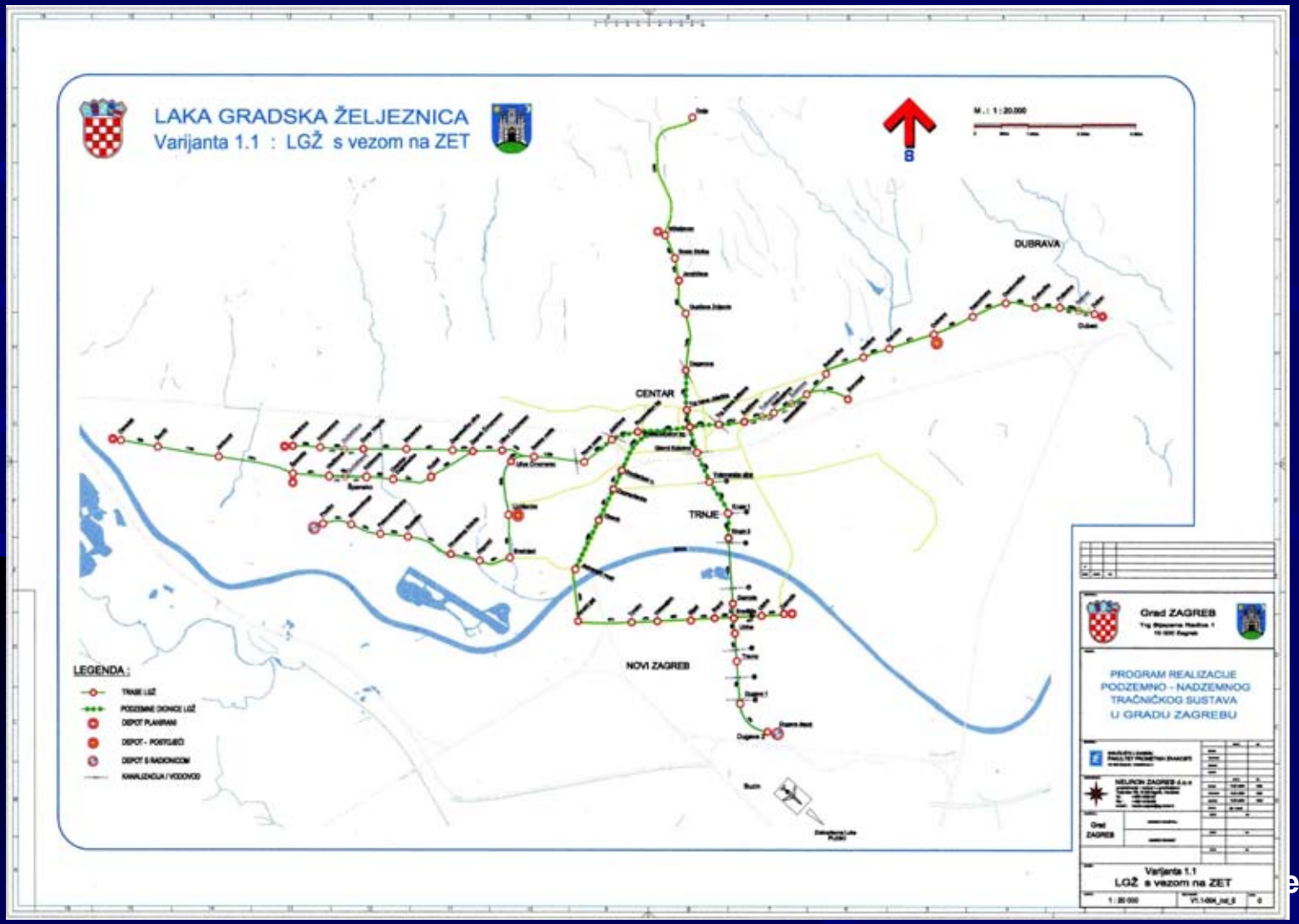
1. Development of alignment variants

Variant 0 : GUP 2003 with improvements



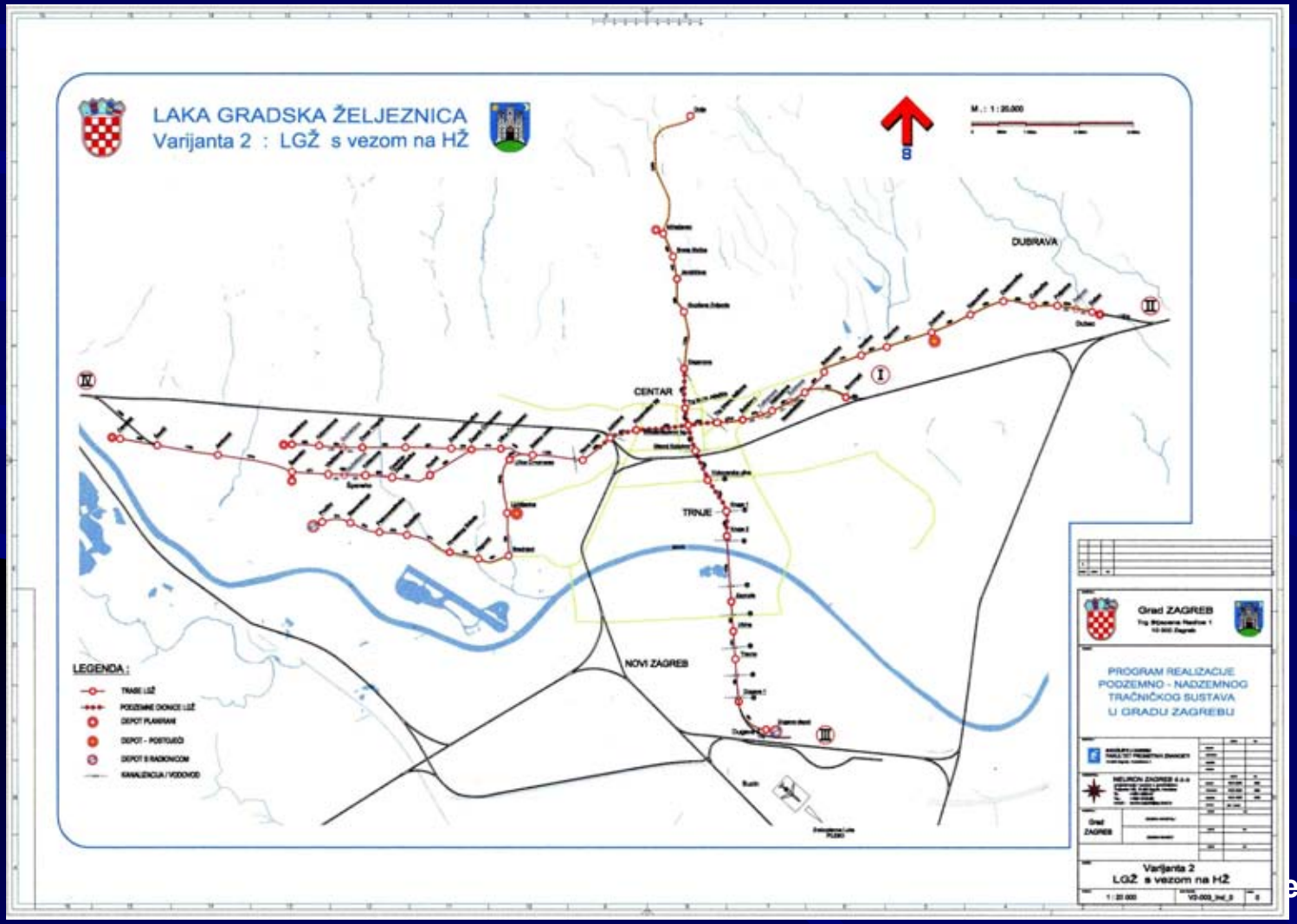
1. Development of alignment variants

Variant 1.1 : Light rail with tramway connection



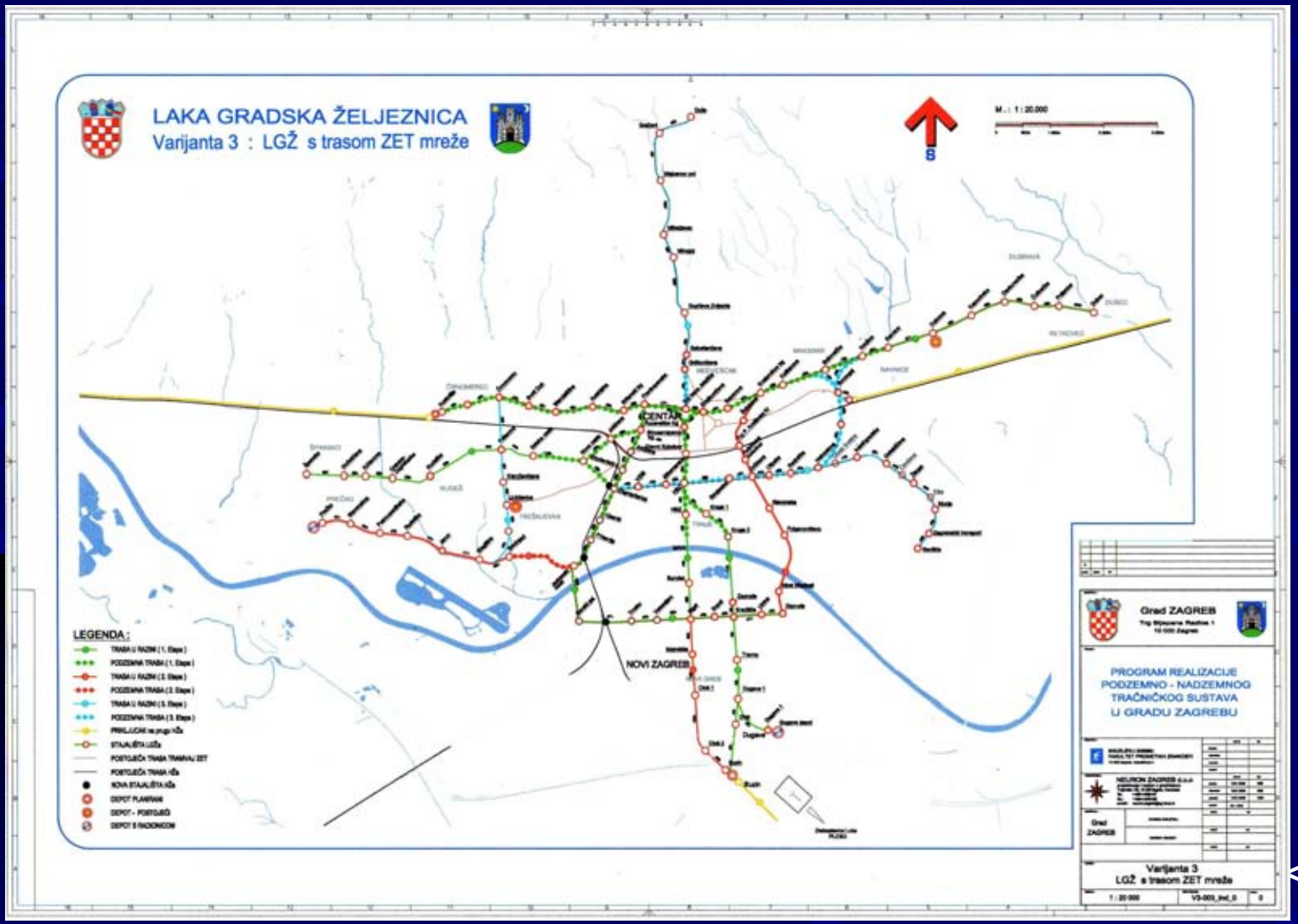
1. Development of alignment variants

Variant 2 : Light rail with railway connection



1. Development of alignment variants

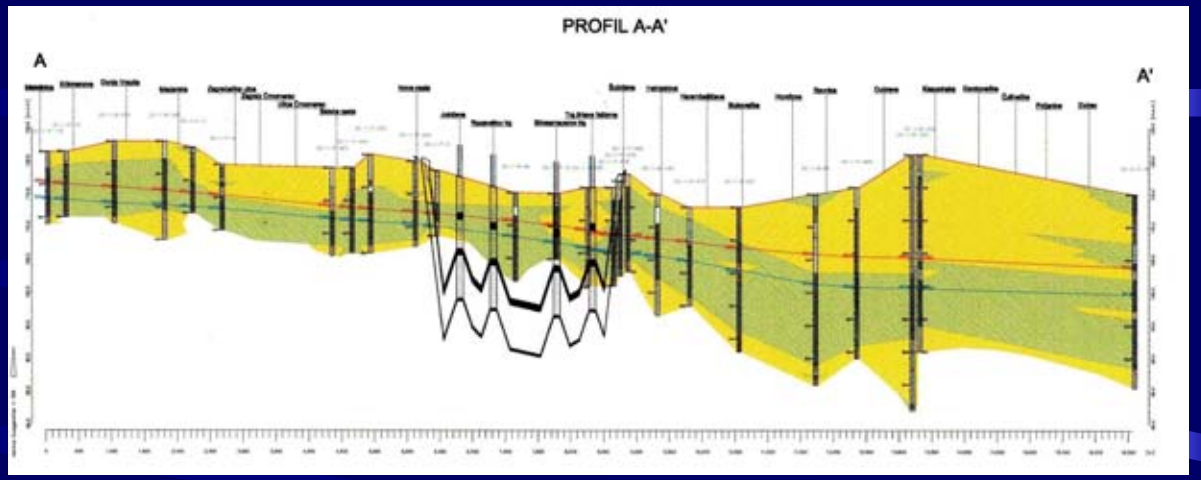
Variant 3 : Light rail on basic tramway network

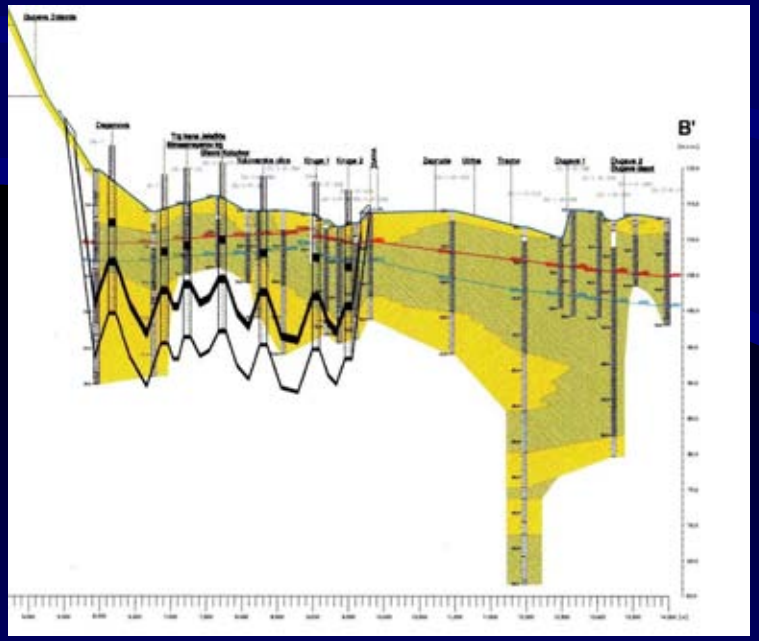


2. Structures on light rail lines

Hydro-geological longitudinal sections

East - West section



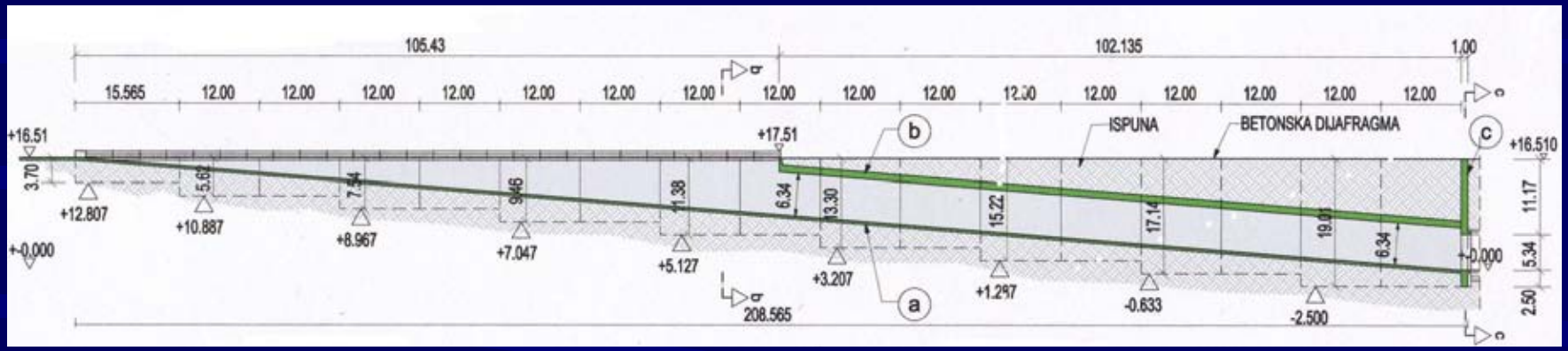


North – South section

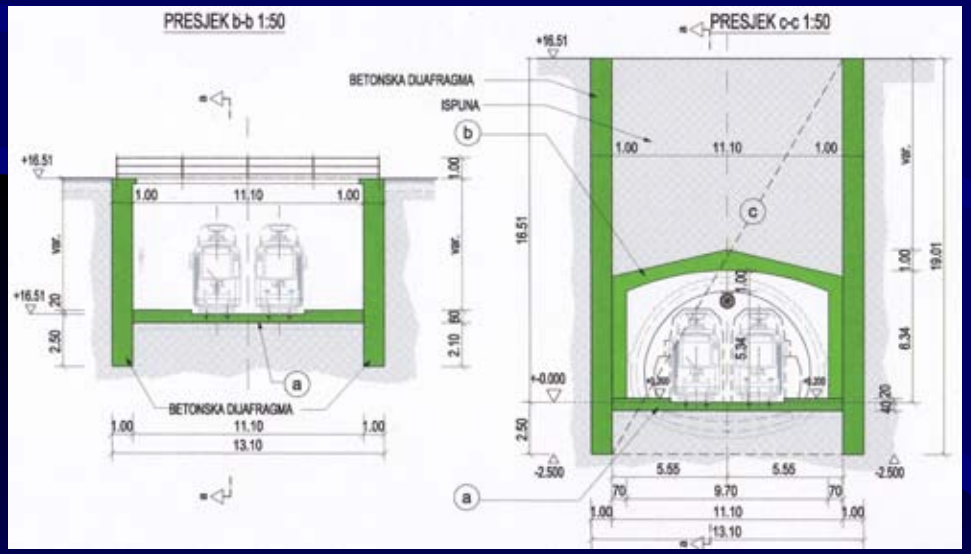
Required additional investigation works and deep boreholes on underground parts of the alignment.

2. Structures on light rail lines

Ramp to go underground



Ramp longitudinal section



Ramp cross section

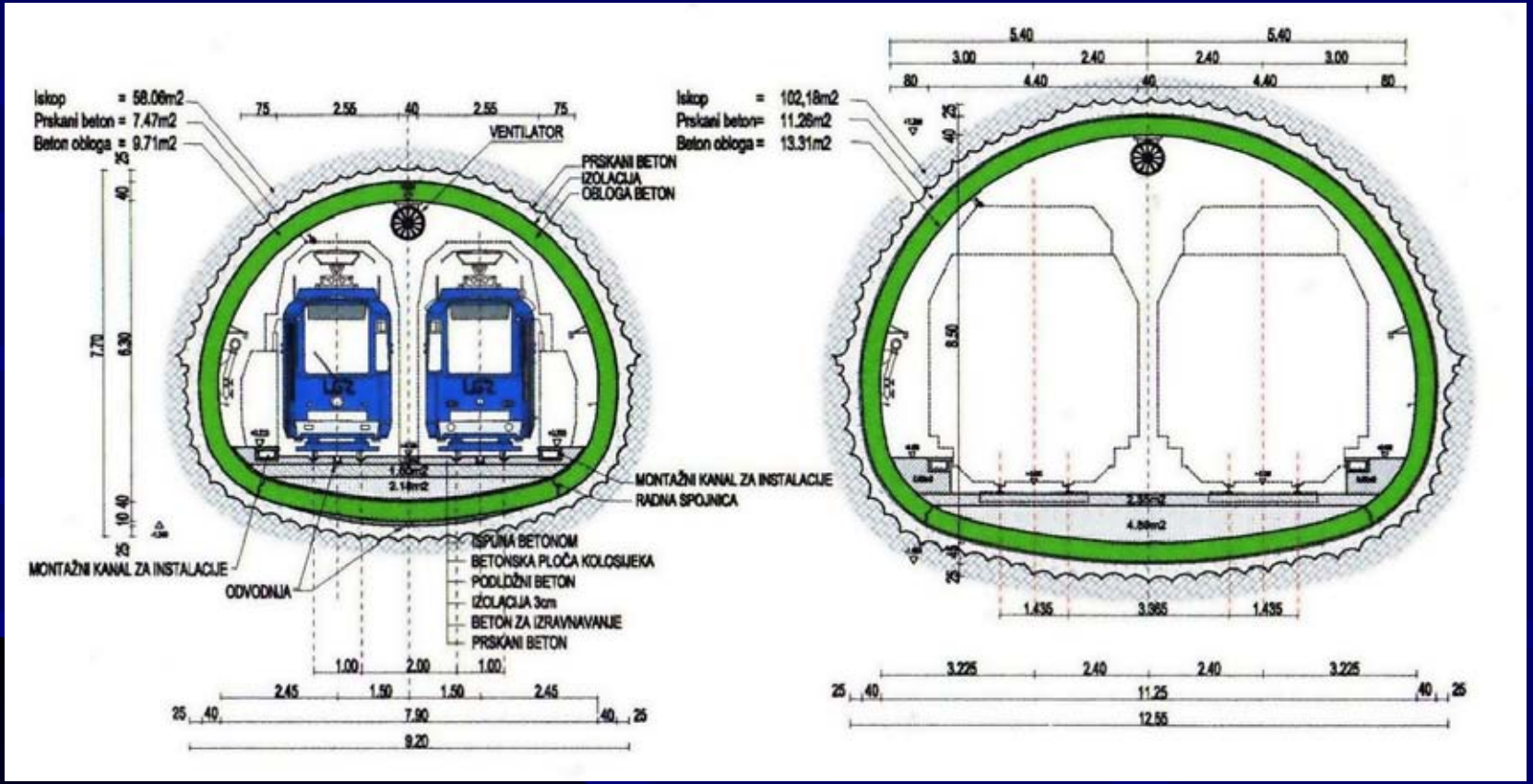
Construction costs :

1 ramp = 4.500.000 €

= 32 000 000 KN

2. Structures on light rail lines

Tunnels for underground parts of line



Double-track tunnel, gauge 1000 mm

Excavation area = 58 m2

Construction costs = 29.500 € / m

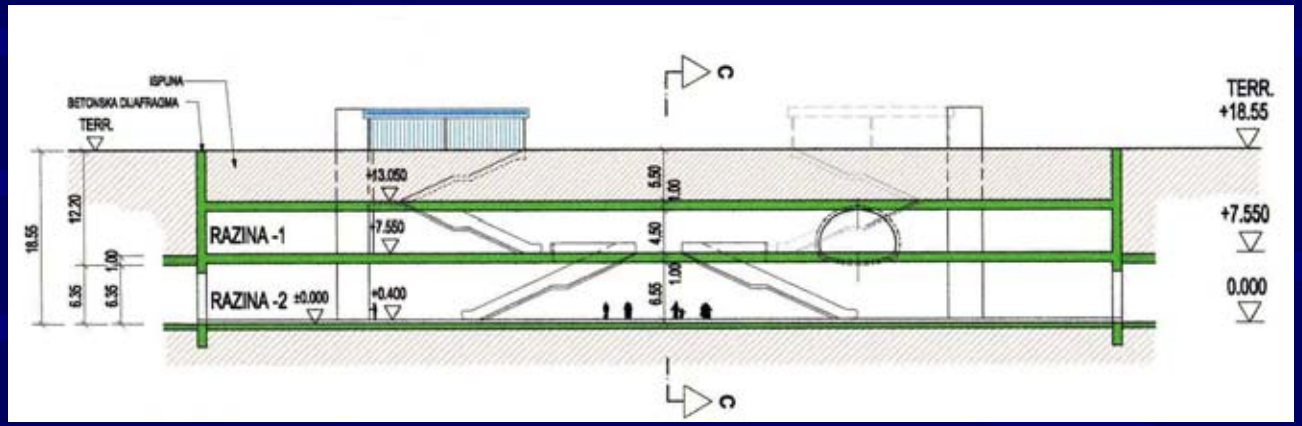
Double-track tunnel, gauge 1435 mm

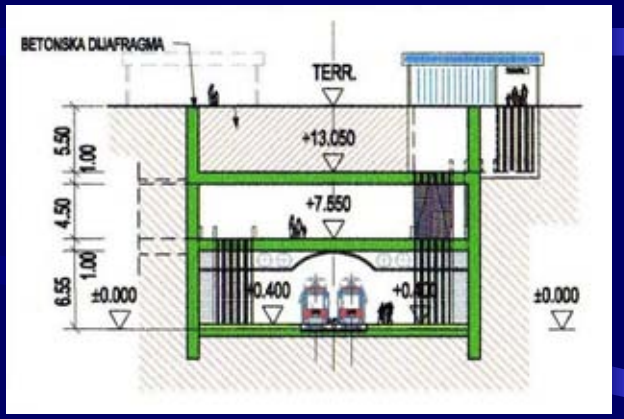
Excavation area = 102 m2

Construction costs = 47.500 € / m

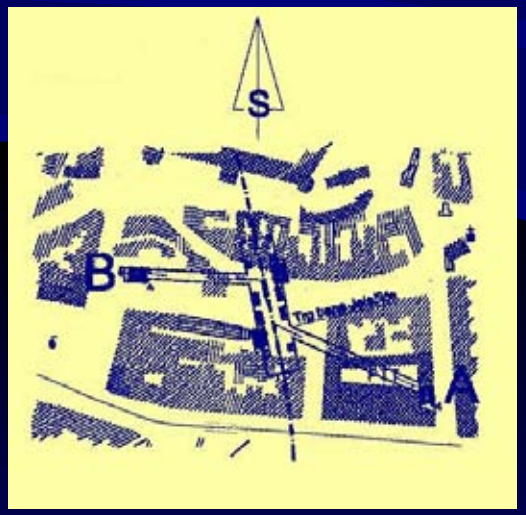
2. Structures on light rail lines

Underground station : Main square Zagreb

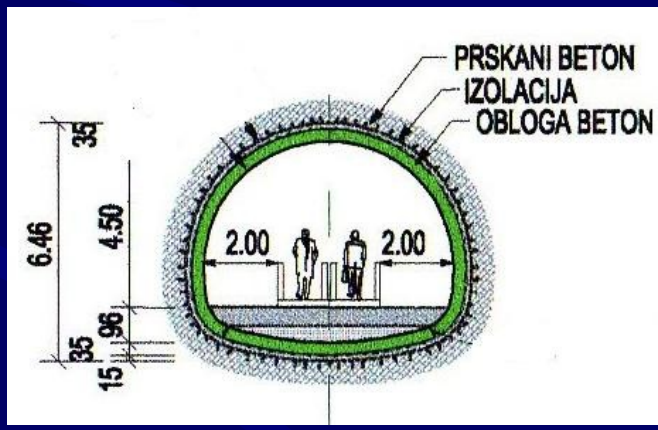




Sections through station



Pedestrian tunnel



location :

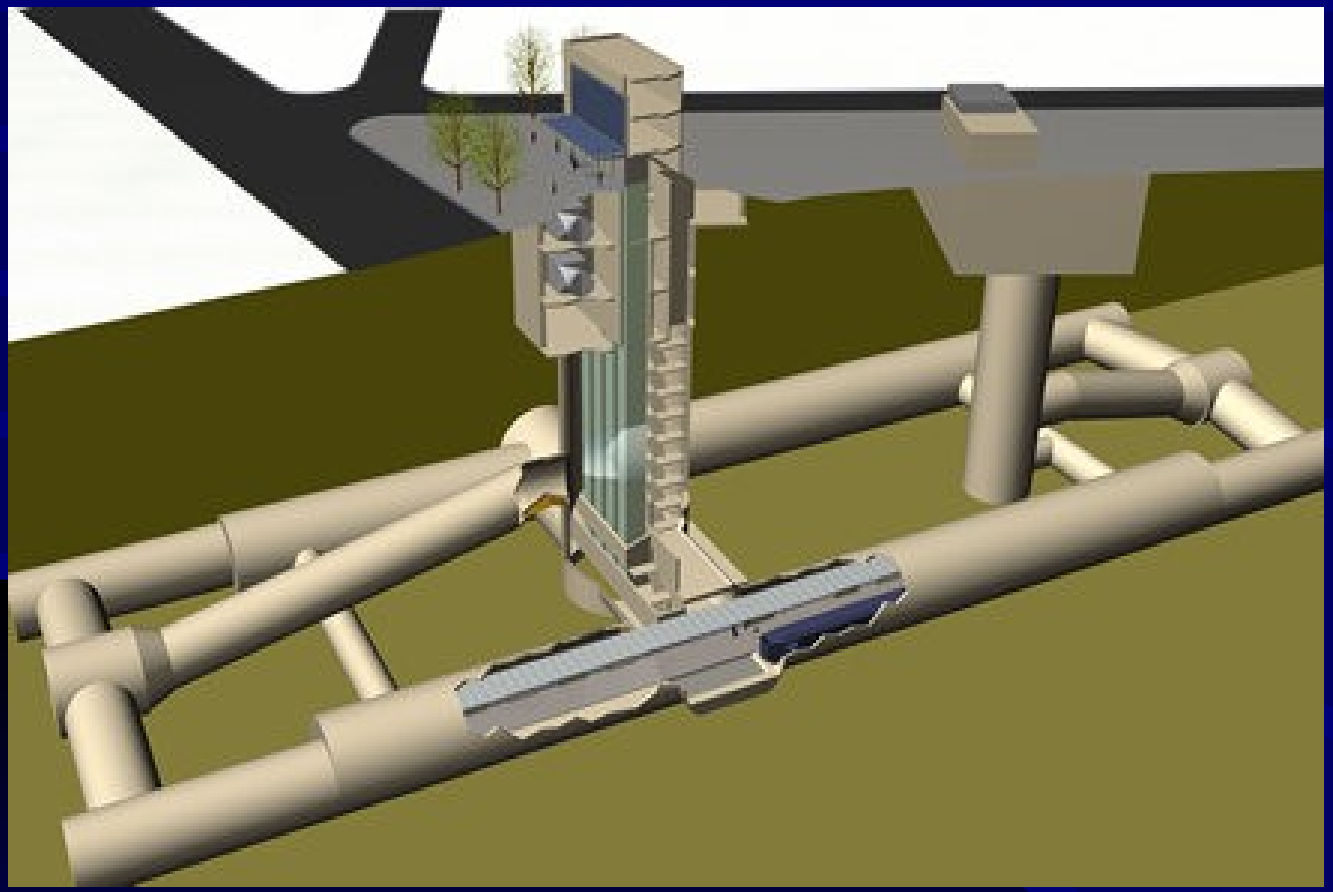
Cesarčeva-Getaldićeva

Construction costs = 5.500.000 €

= 41.000.000 KN

2. Structures on light rail lines

Underground station : Main railway station

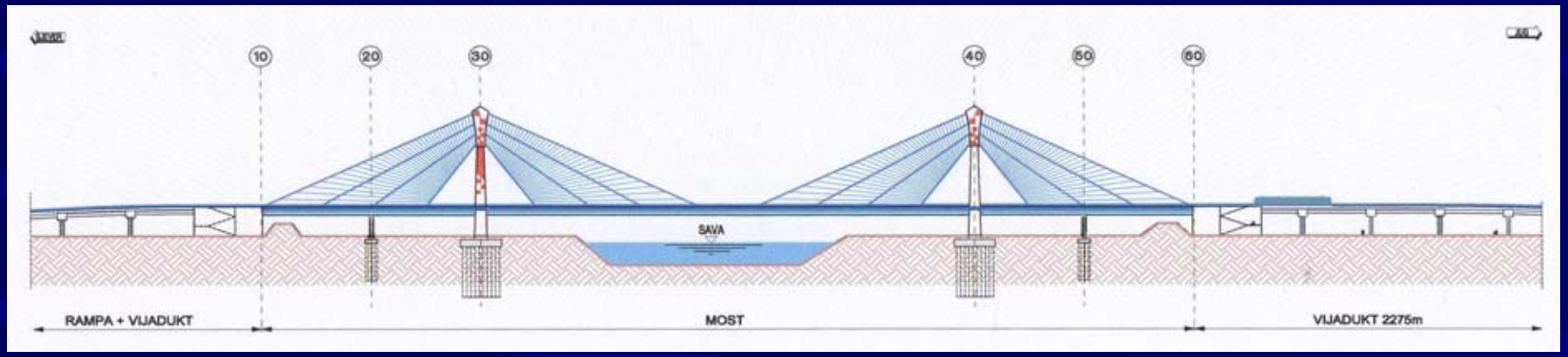


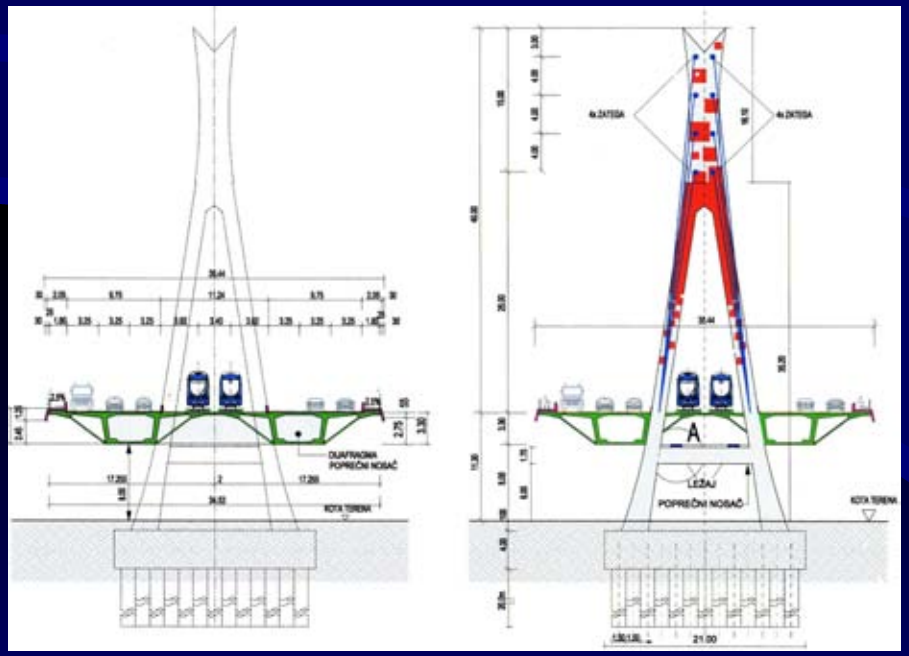
Example of underground station constructed using tunnelling techniques

Cost estimation relation:
top-down vs. tunnelling station :
Range 1:2 – 1:5

2. Structures on light rail lines

River Save crossing : Avenue of FR Germany





Longitudinal section L = 340 m

Cross section :

Main span and at the pylon

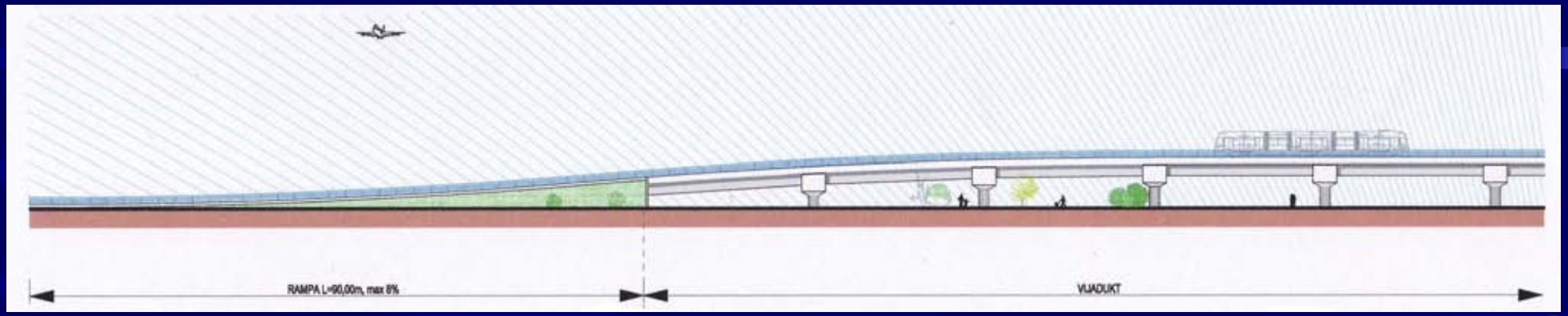
Construction time : 24 – 30 months

2. Structures on light rail lines

River Save crossing : Avenue of FR Germany

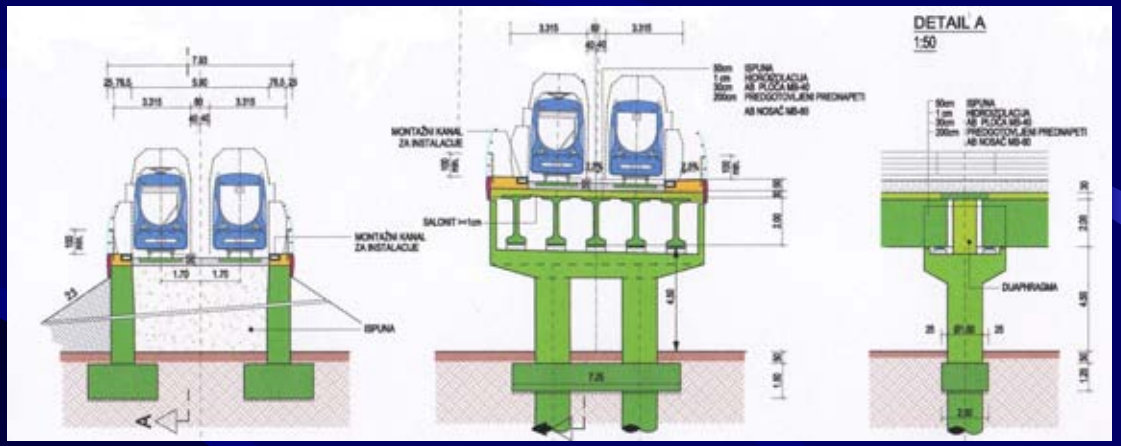
Cost estimation :
1.450 € / m2 = 17.500.000 €
= 130.000.000 KN

2. Structures on light rail lines



Longitudinal section ramp + viaduct

Cross sections : ramp + viaduct



Cost estimation :

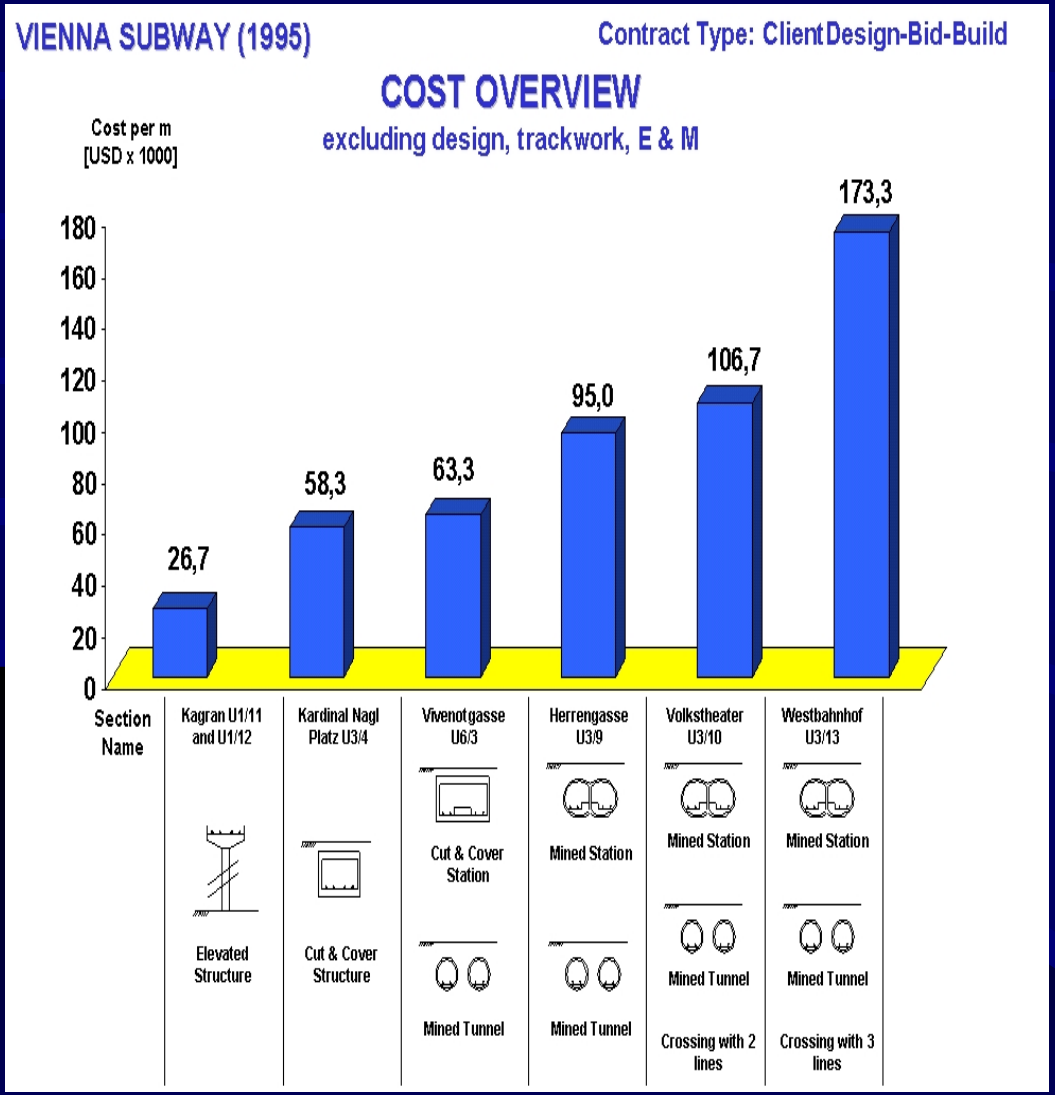
1.100 € / m2 => **15.000 € / m1**

(civil part) (with equipment)

Dubrava 2100 m = 3.150.000 €

N.Zagreb 2275 m = 3.415.000 €

3. BoQ and Cost estimation



Light rail Zagreb 2006 (with equip.) :

Double track, 1000 mm, on surface :
5.500 € / m1

Double track, 1000 mm, on viaduct:
15.000 € / m1

Double track, 1000 mm, in tunnel:
29.500 € / m1

Underground stations (top-down / tunnel):
5.500 000 -11.000.000 € / kom 1

River Save bridge :
17.500.000 € / 1 pcs.

4. Construction time schedule: east-west

1. phase: 2.6 km - 116.7 mill.€ - 24 mo..
2a phase: 2.7 km - 15.2 mill.€ - 8 mo.
2b phase: 2.4 km - 98.9 mill.€ - 24 mo.

3a phase: 3.5 km – 22.3 mill.€ - 10 mo.
depot Španska : 20.000.000 €
3b phase : 2.3 km – 15.5 mill.€ - 7 mo.

4. Construction time schedule : north - south

2. phase: 3.3 km – 136.4 mill.€ - 30 mo.

3a phase: 1.8 km – 41.0 mill.€ - 24 mo.

3b phase : 2.1 km – 26.0 mill.€ - 12 mo.

depot Dugave : 20.000.000 €

5. Financing models

- For public infrastructure projects : from private or public financial sources
- Involvement of public institutions is required : city, region, state or state companies

- **„Traditional“ public financing**
- Loans from international financing institutions (IBRD, EBRD, EIB) or banks
- Better conditions, lower interest rates, grace period, long contracting period
- State gurantees needed, Croatian foreign debt of 82.9 % of BNP

- **Private financing by concession (BOT : “build-operate-transfer”)**
- “Private financial resources” from banks
- Public partner is the owner after concession period (20 or more years)
- Concession company returns investment during concession period

- **Private financing based on PPP models (public-private partnerships)**
- Financial feasibility to be investigated at very beginning
- Public partner is the owner during whole time period of the project
- Concession company = private partner = is paid by public partner

6. Conclusions

- **Further project development in phases**

- **Project documentation of 2nd phase**

- Tehnical documentation, preliminary design
- Environmental studies
- Risk analysis for technical, environmental and economical parts
- Fesibility study
- Traffic studies for different project phases
- Ownership and legal procedure matters on future corridors
- Additional geotechnical investigations